MindLink

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CENTER FOR INTEGRATIVE AND DEVELOPMENT STUDIES

MindLink

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Foreword

In this publication, we hope to preserve for future reference the various perspectives and insights on academe-industry collaboration in Science and Technology (S&T) expressed by the academic, industry and government participants in three MINDLINK conferences from 2000 to 2001 on Information and Communication Technology (ICT), Biotechnology and Education Technology. These three areas are among the most-talked about sectors of innovation in our time.

Many contributed time, effort, creativity and financial resources to make MINDLINK possible. The staff of the UP Diliman Information Office (UPDIO), in particular Ms. CHI IBAY and Ms. AILEEN FAMILARA took care of the communications and media campaigns. Professor RUBEN D. F. DEFEO and Mr. DENES DASCO coined MINDLINK and designed the logos. The staff of the Vice President for Development—EDMUND CAMELLO, NELDA GUTIERREZ and LOLIT VICTORINO—contacted the participants, funding organizations and guests. Many firms and organizations contributed financial resources. Since they are too many to mention here, there are listed at the end of the book.

The Center for Integrative and Development Studies (CIDS) made the publication of the book possible. The CIDS staff and Dr. MA. CARMEN C. JIMENEZ did not give up on the publication of the conference proceedings even during times when the organizer made himself scarce because of other commitments and the difficulty in getting written versions of the conference talks completed. Ms. IBAY did most of the work in getting the written versions of the talks completed. Vice President for Academic Affairs MA. SERENA DIOKNO edited the articles in MINDLINK 1, the introduction and the wrap up article. The UPDIO edited the articles in the second and third MINDLINKS.

We acknowledge with appreciation President FRANCISCO NEMENZO's encouragement, support and participation throughout the MINDLINK series. Since UP was the host of these conferences, the active cooperation of various academic departments, in UP Diliman and UP Los Baños in particular, were crucial to the success of the activity. Last and decidedly not least, Prof. JOSE A. MAGPANTAY and the National Institute of Physics deserves the largest credit for initiating, planning and implementing the entire project, including its publication. For a theoretical physicist, his interest and success in this mundane endeavor seems all the more commendable.

Prof. RAFAEL A. RODRIGUEZ
Vice President for Development
University of the Philippines

Why *Mindlink*?

When the Americans established the University of the Philippines in 1908, the early presidents clearly enunciated the goal of a public national university. In their inaugural addresses, Mr. MURRAY BARTLETT, the first president, and Mr. GUY POTTER BENSON, the third, declared that the purpose of the university is to achieve a balance between **national needs**—"the efficient training of efficient workers who shall be leaders of their people in the development of a strong national life"—and **world-class scholarship**: "If, then, we are to measure up to world standards, as directed by our charter; if we are to build up an institution which shall be credit to the Philippine Islands in the intellectual world, the spirit of research must find a wide sphere in this University."

Today, as we are about to celebrate the University's centennial, it is necessary to reflect on the University's performance in meeting both goals. With respect to the first, the fact that many of the country's leaders in the public and private sectors are alumni of the University lends credence to the view that the University has performed creditably in providing national leadership. On the other hand, these leaders have spanned the entire spectrum from crooked to honorable. The unsavory reputation of some of them and the apparent failure to develop a strong national life (compared to other countries in the region) have caused the University to reflect periodically on its record of service.

As for the second task—the development of a vigorous intellectual tradition up to par with international standards—the University's performance has been less than successful. The proof abounds in low publication rates in ISI (Institute for Scientific Information) journals and even lower citations of University researches in international

journals. (That UP has done far better than other Philippine universities offers little consolation.)

More than the statistics, the publication rates reflect the near absence of a culture of scholarship and research in the University today. Hence in 1999, President FRANCISCO NEMENZO established the Academic Distinction Program to provide attractive monetary incentives and recognition programs for UP authors of international refereed publications, and the Creative and Research Scholarship Program to award creative and research grants to faculty and research staff on a competitive basis. The positive response to these incentives and the significant increase in publications are hopeful signs that a culture of scholarship is taking shape. The best measure, of course, will be when the faculty continue to research as a matter of course, with or without incentives. The ideal here is obvious: scholarship is (or ought to be) its own reward.

Part of the reason for the University's present state stems from the dichotomy that evolved between the two closely intertwined functions of service to national needs and excellent scholarship. This dichotomy in turn explains why the University has not progressed from a teaching university to *both* a teaching and research institution of excellence. The fact is that service combined with weak scholarship is true disservice to the nation, just as "ivory tower" scholarship denigrates the public role of the University. The pitfalls of this dichotomy are evident (and endless). Students learn facts and book knowledge (which are easily forgotten when they join the real world) from professors who stand at a distance from the frontier of knowledge. These professors are hardly in a position to impart enthusiasm, a hunger for knowledge and the culture of doing things right (the way things ought to be done) since they themselves are not active in the production of knowledge. True, UP students have become leaders in the public and private arena. But how many have become genuine innovators and agents of change? It is not an accident that only a few important products and processes crucial to

the competitiveness of the economy have been developed locally. Even today, foreigners continue to own most of the patents in the country.

The sorry state of science and technology (S&T) and the domestic economy should not be allowed to continue lest our children inherit our present role in the international division of labor. The University needs to take on another goal that is supportive of and complementary to the two objectives defined at the outset, and that is to participate directly in the country's wealth generation activities. This is a role necessitated by the global economy, which in turn is driven by rapid developments in S&T. Since universities even in developing countries have the most advanced human resources in S&T, they are in the best position to lead their countries' efforts in establishing niches of future economic growth.

It seems ridiculous to propose yet another task to an institution that has had difficulty carrying out its main tasks. Another aggravating factor is the adversarial attitude of some in the University toward commercialization (a dirty word). While the University is one in rejecting commercialized education, a distinction must be made between the commercialization of its assets (land and income), and the commercialization of education (pandering to the market at the expense of academic standards and merit). Those who wrongly equate the two also insist that the national government shoulder all of the University's funding requirements—an unrealistic scenario now and in the foreseeable future. Not only does government have to address competing social claims against severely low revenue collections; it, too, has to battle corruption, bureaucratic inefficiency and inconsistent (sometimes self-defeating) national policies that block development. Inadequate support for the University is itself a vivid example of the problems that ail Philippine society.

The University can sit back and wait for the problems of Philippine society to be resolved, expecting that as a result of this development, more money will be placed into education. But this track is not only unlikely; it is also artificial. There is no way the University can be isolated from Filipino society; the relationship between them is

fundamental and reciprocal. The superior, indeed sole, option is for the University to actively raise support for its academic programs by entering into partnerships that help create knowledge *and* generate wealth. It would be a mistake to assume that the requirements of such an endeavor are essentially commercial. In fact, the partnership between academe and the private sector rests primarily and predominantly on academic requisites.

Consider the example of universities abroad that have successfully participated in resource generation. Their principal means are intellectual properties, solid products of strong, vibrant research programs not only in the sciences but also in business, humanities and the social sciences. These institutions of higher learning have been able to produce results because of a well-entrenched culture of scholarship and rigorous hiring and promotion policies. Some examples are Stanford University (Silicon Valley), Massachusetts Institute of Technology (Route 128), Tsukuba University (Science City), and the Indian Institutes of Science, Information Technology, and Management (Bangalore).

The strong correlation between engagement in wealth generation and strong academic and research programs is easily explained by the fact that both activities require doing things correctly—avoiding egregious shortcuts and not compromising standards for immediate gain. More importantly, both activities feed each other symbiotically. Solid research and academic programs result in more intellectual properties, which can then be used to generate the resources needed to conduct further explorations of knowledge. At the same time, a strong wealth generation activity will enable the university to attract the best and most promising scholars who can strengthen academic and research programs.

The benefits from this symbiotic relationship extend to learning in the classroom and laboratories. Students will be taught by professors deeply steeped in scholarship. These students will acquire, at least by example and through osmosis, the culture and value of doing things right, which they will take with them to the real world and enable them to become innovators and agents of meaningful change.

Skeptics may point out that this kind of institution of higher learning may just churn out graduates who are good in the sciences, engineering and business but are weak morally and indifferent to the larger needs of society. This is a valid concern and is not easy to address. But the challenge is not insurmountable. A strong liberal education program should address this concern by broadening the world of the student beyond his or her own limited community and developing social awareness. Although the University cannot always undo values and attitudes formed in the home, its influence is significant and excellent teachers have been known to leave an indelible mark on their students.

There is one problem, though, with the proposed participation of the University in generating resources, and it is a major one. The University is not good in business. Supported by public funds, the University grapples annually with reduced budgets though it is assured of its basic subsidy. Also, UP professors, even in business and economics, tend to have an academic rather than practical view of the market. Thus, if the University is to participate in the country's wealth generation, it must reach out to the private sector. The University may possess the expertise and research facilities in the sciences, engineering and other areas; its professors may have a clear reading of where future developments might come from. But without knowing what works and clicks in the market, the University will not succeed in this goal. The private sector, on the other hand, knows the market because they compete in it but do not possess the University's varied expertise. The answer, then, lies in collaboration between industry and the academe.

What is the best type of industry-academe linkage? One must bear in mind that the purpose of the linkage is resource generation but not at the expense of the other two functions of the University. The University's participation in the market must be consistent with its character as an institution of higher learning, which can be realized by establishing a Science and Technology Park (STP) on University land. Close to the University, the STP will serve as the arena in which the University makes optimal use of its intellectual properties.

The STP is also where the private sector can interface with an institution of higher learning without unduly interfering in the University's main functions and cherished academic freedom. At the same time, an academic who agrees to work in the Park must accept the private sector culture and work ethic. Thus, an STP is like a buffer zone in the University where academics and entrepreneurs collaborate to create new products, processes and services that respond to particular market needs. Since the basis of collaboration is the academe's technical expertise and the entrepreneur's knowledge of the market, the resulting product, process or service is innovative and responsive to identified needs. The result of the collaboration may not have a big market in the beginning and may require a long gestation period before large-scale commercial success is achieved. The important thing is that entrepreneurs who make extensive use of S&T have a place where they can try out their ideas in collaboration with similarly minded academics.

Furthermore, the STP can enrich the University's academic offerings. In the present set-up, students from the Colleges of Science and Engineering learn mostly technical knowledge and almost nothing of entrepreneurship. Students from the College of Business Administration, on the other hand, learn very little technology and practical knowledge of technology-based enterprises. While it is true that a practicum course or on-the-job training can address these shortcomings, the presence of an STP will provide a rich training ground for the students of these Colleges on entrepreneurship in technology-based businesses. The experiences of the firms in the STP can be used as case studies in courses. It is not far-fetched that some students may even try their luck in putting up small technology-based businesses in the STP.

In the particular context of the University, there is another important reason for establishing an STP. The salary standardization law makes the University's salary scale uncompetitive with that of the private sector in education and industry. As a result, the University has had difficulty retaining its competent faculty. Some of those who stay augment their income through private consulting work, which takes them away from

the University. In the long run, academic and research programs could suffer, which would eventually lead to a marked decline in the University's reputation. The STP solves this problem by allowing faculty members to serve as industry consultants or set up their own businesses within University premises. At the very least, this arrangement would reduce the travel time of the faculty for his or her limited practice of profession. At best, the faculty will be able to commercialize the intellectual property developed in the University, which would also bring in revenue for the University.

For these reasons, the University, under President NEMENZO is determined to establish the STP. The first phase of the Park is the "Joint Experimental Facility for Technology and Technology-Based Entrepreneurship" (JEFTTBE), an undertaking with the Ayala Foundation. The immediate goal of the first phase is to stop the University's escalating losses in the operation of the Technology Business Incubator (TBI), which was established with a small grant from the Department of Science and Technology in 1994. Because the TBI concept was poorly executed, the University was losing about P70, 000 a month in 1998-99. Thus during the term of President NEMENZO (2000), the University entered into an agreement with the Ayala Foundation to establish the Joint Facility. The Ayala Foundation is an excellent choice as partner because it is a non-profit organization that can rely on technical support from the Ayala group of companies. Also, among the new crop of business leaders, JAIME AUGUSTO ZOBEL DE AYALA stands out as among the most technology-oriented, being a strong proponent of wireless telecommunication, information technology and the semiconductor industry in the country.

Amid these developments MINDLINK was conceived as a meeting of ideas from industry and UP on information and communication technologies (ICT), in part to inaugurate the JEFTTBE. However, before the conference was held, MINDLINK had evolved into something bigger: a venue primarily for industry and academe to discuss scientific and technological developments relevant to the market, industry concerns

and governance issues. Government was now to play the role of listening to the two sectors, explaining official programs and policies, and stating government's position on controversial issues related to these technologies. The reason for this rather minimal role is explained by the general objectives of MINDLINK, namely:

- For academe to show industry what it does today and can do in the near future in various technology areas.
- For industry to point out to academe the technologies they are interested in and the technical problems they face in their businesses, and to voice out to government their particular concerns.
- For the meeting of the minds to pave the way for mutually beneficial collaboration—joint venture, technology-related consulting, licensing agreement, etc.—between industry and academe, with the knowledge and support of government.

To date there have been three MINDLINK conferences: Information and Communication Technology (December 13, 2000), Biotechnology (September 7, 2001), and Education Technology (September 28, 2001). These technology areas were selected because of their long-term importance to the national economy and the contribution of the University in all three areas. The country's participation today in the broad area of ICT is primarily in the low value adding segments of the business. In semiconductors, the multinationals in the country engage mostly in assembly and packaging of microprocessors, memory chips and digital-signal processors while they do design and manufacturing in their home bases and elsewhere. There are MNCs (Multi National Companies) that assemble desktops and laptops, produce storage devices, peripherals and power supplies but local firms are primarily into contract manufacturing for some MNCs. The same is true of electronic consumer products, a sector controlled by MNCs or by local firms doing contract production for other MNCs.

We do have a profitable telecommunication industry because of the boom in wireless communication, in particular, the short messaging service. However, the technologies used—cell phones, standards, equipment and even billing systems—are all imported. In terms of software, we are mainly users of operating systems (Windows, Linux), middleware (graphical user interfaces, communications software, languages) and application software (word processing, database applications, presentation graphics, etc.). In IT services, the labor intensive sector of the business stands out, such as call centers, backroom operations of banks and data transcriptions.

In the ICT area, the University has three academic departments and an interdisciplinary program in UP Diliman that could collaborate with industry, namely, the National Institute of Physics (NIP) of the College of Science, the Computer Science (CS) and the Electrical and Electronics Engineering (EEE) Department of the College of Engineering, and the Material Science and Engineering Program of the two Colleges. Their degree programs are good and their faculty members have the academic credential, extensive consulting experience and links with the local ICT industry.

The second area of collaboration, Biotechnology, is one in which several constituent universities in the UP System have academic programs. The Los Baños campus, through the Institute of Plant Breeding, Institute of Biotechnology and College of Veterinary Medicine, focuses on agricultural biotechnology. UP Manila, through the Colleges of Medicine and Pharmacy, works on medical and pharmaceutical biotechnology. UP Diliman's Marine Science Institute works on marine biotechnology, while the National Institute of Molecular Biology and Biotechnology and the Natural Sciences Research Institute work on the basic science of molecular biology and gene mapping. UP Visayas focuses on aquatic biotechnology and UP Mindanao recently started its program on agriculture biotechnology. The University is thus fertile ground for collaboration with industry in the field of biotechnology.

The important developments in this area relate to recombinant DNA techniques. Unfortunately, the country is still in the traditional or classical areas. The big agricultural firms, which are mostly in Mindanao, do work at the level of tissue culture while others are into biopesticides, biofertilizers and diagnostics for plant diseases. In the veterinary field, the country has very limited capability. Only few animal vaccines are produced locally, and the diagnostics that are developed in the country, such as those for mycotoxins and red tide, have yet to be commercialized.

Moreover, the local pharmaceutical industry still does not have the capability to produce the active ingredients of drugs. In biomedicine, we possess the capability to produce herbal drugs but not the bioactive therapeutic proteins such as alpha interferon and insulin. Monoclonals, bioactive peptides and effective biotech drug delivery systems are not produced locally.

As for food, the local industry is capable in the traditional fermentation and preserving processes, but does not have genetic engineering capability to improve the starter culture. Neither has the country developed the capability to genetically engineer enzymes, which are used extensively in food processing.

Education technologies fall into two main areas: instructional and learning technologies. Instructional technologies refer to the ICT technologies used by the educator to facilitate the transfer of knowledge to students. These include telecommunication networks (Internet), authoring (Multimedia Toolbook) and presentation (Powerpoint) software, instructional delivery systems (video conferencing), and instructional management systems (on-line registration, etc.). Learning technologies, on the other hand, refer to the ICT technologies that enhance the student's learning capacity and include learning appliances (desktops, laptops), learning ware and computer tutors (interactive CDs), virtual reality and simulation technologies (flight simulators, etc.). Clearly, these technologies have sprung from developments in the ICT area and are causing a paradigm

shift in education from the present "sage on the stage"—classroom learning with fixed schedules and set standards—to the future "guide on the side," anywhere, anytime, customized lifelong learning.

However, the major ICT technologies used in Philippine education, whether hardware, software or networking, are all imported. Courseware in the fields of science, mathematics and engineering are also imported, reflecting the low level of science and technology in the country. But there are institutions that develop teaching materials and modules up to the tertiary level although these are mostly of the traditional kind and make little use of the multimedia technologies available in the market.

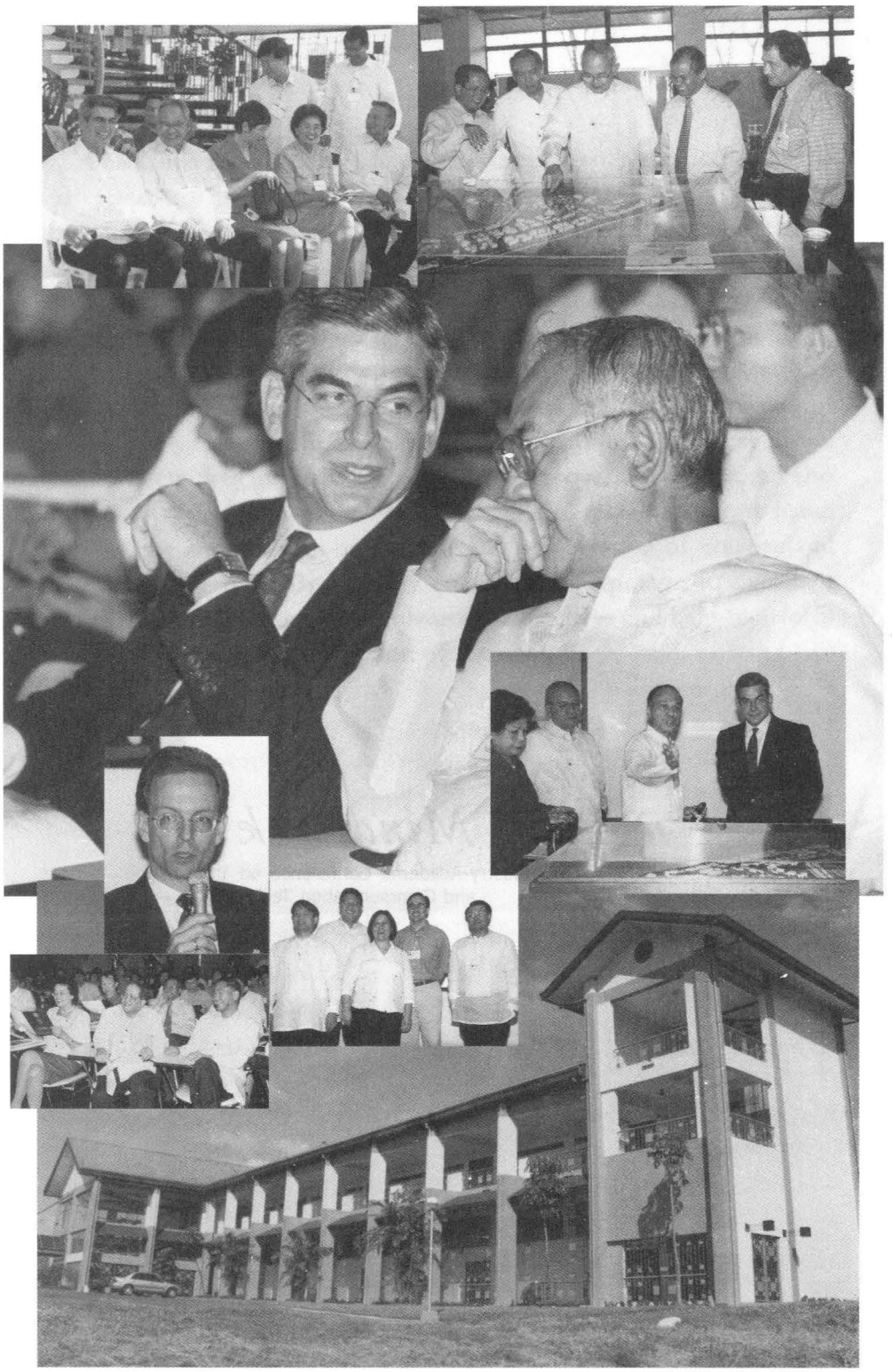
The University's contributions to Education Technology come not only from academic but also from research and support units. The Open University is an obvious and important resource. UP Diliman's College of Education does work on diverse topics, from the use of the Internet and other modern education technologies to more traditional methods of teaching. The College of Mass Communication works on the effective use of multimedia technologies; the Technology Management Center forecasts the future of education, while the National Institute of Science and Mathematics Education Development studies how to improve the teaching of science and mathematics in the country. The University's Library System is in the process of shifting to an electronic library, relying on the Internet and other technologies to facilitate the search for information.

Significantly, the UP Diliman Computer Center has developed the University's program for on-line registration, the first of its kind in the country. About a year ago Engineering students developed virtual learning software through the Internet, for which they were awarded an international prize. Although at this stage there are only a few faculty members in select schools who make use of the Internet in their course offerings, the practice can easily be made the norm if schools were to provide access and technology experts were to help the faculty make use of these new developments.

The University is committed to furthering collaboration with the private sector in these technology areas, motivated by the desire to reduce the huge gaps in the country's technological capabilities. The ultimate objective is clear: to develop a national economy able to compete and stand on its own. The University's capabilities in these technology areas, although not quite up to par with those in developed countries, are nevertheless good starting points. MINDLINK provides the path to greater knowledge and resources, which are the necessary requisites of economic and scientific development. But MINDLINK offers more. Returning to the University's fundamental purposes, MINDLINK can also help bridge the distance between teaching and research on one hand, and service and research on the other. A combination of creative and intellectually productive faculty and student exposure to excellent laboratories will advance the University's objectives and help transform UP into a 21st century institution of learning.

MindLink I

Industry-Academe Conference on Information and Communication Technology



MINDLINK I

Industry-Academe Conference on Information and Communication Technology

December 13, 2000
STTC Auditorium, University of the Philippines Diliman
Quezon City

PROGRAMME

8:00 am **Registration**

8:30 am **Welcome Remarks**
Dr. Francisco Nemenzo
President, University of the Philippines
Message
Mr. Jaime Augusto Zobel de Ayala II
President, Ayala Corporation

Plenary Session I: What the Academe is Working on at Present

Keynote
Atty. Lilia B. de Lima
Director General, Philippine Economic Zone Authority

9:00 am **Microelectronics**
Engineer Louis Alarcón
Department of Electrical and Electronics Engineering
College of Engineering, University of the Philippines Diliman

9:20 am **Digital Signal Processing**
Dr. Rowena C. L. Guevara
Department of Electrical and Electronics Engineering
College of Engineering, University of the Philippines Diliman

9:40 am **Break**

9:55 am **Internet Technologies**
Dr. Mark J. Encarnación
Department of Computer Science
College of Engineering
University of the Philippines Diliman

10:15 Am	**Optoelectronics** Dr. Arnel Salvador *National Institute of Physics* *College of Science* *University of the Philippines Diliman*
10:35 am	**Wireless Communications** Dr. Jay Sabido IX *Department of Electrical and Electronics Engineering* *College of Engineering* *University of the Philippines Diliman* *Director, Advanced Science and Technology Institute* *Department of Science and Technology*

Plenary Session II: What Industry is Currently Involved in 20-minute presentations

10:55 am	**Technology Venture Financing in the Philippines** Mr. Jonathan R. Madrid *Executive Director, iAyala*
11:15am	**State of the Telecommunication Industry in the Philippines** Atty. Rodolfo A. Salalima *President, Philippine Electronics and Telecommunications Federation*
11:35 am	**Multimedia Systems** Mr. Paolo Lopez *Business Development Manager, Intel Philippines*
11:55	**Open Forum**
12:10 pm	**Lunch Break**
1:15 pm	**Software Platforms** Mr. Richard Francis *Managing Director, Microsoft Philippines, Inc.*
1:35 pm	**IP Convergence Mobile Business** Mr. Albert Manlulu *Head, Enterprise Network Sales* *Siemens Inc.*
1:55 pm	**Business Solutions for the New Economy** Ms. Carol Esguerra Carreon *Chief Executive Officer* *Bayantrade Dotcom, Inc.*

2:15 pm **Open Forum**

Plenary Session III : What We See in the Future

2:30 pm **Industry-University Collaboration in the 21st Century**
Mr. Art Pasquinelli
Manager, Knowledge Enterprise Group, Global Education and Research, Sun Microsystems

3:00 pm **New Generation Solutions for e-Commerce**
Mr. Gregg P. Marshall
President, Lucent Technologies Philippines, Inc.

3:20 pm **Open Forum**
26 Parallel Sessions
Discussion on specific technologies relating to the five major topics presented in Plenary I

4:35 pm **Break**

4:50 pm **Summary**
Mr. Filemon T. Berba, Jr.
Senior Managing Director, Ayala Corporation

5:10 – 5:15 pm **Closing Remarks**
Dr. Emerlinda R. Roman
Chancellor, University of the Philippines Diliman

5:15 pm - **Tour of UP-Ayala Joint Experimental Facility on Technology, Development and Technology-Based Entrepreneurship**

University-Industry Relations

DR. FRANCISCO NEMENZO

President, University of the Philippines

Welcome to the University of the Philippines. Welcome to the first UP-Industry Conference on Information and Communication Technology.

This conference is part of our effort to develop closer ties with industry, a key item in our UP Modernization Plan. If I may state the objectives of this plan in two phrases, it is to catch up with the other universities in Asia and to place our country in a stronger competitive position in the new global order, especially in the field of Information Technology. I trust that this is a goal we share and in this field we can work together. You need us and we need you.

In this conference we shall inform you of what we have been doing and what we are capable of doing in the University, if we gain access to the necessary resources. We also expect you to inform us of what technologies you want to develop and what research projects you are willing to support.

Hitherto, our relations with industry have been haphazard and sometimes counter-productive. Pirating the best of our faculty members or diverting them from academic duties through the usual consultancy arrangements will kill the goose that lays the golden eggs. This may be

convenient in the short run, but in the long run it will hurt your corporate interests because, unable to reproduce the scientists and engineers required for technology development, you will always run short of the needed brainpower. You will lose out to competitors in India, Taiwan, Singapore and Malaysia; and in the near future also to China and Vietnam, whose governments and private companies are investing heavily on higher education.

Our government, already impecunious to start with, has a big problem that it created for itself, the problem of financing the numerous state universities and colleges it recklessly established. Up to 1961, UP was the only state university; now (believe it or not) there are 108 state universities and colleges competing for the limited budget for higher education. For this reason, we cannot rely on state subsidy for UP's modernization. Of course, we will fight relentlessly for increased state subsidy; but we are realistic enough to know that we can only hope to repel another savage budgetary cutback and, at most, get an inflationary adjustment. That will just keep us where we are today and we will continue lagging behind our counterparts in neighboring countries.

We therefore turn to the private sector. No, not with a begging bowl, although donations are always welcome. We propose a mutually advantageous partnership. UP has two valuable assets: lands and brains. The Board of Regents has set aside five hectares along C.P. García Avenue for the UP-Ayala Foundation Joint Experimental Facility, but we have 10 hectares more on the south side of our campus. We are also negotiating with the Philippine Economic Zone Authority to proclaim almost 100 hectares across Commonwealth Avenue for a Science and Technology Park (STP). Yes, we have many more open spaces for those who intend to go into technology development on a big scale and are willing to put up their own buildings.

You will find no better site for research and development (R&D) operations than the UP STP because of its proximity to the finest collection of brains in the country. Silicon Valley may be too fantastic a model, but together we can build something like Bangalore in India.

As my colleagues will tell you later, our faculty and students have already been doing a lot of work in Information and Communication Technology. And we have the good fortune of attracting the brightest Filipino students, especially to courses in science and technology.

Unfortunately, we cannot provide them the materials to fully tap their creativity and imagination. If you locate your R&D facilities in our STP, you will have the first crack at the best of our undergraduate students. Since the Diliman campus is already wired, you can also link up with our research laboratories. And our faculty members can do their consultancy work across the road, without having to navigate the terrible traffic of Edsa and C-5.

Our interest here is quite obvious. We want to give our students access to state-of-the-art equipment that we cannot acquire with our regular budget. We also hope you will support student projects that fit into your own R&D agenda. By providing our faculty members with extra income as consultants, you will help us retain them; and we will be able to produce a large pool of first-rate scientists and engineers for our country.

As I have said many times before, our country can only survive and prosper in the fiercely competitive world of the 21st century if we can build up this intellectual capital. We have to train scientists and engineers who can create new technologies so that the Philippines will not remain a nation of users and vendors of imported technologies. This entails a real cultural revolution, a shift from a culture of imitation to a culture of innovation.

Before I am tempted to deliver a long speech, let me end by thanking you all for joining us today. May this conference signal the beginning of a fruitful relationship between us.

OPENING REMARKS

A KEY STEP TO RP COMPETITIVENESS

MR. JAIME AGUSTO ZOBEL DE AYALA II

President, Ayala Corporation

To the words of welcome of President NEMENZO, I will add the enthusiastic support of the private sector for MINDLINK, and our collective belief that this kind of dialogue on Information and Communications Technology (ICT)—if sustained by our academic and business communities—will go a long way in bringing our economy, our people and our country to speed with the global economy of our time.

Some are probably wondering what possible significance and success this dialogue could have in the light of that other show in town on which attention of the nation is riveted—the impeachment trial of the President of our Republic. Our answer is that although the trial is of surpassing importance to the future of our country and our people, it does not render all our other activities and undertakings moot and irrelevant. Indeed, it is precisely because our other institutions and

relationships continue to function that the nation remains afloat, even though political leadership and governance are sorely wanting.

This conference takes its meaning from the phenomenal transformation that ICT has wrought in our time. In just a decade, the new technology and globalization have become the major drivers of economic change and progress. In place of capital and natural resources, people have become the most important resource for economic advancement. A New Economy is rising to replace the Old Economy created by the industrial age.

The key issue facing industries and nations today is how to compete in this new environment—especially industries and nations in the developing world which stand in danger of being left farther behind by the new digital divide. Some among us wonder whether it is realistic to hope that the Philippines can compete in this new economic area. They ask whether we are just indulging in fantasy and histrionics when we declare that we can match what other countries are doing today.

Our answer is yes, we can compete—but *only* if we align our educational system and our economy for the provision of world-class products and services, and *only* if we bring academe and industry together in one concerted effort to make the New Economy come alive in our country.

This is the rationale for MINDLINK. And this is why the UP Technology Park Project—supported by both our premier state university and key players in our business community—is such a critical factor for national competitiveness.

We need to open this front here in our academic sector because if we know one thing for certain about the New Economy, it is the fact that it has fathered a war for talent in the world today. Human resources define the capability and competitiveness of companies as well as nations. And there is a war for talent because the demand for competent and skilled Information Technology (IT) workers far exceeds the present supply.

This global war for talent is most dramatically evident in the US high-tech sector. The huge success of Silicon Valley has been driven mainly by the exodus of IT professionals from all over the world to what used to be a quiet college town in Southern California. Now other countries are also opening their doors to foreign workers.

Not surprisingly, we Filipinos have contributed to this exodus of talent to the US and other developed nations. In accounting for a good part of the pool of migrant labor, we have also contributed a considerable number of IT professionals. A recent international study has ranked the Philippines highest in terms of knowledge workers. Years of investment in education have produced a pool of trainable, English-speaking technical power in our country.

This brings us once again to the crux of the brain drain. As in the past when we watched with dismay as our expensively trained doctors and nurses left our shores to work and live in other lands, so now we are confronted with the drain of IT professionals leaving to work abroad. While the remittances of Filipino overseas workers help support the national economy, we cannot and must not be blind to the fact that they would contribute *incalculably more* if we made use of their talent right here in our country.

This requires essentially a change of national mindset—from the policy to the personal level. It requires a transformation in the way we attract and retain our people. And it requires, above all, gathering together our private sector, our government, our universities, our research centers and science laboratories in one supreme effort to construct an advanced system of education for the electronic age. That effort must begin now.

British Prime Minister TONY BLAIR, speaking of his own country's bid for a place in the New Economy said, "Education is the best economic policy there is, and it is in the marriage of education and technology that the future lies."

We could not agree more. We will never compete in the world as just a low-wage economy. Information is not enough; talent and knowledge make the difference.

As a nation, we can be better than we are. As a people, we have the proven capability to learn and acquire the skills necessary to succeed. This conference manifests our desire and resolve to make this happen—not in the future, but now.

May our discussions be crowned with success, and may this conference lead to a long and sustained partnership between our academic and business communities!

KEYNOTE ADDRESS

When Industry and the Academe Dialogue, Government Must Listen Attentively

ATTY. LILIA B. DE LIMA

Director General, Philippine Economic Zone Authority

First of all, allow me to sincerely thank President NEMENZO for honoring me with an invitation to keynote this Industry-Academe Conference on Information and Communications Technology, the first of a series of conferences and collaborative dialogues between the University of the Philippines and industry aimed at ensuring that UP becomes a very active, relevant and indispensable partner in the development of new technologies in the challenging and rapidly evolving fields of information and communications.

The concept paper for this conference, which was attached to President NEMENZO's invitation letter, succinctly, clearly and most appropriately spelled out the important rationale for this exercise: for industry and the university to explore areas where both can work together

for mutual benefit to enable the country to catch up with the global economy where knowledge is the primary source of wealth.

Truly, the Information Age is upon us. Starting this new millennium, a country's wealth will be determined by the ability of its people to access, organize and process information so as to add value to industrial and other processes.

Reviewing the invitation to the conference, I decided that the fitting title for my speech should be: "When Industry and Academe Dialogue, Government Must Listen Attentively," particularly when the subject is development and application of new technologies in information and communication.

I am sure President NEMENZO invited me because of the active involvement of the Philippine Economic Zone Authority (PEZA) in the country's efforts to attract foreign IT enterprises to operate here. PEZA is one of the organizations committed to putting the Philippines prominently on the map of IT services, aggressively in competition with the present group of country leaders such as India, Ireland and Singapore. PEZA was established on February 24, 1995 by virtue of Republic Act (RA) No. 7916, known as The Special Economic Zone Act of 1995.

The extent to which an organization succeeds is often determined by its ability to clearly define its mandate and to unwaveringly focus every effort on achieving it. PEZA is very clear about its mandate, which is:

> To assist in the accelerated creation of employment and other economic opportunities, particularly in the countryside, by encouraging and supporting investments in the establishment and operation of viable, world-class and environment-friendly economic zones.

Many people, including the honorable authors of RA No. 7916, expected PEZA to establish more public economic zones in addition to

the four it inherited from its predecessor, the Export Processing Zone Authority (EPZA). Instead, the very first policy decision we made was for PEZA to concentrate its efforts in encouraging and supporting private sector initiatives and investments in the establishment and operation of economic zones.

At the end of 1994, the country had 16 economic zones. Today, five years and nine months after the creation of PEZA, that number has multiplied significantly to 134 economic zones scattered all over the archipelago, 68 of which are already operational. Notwithstanding this rapid increase, the number of public economic zones remains at four.

PEZA's confidence in the capability of the private sector to serve as the prime mover of the country's socio-economic development and my strong belief in the ability of the academic community, most particularly UP, to provide meaningful professional inputs in the formulation and implementation of the country's development plans, programs and strategies, are what brought me here this morning.

Allow me to briefly highlight some important achievements which have resulted from PEZA's active collaboration with the private sector in investment promotion:

- Total economic zone investments of P530.1 billion from 1995 to 1999, PEZA's first five years of operations, which are more than 27 times the total economic zone investments during the last five years of EPZA (P19.6 billion from 1990-1994);
- This year, as of the end of November 2000, economic zone locator investments of P71.1 billion, which is 93.2 percent greater than the total annual economic zone locator investments in 1999 (P36.8 billion) and 58.7 percent more than this year's annual target (P45.0 billion);
- Creation of 450,752 additional economic zone direct and indirect jobs, from 229,650 workers at the end of 1994 to 680,402 workers as of 31 October 2000;
- Total manufactured export revenues of US $66.833 billion from 1995 to October 2000, resulting from the dramatic growth in the

annual economic zone export earnings of US$16.346 billion for the first 10 months of this year; and

- Rapid increase in the share of economic zone manufactured exports in the country's total exports from barely 22 percent in 1994 to 50 percent last year.

During my investment promotion trips in targeted investment-source countries in 1997 and 1998, I met a good number of foreign businessmen in the IT sector who expressed great interest in making the Philippines the base of their operations. They cited the high level of adult literacy of Filipinos, our people's facility for English and the easy adaptability when given proper training as elements of our very important competitive edge to excel and compete in IT services. Many urged me to recommend to the government that the Philippines make a strong bid to catch up with the already existing software development parks of India, the Cyberport of Hongkong and the Multimedia Corridor in Malaysia and become the next Asian counterpart of Silicon Valley.

What I saw, heard and observed in side trips to selected IT companies excited me. Enthusiastically, I shared my thoughts and information with a number of government officials, among them, then DOST Secretary WILLIAM PADOLINA, as well as people I know in the Philippine software industry sector. They, too, were very excited and confident over the prospect of the Philippines becoming a preferred location of world leaders in Information Technology.

My predicament then was that while RA No. 7916 lists the different kinds of economic zones that PEZA can establish and/or cause to be established (such as agro-industrial estates, tourism complexes and investment, banking and financial centers) the Charter makes no mention at all of economic zones hosting IT enterprises. The main thrust of PEZA's investment promotion, therefore, focused on encouraging the establishment and operation of export processing zones and attracting foreign export manufacturing enterprises to locate in such zones.

However, early last year, I broached the idea of encouraging the establishment and operation of IT parks with the PEZA Board, which would provide not only infrastructure and facilities required by IT enterprises but also essential services as well as social and cultural amenities sought by IT professionals and workers. As expected, the issue of our Charter's silence about IT Parks came up. My response was more personal than official. I informed the PEZA Board that in case someone subsequently questions PEZA's decision to extend incentives to IT Parks and enterprises, I would welcome being hailed to court for initiating this policy decision. The very supportive and progressive PEZA Board of Directors immediately recognized the importance of promoting the country as an ideal location for IT service enterprises and approved the PEZA guidelines on the registration and grant of incentives to developers of IT Zones, providers of IT facilities and IT service enterprises.

The PEZA Board approved the country's first IT park in June 1999: Eastwood City Cyberpark owned by Megaworld Properties and Holdings, Incorporated in Bagumbayan, Libis, Quezon City with a land area of 13.3 hectares. Soon after, the PEZA Board approved the establishment of Northgate Cyberzone owned by Filinvest Group of Companies in Alabang, Muntinlupa City, with a land area of 18.7 hectares; and E-Square Information Technology Park, owned by the Fort Bonifacio Group of Companies in Fort Bonifacio Global City, Taguig, with an area of 24.4 hectares.

All three have officially been proclaimed economic zones and are authorized to host IT enterprises registered with PEZA for the availment of incentives.

The PEZA Board has also approved two other IT Parks in Metro Manila: the Bonifacio Information Special Technology Zone established by the Bases Conversion and Development Authority at Fort Bonifacio Global City, Taguig, with a land area of 25.0 hectares; and the 6.81 hectare Robinson's Cyberpark, owned by Robinson's Land Corporation on EDSA corner Pioneer Street, in Mandaluyong City.

In addition, PEZA approved the establishment of two IT buildings, also in Metro Manila: RCBC Plaza on Ayala Avenue corner Senator Gil Puyat Avenue, Makati City, where 50,000 square meters are to be allocated for IT enterprises; and PBCOM Tower of Filinvest Asia Corporation, on Ayala Avenue corner Senator Gil Puyat Avenue, Makati City, where 29,300 square meters are to be allocated for IT enterprises.

Outside Metro Manila, the PEZA Board has approved the establishment of two IT Parks in Cebu City: CCTC IT Park owned by Cebu Property Ventures and Development Corporation covering 23.7 hectares; and Cebu Cybertown IT Park of First Centro, Inc., containing five hectares allocated for IT enterprises.

PEZA now has a well defined incentives policy for IT zones and enterprises except for those located in Metro Manila, which are still under deliberation.

As you know, fiscal and non-fiscal incentives are important tools we use to influence investors' decision making, while giving importance to the service orientation. Close to 90 percent of locator enterprises operating inside economic zones are foreign companies which could have chosen to locate in many other countries. For this reason, we in PEZA earnestly endeavor to ensure that enterprises operating here are satisfied with the attention and service they are given to encourage them to expand their operations in the country and serve as effective agents promoting the Philippines to other foreign investors. As PEZA implements an aggressive program to attract IT enterprises to the Philippines, we note that government's efforts towards eliminating disincentives (such as corruption and a disruptive bureaucracy) as well as conscious efforts toward facilitating business procedures are often even more effective than incentives for foreign investors.

Let me now mention a number of concerns that need immediate attention and which may require a good deal of time and resources to address. First in my list is the deteriorating facility of Filipinos for spoken and written English. This problem has been acknowledged for some time now and yet no clear-cut program has been formulated and

implemented to reverse this worrisome trend. In the meantime, other nations have launched aggressive and well-supported programs to develop their young people's fluency in English. The same can be said of the quality of math and science education in the country. Unless we effect significant improvements in this area, we may have to content ourselves with carving out a niche in low-value added IT services of call centers and data encoding.

To promote computer literacy, PEZA has recommended Zero-VAT rating of personal computers and related equipment and accessories. PEZA is of the view that government should forego revenues from personal computers in consideration of the very critical role computer literacy will play in the country's long-term global competitiveness.

In closing, I believe the Philippines is globally competitive in some manufacturing sectors, as evidenced by the appreciable growth of export revenues in these industries. We only need to continue diversifying the mix of export products and country markets for these products. We in PEZA are confident we can adequately attend to this concern.

The real challenge before us today is to put the Philippines forward, in the next two to three years, as a country to reckon with in the highly competitive and dynamic field of IT services. To successfully respond to this challenge, we critically need what you have initiated today. On behalf of Filipinos presently unemployed and underemployed, those who had been constrained to go abroad in desperate pursuit of employment opportunities, and the estimated 800,000 Filipino youths who reach working age annually, we hope and pray for your success.

Microelectronics Programs in UP

PROF. LOUIS ALARCON

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Three departments actively undertake microelectronics research at UP Diliman. At the College of Engineering are two departments, the Electrical and Electronics Engineering (EEE) for information and communications (IC) design, and the Department of Mining, Metallurgical and Materials Engineering (MMME). The third is the National Institute of Physics at the College of Science for semiconductor device fabrication and characterization.

The EEE Department offers Bachelor of Science programs in Electrical Engineering (BSEE), Electronics and Communication Engineering (BS ECE), Computer Engineering (BSCoE), and master's and doctoral programs in Electrical Engineering. Microelectronics is a field of undergraduate and graduate specialization and is the focus of two laboratories: Microelectronics and Microprocessors Lab (Microlab) and the Intel Microprocessors Lab (IML).

The Microlab was established in the late 1980s to develop the University's capability in IC design. Its hardware facilities include 14 Scaleable Processor ARChitecture or SPARC-based work stations, two digital test mainframes, a wafer probe station and a semiconductor

parameter analyzer. The lab also uses IC design software from Cadence for design entry verification and layout.

The IML, on the other hand, was created in 1997 through a grant from Intel Corporation to develop specialized processor architecture and improve the university's computer engineering curriculum. The IML has 45 Pentium-based workstations, a digital test mainframe and a host of microprocessor development systems. It also has some Field Programmable Gate Arrays (FPGA) development tools, as well as Hardware Description Language or HDL synthesis software for rapid digital prototyping. The microprocessor designs at the IML are then implemented in silicon at the Microlab. Six full-time faculty members are at the Microlab and the IML. To date, the total research grant provided by Intel has exceeded P15 million.

Research at the Microlab and IML follows two programs. The first is a five-year Reduced Instruction Set Computer or RISC microprocessor core development program started in 1999, aimed at the design implementation of special-purpose RISC microprocessors with emphasis on signal processing for mobile communications. The two projects under this program are: an 8-bit Harvard architecture pipeline RISC microcontroller implemented in 3.5 micron Complimentary Metal-Oxide Semiconductor or CMOS technology (scheduled to be fabricated in January 2001) and a 32-bit pipeline RISC microprocessor in 0.25 micron CMOS technology (scheduled for fabrication in April 2001.)

The second research program is a five-year RF or radio frequency microelectronics program which also started in 1999. Its goal is to design and implement RF-integrated circuits both at the block and at the system levels. Some projects in this program include the design and characterization of analog building blocks (scheduled for fabrication in February 2001) and the development of basic RF transceiver building blocks, low noise amplifiers, mixers, oscillators and power amplifiers at 2.4 gigahertz. These are scheduled for fabrication in March 2001.

Together, these lead to a long-term program that will enable the lab to develop its own system of chip design and capability, specifically

integrating the RF front end and the signal processing back end on a single chip for a fully integrated communications system in a chip.

The MMME Department offers a BS Materials Engineering program and MS and Ph.D. programs in Materials Science and Engineering. To support its activities, the Department has the following infrastructure: semiconductor device fabrication lab, electron microscopy laboratory and the materials characterization laboratory. Research at the MMME Department includes silicon wafer fabrication, semiconductor device prototyping and the development and improvement of its procedures and methodologies. At the parallel sessions, Dr. ALBERTO V. AMORSOLO of the MMME will discuss the Department's other activities.

Digital Signal Processing

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Digital Signal Processing or DSP is becoming a household word. I have seen two or three television commercials using the term DSP and most entertainment products, like Video Cassette Recorders or VCRs, Karaokes and Digital Versatile/Video Discs or DVDs have the word DSP on their front panel. In the next 16.525 minutes I would like to broaden your appreciation of DSP by answering the questions: What is DSP? and What can you do with DSP? In the course of answering these questions, I will feature some of the research work at the various laboratories at the Department of Electrical and Electronics Engineering (EEE) and the National Institute of Physics (NIP).

We interact with the world using our five senses; six, if you're psychic. Of these five, we rely most on our senses of hearing and sight. The fact is, we live in an analog world and we sense analog signals. How do we listen to music from a Moving Pictures Experts Group Layer 3 or MP3 sound file or compact disc? How do we get to watch a movie on a digital video disc or view a picture in Joint Photographic Experts Group or JPG format? And most importantly, how do we take advantage of the pace of digital technology?

DSP is a technology enabler. The DSP market is exploding. In the US four years ago, the market accounted for approximately $3.5 billion. By 2007, it is expected to surpass $50 billion. With almost everything—such as cellular phones, personal digital assistants, MP3 players, voice over IP and voice command and control of consumer electronics (washing machines, water pumps, security system, and instrumentation)—dependent on DSP, it is easy to see that DSP technology is the primary engine of change in the world today. And knowledge of DSP technology is the key to success for many individuals as well as corporations.

Let me get you on the road to conversion. An analog signal takes on continuous values at all times. On the other hand, a digital signal takes on discrete values at discrete times. In most cases, these discrete times have equal values such that we can specify a digital signal as a sequence of numbers. If you have numbers to deal with, you can add, multiply, do a series of algebraic manipulations and essentially do digital signal processing. ERENI KATSAGGELOS, a 10-year old child, defined DSP as follows: "A digital signal is a voice, a sound, or an image that is either on the computer or the Internet. DSP means changing such a voice, sound or image to help make it sound or look better, clearer or sharper."

Let me give you some examples. In an analog electronic amplifier, to change the volume of the sound output, you turn a knob that consists of a potentiometer to change the output voltage. In a computer sound card, multiplying the signal with a number alters the sound output. Another example is rendering animation. Before 1989, animated films or cartoons were drawn frame by frame. With advances in video processors and with the trend for life-like animation, more and more aspects of animation have been carried out on computers, culminating in the movie Toy Story, which was the first full-length computerized animation.

The most highly used mathematical expression in DSP is the Fourier Transform (FT), which was formulated in 1822. The FT gives the mathematical relationship between signal representation in time and in frequency. If one were to carry out the computation of a 512-point Fourier Transform on a computer in the 1980s, it

would take about a minute. Nowadays, a DSP processor can do the same operation in 10 microseconds.

DSP usually starts with the conversion of an analog signal into a digital signal. The signal processing follows and if an analog output is necessary, the digital signal is converted back into analog form.

DSP provides engineers, scientists and IT professionals a bag of tools spanning a spectrum of applications. To get us started, let us look at the role of DSP in the music entertainment business. The human ear allows for the removal of redundancies in a musical signal without affecting the perceived sound. This characteristic is the basis of most compression algorithms such as the MP3. MP3 players use compression technology specified in Layer 3 of the Moving Pictures Experts Group standard, MPEG-2. Used to store downloaded digital music files from the Internet, MP3 players then play them back off line. The first MP3 player came out in June 1999, after an appeals court nixed attempts by the recording industry to get an injunction against its sale. Since any form of music can be converted into MP3, and MP3s are downloaded free, the music industry feared the proliferation of pirated music. Meanwhile, the recording industry's attention has turned to the development of security standards to protect copyrighted material. MP3 will influence the future of music marketing.

DSP algorithms are used in different applications. I would like to introduce two high-impact DSP algorithms. The first is Linear Predictive Coding or LPC.

You are all familiar with the sound of being in between radio channels. We call this sound white noise. In LPC, we start with a signal, x(n), and we create a filter, A(z), such that when you pass x(n) through A(z), what comes out is white noise. A(z) is simply a sequence of numbers that get multiplied with x(n) and are summed up. If we can invert the filter into 1/A(z), and if our input is white noise, we then expect to get back the original signal, x(n).

As an example, consider the following. The syllable "ew," consisting of 2000 samples, can be modeled by an LPC filter consisting of 16 coefficients. Instead of sending the 2000 samples over the channel, we

only need to send the 16 coefficients. At the receiver, white noise is filtered using the 16 coefficients of LPC filter. The resulting sound, when compared to the original, is quite close. (Let's listen to the synthesized sound followed by the original sound). This algorithm gave us a reduction of a factor of 125.

LPC implementations are used in Speech Codecs that convert analog speech into coded digital signals, which are sent through a communication channel. At the receiver, the codec decodes the signal back into analog speech. This is one of the functions of the Texas Instrument chip that you will find in every Nokia cell phone. The compression algorithm used in a codec allows more and more simultaneous phone conversations in a single channel. The added bonuses of codecs are encryption for security and error resiliency. All these translate into better quality of service at lower cost.

The rapid proliferation of the Internet in the last few years has led to strong interest in carrying telephony over the Internet, or voice over IP (VoIP). The Internet, however, was designed for non-real time data communications and hence poses several technical challenges that must be overcome before it can be successfully used for carrying telephone services.

Residential users have two ways of doing VoIP: talk through a PC or bypass the PC entirely through "voice-enabled" cable modems or digital subscriber line (DSL) boxes.

In the Voice Trunking Model, long-distance telecom providers use a computer network link to handle the voice data instead of using the regular T1 link. The Computer Telephony Model targets business application, integrating the Private Automated Bank Exchange or PABX system into the computer network system. Instead of having two cable installations on the enterprise campus, only one high-capacity backbone is needed.

In 1996, UP Diliman's PABX was destroyed in a fire and we have since been renting one. Since we have a network that can easily accommodate voice traffic, we are considering the possibility of switching to a VoIP phone system. A research team in our department

designed a Telephony Peripheral Component Interconnect or PCI card that can be used in such a system.

The challenges in VoIP can be divided into quality of service, quality of voice, standardization and packet overhead. All of these are staple DSP problems that can be solved by computer networking professionals, communications engineers and speech coders.

Convergence between the existing telephone networks and data transfer over the Internet not only demands that new software be written to handle telephony applications which span both networks, but also makes new and innovative applications possible.

Last Christmas, Internet telephony wholesaler ITXC announced that its customers logged approximately 1.5 million minutes of traffic on Christmas Day for completion over the Internet. This is more than 15 times as much traffic as they handled only a year before. The increase indicates that Internet long-distance is growing at a faster rate than Internet shopping, which is estimated to have tripled during the same period. VoIP traffic is expected to grow by another 5000 percent by 2004. In the first quarter of 1999, the Synergy Research Group measured a 67 percent increase in VoIP equipment revenue over the prior quarter and a 453 percent increase over the same period last year.

A second high-impact DSP algorithm is the Hidden Markov Modeling or HMM, which is based on statistical variations that can be modeled as Markov chains. A tossed coin comes up either heads or tails (if it is fair). If I were to give you a sequence of heads and tails as a result of an experiment, and I do not tell you how many coins I tossed and what rules I have for going between one coin and another, the sequence is an example that can be modeled as an HMM. HMM can be used for speech recognition. For example, I can have eight female and eight male speakers utter 10 words twice, resulting in 320 samples. Half can be used to create the Hidden Markov models and the other half can be used to determine the performance of the system by measuring the number of words that were correctly recognized. HMM is also used for speaker recognition where the uttered name of each speaker is modeled. These are often used in security systems. HMM is also used in speech codecs.

Instead of sending the entire speech signal, it is segmented and for each segment, the nearest phoneme is determined among the Hidden Markov models. The index of the model in the dictionary is the only information sent over the channel. Models such as these allow for huge bandwidth savings, which translate into cheaper phone calls. Interestingly, HMM can also be used in identifying whether a coconut is young or old. In this set-up, the coconut is tapped and the resulting sound and its HMM model are used to classify it.

DSP also finds applications in audio processing, especially in room modeling. Future audio engineers will be controlling the sound environment through DSP instead of putting up physical barriers and reflectors.

Automatic fingerprint identification systems have found their way through many branches of government. To identify a person, a one-to-many comparison is made with all the existing fingerprints in the database. This is a long process. At the FBI, it takes three hours to do a match for known perpetrators. One way to reduce the matching time is to classify the fingerprints into whorl, right loop, left loop, arch and others. This will reduce the matching time by a factor of 5.

In this afternoon's session, you will listen to five DSP presenters from the various laboratories in UP Diliman. Dr. MARICOR SORIANO from the Instrumentation Physics lab's talk "What's in an image" will introduce you to image processing. JOEL JOSEPH MARCIANO from the Communications Engineering Laboratory will discuss adaptive filters as applied to the various parts of a communications system. Dr. LUIS G. SISON from the Instrumentation, Robotics and Control Laboratory will talk about a web-based virtual lab for real-time control with DSP. ALVIN MANLAPAT from the Advanced Science and Technology Institute of the Department of Science and Technology will discuss a P/4 differential quadrature phase shift keying modulator-demodulator system using TI TMS320C6000 digital signal processor. Lastly, IAN GARCIA from the Digital Signal Processing Laboratory will give a talk on simulating three-dimensional sound over stereo speakers.

All are of course welcome to visit any of these laboratories at the NIP and the EEE Department.

Internet Technologies

DR. MARK ENCARNACION

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Work in this area began with a project some members of the Computer Science Department worked on for NTT, the Japanese telephone company. I think they were interested in getting into the area of virtual communities so they requested our assistance. JIMMY CARO was one of the project leaders then. As a result of that project, we now have quite a bit of expertise in the area of e-learning. In particular, we have expertise in courseware development, which is also related to some of the work faculty members are doing with the UP Open University, UP's distance learning initiative. We also are gaining expertise in what is known as collaborative learning. In fact, this semester, we have a joint class with an intellectual property rights class being held at the Massachusetts Institute of Technology. We held the first video conference classroom yesterday, which went pretty well. We also have expertise in virtual communities, an area where we do feasibility studies and develop web applications.

Going over to the National Institute of Physics, Dr. VINCE DARIA and Dr. CAESAR SALOMA developed a model for simulating the flow of traffic in networks. Networks here is taken in an abstract sense: it can be a

network of computers, telephones or roads where traffic flows. The advantage of the Daria-Saloma model over those being used outside is that their model is more realistic in the local setting. For example, foreign models will assume drivers do not change lanes very often, or they go at certain speeds—at minimum or maximum speeds—which is of course a ridiculous assumption in the Philippines. The Daria-Saloma model takes these idiosyncrasies into account.

Moving over to UP Manila, Dr. RODERIC OFRIN of the College of Medicine, who is the only real doctor among us—the others are mere Ph.D.s—is involved with the National Tele-Health Center. The objective of the Center is basically to use information technology for distributing information on health to the general public. The Center is also looking at applications of information technology to health care; in particular, they are looking at personal digital assistants that physicians can use to take notes, electronic nurse's notes and web referrals. If you are interested in this area, please attend Dr. OFRIN'S talk this afternoon.

Returning to UP Diliman, a project of the Office of the University Registrar, in collaboration with the Department of Computer Science, is the Computerized Registration System (CRS). UP Diliman has long been known and is notorious for the long queues at registration time. We are hoping that with the CRS, queues will become a thing of the past and indeed, the last semester it showed some promising results. The lines are now at the payment and no longer at enlistment. We still have lines but they are fewer now. The CRS is quite a sophisticated system; you can view class schedules and enlist for classes online. It is a non-trivial application because you have, working behind the scenes, algorithms for room allocation, which is a problem in the university. There are also algorithms for class schedules. We all know UP Diliman is a large campus, making it difficult for a student with a class at the Math Building along CP Garcia to have the next class at the College of Engineering, for example, which is on the other side. Concerns like this are incorporated into the system and soon, the CRS will be WAP (Wireless Application Protocol)-enabled.

Although not part of UP, ASTI (Advanced Science and Technology Institute), which is part of DOST, sits on the Diliman campus and many of its researchers come from UP. DENNIS VILLORENTE, for one, will be giving a talk this afternoon on what is called the A13 project. It is a Japanese-led project, a consortium of research groups from 10 Asian countries, that set up a satellite which members of the consortium may use for their research. At ASTI, they are working on voice-over IP and multimedia-over IP. If any of these topics interest you, I invite you to attend DENNIS' talk.

I would also like to give you a brief overview of student projects in our undergraduate program. The fourth year computer science students are required to undertake a software project as part of their degree program. We have posters describing these projects, which you are welcome to view. We currently have over 20 projects; as an example, the WAP caster is a WAP application that scours the news sites such as Inquirer.net, and summarizes the news for viewing on your WAP phone.

Let me end with a shameless promotion of my own work which I started in September. Called "Gets Mo," it is an e-mail browser that lets you browse the Internet using just e-mail if you only have an e-mail connection. It works this way. You send an e-mail to an address which will get it at Getsmo.com with the requested URL in the subject field; you will receive the requested pages and e-mail attachment in response. Usually, it will respond in a few seconds, or at the most, a few minutes. You also have a search request: you query Google and the program sends you back the results. You also have a sitemap request where you get a bulleted list of all the links at the site. This is 3-deep and if you are interested in a particular link at the site, you click that link and your mail program will come up automatically. You click-again to make the request; the e-mail message is pre-initialized. I invite you to try it out. It works although there are some bugs, which I still need to work on. Just send me an e-mail if you find anything that needs improvement.

Optoelectronics

DR. ARNEL SALVADOR

Professor, National Institute of Physics
College of Science, UP Diliman

My talk will dwell on the research activities at the Condensed Matter Physics Laboratory (CMPL) of the National Institute of Physics (NIP) in the field of optoelectronic devices.

The basic components for fiber optic communication consist of a laser, an optical fiber, and a photo detector. The data or information, which is in the form of an optical pulse, is sent by the laser, travels through the fiber and is eventually read by the photo detector. The photo detector in turn converts the optical signal into an electrical signal. In the scheme of things, we would like to have a big bandwidth wherein a huge amount of information/per unit time can be relayed through the optical fiber. One possible scenario for this is that you would have many lasers on one end of the fiber, each laser emitting at a different wavelength and sending optical pulses at its own pace. At the other end, you will need to have an array of photo detectors which can discriminate or selectively detect signals at only one particular wavelength.

At the NIP, two laboratories have been working on this project over the past few years. The CMPL does the growth and the characterization

of the optical devices. We can grow the semiconductor device in-house, we can characterize it, we can fabricate it here. The other facility, the Photonics Research Laboratory, studies the propagation of the optical signal in the fiber optic cable. At the same time, they are also looking at optical data storage. One exciting highlight is, in theory, we could have 250,000 gigabytes possible in optical storage. I believe the largest we have commercially is something like only 20 gigabytes.

The machine we use to grow semiconductor devices is called a molecular beam epitaxy facility. We grow the wafers at very, very low pressures at an ultra high vacuum environment. This technique allows one to grow the film one atomic layer at a time. This is the preferred mode when you want to make devices with well-defined composition and doping profiles. This is the way people grow the lasers you have in your compact disc. The other devices we can grow here are high electron mobility transistors, which are suitable for satellite and wireless communication. Thus with the machine called Riber 32, we can work on RF devices and we can also do optoelectronics.

We have been working on the Riber 32 machine for the past three years. The wafer is first loaded in a nitrogen glove box and then transferred to the load lock chamber where the sample is heated up to remove the moisture and other possible contaminants. The wafer is eventually transferred into the growth chamber which is maintained at ultra high vacuum pressures to ensure that the chamber is very clean. To give you an idea of how much it costs to run this machine, over the past two months, we had to pay P100, 000 per month for liquid nitrogen consumption. In addition, we have costs for electricity and the chemical supplies we have to import. In turn, we also have to pay for additional cost overruns such as VAT. The machine was purchased through the Department of Science and Technology - Engineering Science Education Program and costs something like US$700,000. It normally costs US$1.5 million so UP got a bargain for this.

Through this machine, we can grow GaAs, the preferred material for optoelectronics. We do not grow silicon here. Silicon is for a different

type of application. In the future we can also do InGaAs, another material suitable for optoelectronics and transistor work. Right now, we have grown light-emitting diodes, photo detectors and also a transistor.

We also have support facilities to characterize the films we grow and fabricate them into devices. The tools that we have right now include the following: an x-ray diffraction system which can get the composition of the material to check if we grew the right layer; a scanning electron microscope which is actually used by the semiconductor industry to measure thickness; an electrical characterization equipment to figure out if we did the right doping concentration; and an optical characterization equipment to look at the emission properties of the devices.

We start with a wafer and grow the film on it using the Riber 32 . It takes a while to complete the film growth. Normally it takes three hours, sometimes it takes a day. After growth, the wafer is taken out of the chamber and cut it into tiny pieces for characterization. Some of the pieces would be sent to the characterization facilities while some are fabricated into the devices. Our scanning electron microscope has a resolution of 200 angstroms. Note that we are working on dimensions that are very, very small. Using x-ray diffraction and photoluminesnce spectroscopy, we can assess the quality of the layers we are growing.

We also have a facility for device fabrication. We employ standard photolithographic techniques and wet chemical etching to define mesas and patterns for metallization. The resolution for our patterns is one micron.

Currently we are working with the surface emitting lasers. These devices emit on top as opposed to edge or side emitting lasers. This is the preferred mode right now for optoelectronics since the light quality of the surface emitting lasers are better suited for coupling with the fiber optic cable and you have the ease of making two-dimensional arrays.

The resonant cavity enhanced photo detector we have grown consists of a bottom and top mirror and an active layer in between. Each layer

actually corresponds to several hundred angstroms. This concept was developed in 1990, so we are not that far behind. Operated in forward bias, what we have is still a light emitting diode. We do not have the facilities yet to fabricate it into a laser because we cannot buy the masks right now. The masks costs $500 each and we ran out of money. We normally need a set of six masks so if somebody could come up with $3,000 we would be more than happy.

The goal in fiberoptic communication is to make the emission line width very narrow so you can put many light signals into that fiber optic without having to worry about cross-talk. Of the devices we grew here, one is edge emitting and the other surface emitting. Operated as a light emitting diode, we can get narrow line widths with the surface emitting design.

Another concept we have applied is a resonant cavity-enhanced photo detector. It is a nice name; basically, it is a detector that discriminates certain wavelengths. It can only detect certain wavelengths and the rest it cannot see. This fits the demands for fiber optic communications very well. Again, we have many, many light signals coming into that fiber optic cable; at the other end, the detector must be able to discriminate which one it will pick up. The photo detector we have fabricated practically cannot detect signals in these wavelength range and display wavelength selectivity.

In summary, we have an active ongoing research in optoelectronics where we are pretty much self-contained. We can make the devices here, we can characterize them here, and we can also look at the data transmission. We would like to acknowledge the funding support of DOST-Philippine Council for Advanced Science and Technology Research and Development and UP's Office of the Vice Chancellor for Research and Development. These agencies have been very generous and supportive of our research work. Do visit our webpage at www.nip.upd.edu.ph in case you need more information regarding our work.

Wireless Communication

DR. DELFIN JAY SABIDO III

Department of Electrical and Electronics Engineering
College of Engineering, UP Diliman
Director, Advanced Science and Technology Institute,
Department of Science and Technology

It is a great pleasure and honor to talk to you about a very exciting field—wireless technologies. Because of cellular phones, we all probably are, in one way or another, familiar with this technology that enables what we call the "connected anytime, anywhere" concept.

I just went over some magazines and realized we are really bombarded with a lot of advertisements on wireless technologies. For example, Japan's NTT and DoCoMo's i-mode service is very popular, with 14 or 15 million subscribers at present. The company recently announced they will offer 3G or third generation service by March next year. With 3G, we can access the Internet through wireless means. Phillips is advertising a new phone that has voice navigation; Siemens is also advertising their mobile phone prepaid card, which is actually equivalent to cash and can purchase from vending machines, department stores, etc. This is something very big in Europe right now. Ericsson claims 150,000 Internet-ready phones are being purchased everyday; Nokia just announced they are developing a phone with Java capability that will be released in the first quarter next year.

In the local scene, we are all very familiar with cellular phones and service providers such as Globe and Smart. We all know about WAP, and Dr. ENCARNACIÓN talked about some of the researches UP is doing to WAP-enable some of the web sites.

Globe and Smart are also starting to advertise GPRS (General Packet Radio Service) and a month ago, a satellite phone capable of delivering phone services to rural areas via satellite. There are also several companies bombarding us with news on wireless broadband access such as Broadband Philippines, Meridian Telecoms, PLDT and Globe. We also hear about Internet access via satellite. Some government programs are currently connecting rural areas to the Internet via VSAT and some government agencies are likewise being connected. There are Internet Service Providers (ISP) offering this service such as PLDT Mabuhay, Philcomsat and Moscom.

Dr. GUEVARA spoke earlier about digital signal processing and mentioned that the signal processing chips used in Nokia cellular phones are actually manufactured here in the Philippines, in Baguio City by Texas Instruments. Intel is producing a lot of memory-type devices; flash memory will also be used in many portable or mobile devices. Pacific Microwave Corporation in Cabuyao, Laguna is producing microwave devices—components and subsystems for broadband, wireless connectivity. Recently, Phillips Semiconductors announced they are investing $23 million in Bluetooth, a short-range connectivity wireless solution for personal digital assistants, wireless appliances, computers and cellular phones. The company is investing in its manufacturing facility in the Philippines and a lot of work is being done by small and medium enterprises.

Aside from the service sectors, there are also numerous opportunities in wireless applications and solutions similar to those Dr. ENCARNACIÓN mentioned. About a week or so ago, Icon Designs Multimedia—a Filipino company—established an alliance with Ericsson to start a company here that will provide wireless applications and solutions.

We hear a lot about SMS (short message service) or text-based access through the Internet for appliance control or wireless checkbook, for example. A Filipino recently announced that certain bank or financial transactions can now be done via SMS. An example is Lakbay.net where you can access travel information via SMS. A lot of these developments are going on here in our country.

There is also talk about wireless Java as I mentioned earlier, an example is the Nokia 9210 phone which will come out in the first quarter next year. Companies like Sun Microsystems, NTT-DoCoMo, Siemens, Nokia and Ericsson are working towards offering wireless Java applications and solutions. Motorola is establishing a comprehensive developers' support program for their Java 2 platform micro edition technology and they hope to tap Filipinos for this project. With these technologies come a lot more opportunities. As the honorable JAIME AUGUSTO ZOBEL DE AYALA II put it, yes, we Filipinos can compete. More than software, working with the SMS and manufacturing these devices, we can contribute to the design, development, production and research on wireless devices component systems and complete solutions, with emphasis on the value-added aspects of wireless technology.

Let me highlight two R&D organizations working in this field: the Advanced Science and Technology Institute (ASTI), which is a part of the Department of Science and Technology and located in the UP campus beside the joint experimental facility that was recently inaugurated by UP and Ayala Foundation; and the Communications Engineering Laboratory (CEL) of the Department of Electrical and Electronics Engineering (EEE) of UP Diliman. The EEE has 14 research laboratories that encompass the different fields and aspects of wireless communications while ASTI has technical divisions working on communications, microelectronics, computer software, digital signal processing and a special projects division.

Dr. ENCARNACIÓN talked about an aspect of our next generation Internet project called the Philippines Research and Education Government Information Network or PREGINET. The project deals

with deployment testing implementation research in a satellite network; hence the satellite dish on top of the ASTI building. We are also trying to look at deployment testing and experimentation with wireless broadband systems as LMDS (Local Multipoint Distribution System), MMDS (Multichannel Multipoint Distribution Service) type systems and beyond. These are broadband wireless connectivity standards. We have worked on devices and components in microelectronics similar to that described by LOUIS ALARCON of the work at IML. We are also developing microwave devices such as mixers, low noise amplifiers, power divider oscillators, filters and antenna feeds. Aside from the devices, we are also working on wireless subsystems. To put our work in the proper perspective, we are undertaking the whole range of technologies to be able to compete in the field of wireless technology.

Work on wireless subsystems is done by either ASTI and/or the College of Engineering's CEL. Later, NICK TOLEDO will talk about his undergraduate research project on a 3.07 gigahertz QPSK (Quadrature Place Shift Keying) transmitter. Dr. JOEL MARCIANO will discuss his research on antenna diversity techniques where the two research organizations collaborated to produce WCDMA (Wideband Code Division Multiple Access) as part of the third generation wireless technologies. A WCDMA transmitter, a WCDMA receiver, an automatic gain controlled power amplifier were developed for wireless systems. An undergraduate research project designed, developed and tested a two-way pager prototype, a stand alone wireless system that had software, a microcontroller, an antenna and RF components. One of the big projects is our digital microwave radio link that looks at broadband wireless solutions, which started as an undergraduate project at CEL in collaboration with ASTI. As you can see, we are able to provide complete wireless solutions and that is the message we would like to bring here today.

By complete wireless solutions, I mean the development of key technology areas in network architecture design. This will be highlighted later by DENNIS VILLORENTE, who will talk about our AIII project, which

is part of our next generation Internet project. With the use of wireless technolgy by ISPs to deliver Internet information, expertise in network architecture and design is imperative.

Internet and web technologies are again a must as you start to interface or use wireless phones to access the Internet. Wireless access technologies—signal processing such as coding, modulation and demodulation and microelectronics—drive all these Internet and wireless appliances. Cellular phones are becoming smaller and smaller and some researches right now are developing cellular phones or wireless access devices the size of a ring or a watch; some are experimenting with sound waves going through your fingers so that you simply stick your finger into your ear. (Of course people might think that you are doing something else.) The goal is to design and develop broadband digital microwave radios that will be used to connect base stations, for example, or deliver high bandwidth information (such as Local Multipoint Distribution System or LMDS and Multichannel Multipoint Distribution System or MMDS technologies), as well as develop Internet appliances.

Dr. GUEVARA mentioned IP telephony which plans to do away with a microphone that needs to pass the computer and use instead a stand-alone device. IP telephony can be used in consumer multimedia and embedded products. A lot of products now, even cars for example, have multiple microprocessors. Since a car is a mobile transportation device and a lot of research is going into how to connect an automobile to the Internet, some car manufacturers are already offering portable telephony service similar to our cellular phones and hand-held computers.

To integrate all this, what we did at ASTI was to form a systems development team tasked with the overall coordination and system design of wireless technology focused on wireless communications. We are looking at broadband wireless communications access and short range connectivity solutions such as the up and coming technology that is Bluetooth.

In our work on broadband digital microwave radio link, we actually built the RF transmitter and receiver. Signal processing is of course

required to deliver the information. Voice or video need to be digitized; it needs to be able to be transmitted through the wireless channel and to do that, you need to do some signal processing. Some of the lectures this afternoon will focus on signal processing, modulation, de-modulation and also coding, which is very important. For instance, if you actually compare the cellular phones' text versus the pagers—for those who have used both—you will notice that in pagers, sometimes you receive garbled messages whereas texts from cellphones are accurate. The accuracy has to do with the coding process.

An undergraduate project looked at convolutional coding which is currently used in GSM or Global System for Mobile Communication phones. Another undergraduate research project on the E1 interface, seeks to bring information together and send them through this wireless channel. Our microelectronics division is also developing an RISC core processor based on Intel's Strong Arm. It is currently used in some personal digital assistants, cellular phones, laptops, computers and work stations. We see this as a key technology in Bluetooth.

Finally, allow me to quickly run through the papers that will be presented in parallel sessions this afternoon. The Communications Engineering Department will present an overview of the laboratory and some of the research they are doing in session A; in session B, LLOYD SISON will present our work in microelectronics and his other colleagues' work on RF mixers and low noise amplifiers for the sub-system. In session C, Dr. ROWENA GUEVARA will highlight our work on a DSP modem for a 2.4 gigahertz broadband link; NICK TOLEDO will talk about his undergraduate research on the 3.07 gigahertz transmitter and Dr. MARCIANO will talk about space time processing for wireless communications. Session D is on wireless systems and will highlight the broadband link. ROLANDO GUEVARRA will talk about the RF component while IAN WONG will discuss the wireless systems project. DENNIS VILORENTE will talk about the AIII project, the research that monitors some of the Internet technologies using wireless for Internet connectivity.

To summarize, there is a lot of work going on in these two R&D organizations. As Dr. ARNEL SALVADOR mentioned, the NIP also has the capability to make RF devices. We, the wireless experts—as I would like to call our group—have now identified certain areas for development and I just wanted to share this with the industry in the hope of establishing a linking relationship.

As we move forward after this conference, I just like to reiterate the challenge before us: to compete in this field not only in the software but also in the complete solutions field as demonstrated right now by the projects we are doing. We need to strengthen the areas of packaging, EMC (Electro Magnetic Compatibility) and EMI (Electro Magnetic Interface) testing. Intellectual property rights are of course important; at UP and DOST, this is a priority because the only way we can compete is to protect the research we are doing. Another concern is government's frequency allocation; we are having great difficulty in getting frequencies to use in wireless broadband and also for our satellites. Most of our researches are on the 3-4 gigahertz range but we would like to go beyond that for ultra broadband type wireless services. In the end, we hope to see our research results commercialized.

I would like to end with a message to industry: we would like to sustain and enhance our R&D, where we can do a lot together. We desire a link with industry so that we can do collaborative R&D as distinct from contract research.

The joint experimental facility established by UP and the Ayala Foundation is a good example and starting point. As for the wireless group, our immediate step is to form a wireless discussion group to look at the road map for the Philippines in terms of where we actually want to go. We are being tapped in the ASEAN region to take the lead in wireless technologies as ROLANDO GUEVARRA will attest to later when he presents a summary of the paper he presented in Malaysia.

Technology Venture Financing in the Philippines

MR. JONATHAN MADRID

Executive Director, iAyala

It has been fascinating listening to the presentations from the academe. Based on the quality of the presentations, I must say they are a very tough act to follow. To kick off the industry part of the presentations, let me share with you some of iAyala's thoughts on technology venture financing.

Briefly, iAyala is the Ayala Group's investment arm and holding company for its growing IT initiatives. We established the company in January this year and it is timely that as we complete our first year of operation, I stand before you to share our initial results.

iAyala is basically a start-up company. When we refer to e-ventures, we do not view the "e" as standing for electronic but rather for "entrepreneur." This morning's presentations illuminate the importance of the entrepreneur and I believe that both the academe and the entrepreneur will play a very important role in moving us forward. In particular, incubation will help entrepreneurs establish their start-up companies. Even corporations such as Ayala will continue to employ incubation as a way to build new businesses within the enterprise.

To provide a context for my short talk, I would like to ask what the new economy really is. Maybe it is worth a minute to step back and ask ourselves: Is this new economy for real? Will it have the same high-level impact that the telephone and electricity had over a hundred years ago? Is there now a new set of economic rules we have to play by?

A matrix describes four possible scenarios. The first is that yes, the new economy is real, there is a revolution going on where new players will win, where knowledge workers and where intellectual property will be our premium. The second scenario talks of a transformation, not a revolution but rather an evolution of change at a more modest pace. The third—which is the sort of scenario that we probably have today in the Philippines—is that maybe, this new economy is just an illusion and there will be many IT players who will fail to compete and at the end of the day, there will be many losers. The fourth, which is really the crash, burn and melt scenario, is when leverage brings down the market and everyone actually loses.

So it is worth asking: what does iAyala believe? Which scenario are we facing today? My boss—whom you heard earlier this morning—has expressed many times, at least for iAyala, that scenario 1 is the world we will be facing increasingly. Yes, the new economy is real and for Ayala, it will affect all our businesses.

I would like to describe what we think is going on in Asia because Asia and the Philippines will evolve differently from what we have seen in the US and Europe.

The present situation in Asia is that that it is a fragmented market. It is not one giant market but rather a collection, an aggregation of different markets, each with its own peculiarity. Obviously, the purchasing power and consumer behavior of peoples of Asia vary. Whereas in the US we have seen a wave of innovation, we still have to see that in Asia. I think we are capable of it as evidenced by the academe's presentations this morning but I think in Asia thus far, we have been more of adapters than innovators, making our evaluation models quite different from those of the US.

Lastly, venture funding is not readily available, as Dr. NEMENZO noted. There is no Silicon Valley. It is probably a dream to think we will create one, but I think we will eventually have our own Asian and maybe Philippine version of a Silicon Valley. I believe both UP and the Ayala Foundation have taken a small step toward that in establishing the joint experimental facility.

As Asia evolves differently, the business models will also be different. Both B2B and wireless applications—which we saw a little of this morning—will probably be more compelling here in Asia compared to the rest of the world. I believe traditional businesses will eventually converge and apply and embrace a wireless model. I also think conglomerates and incumbent companies, what we call brick-and-mortar companies in Asia, will remain important and therefore those with established industry knowledge will play a key role. That is why I think B2B will be very important and this afternoon we have a speaker from BayanTrade to talk a little bit about B2B.

Let me also mention a very special community that iAyala helped co-found, a community called PhilWap, which is the country's first wireless community. It is a non-stock, non-profit corporation that iAyala really wanted to help establish precisely because there is no Silicon Valley here. We wanted to establish closer links with the entrepreneur and try to emulate for the Philippines the success of India in software development in the area of wireless applications. Today I am happy to let you know that we have been able to hold nationwide forums for PhilWap: twice in Manila, one in Cebu, and one very recently in Davao. It is an open community where we bring together unlikely partners such as Globe and Smart, Nokia, Ericcson and Lucent. I would like to invite Dr. SABIDO'S group to be part of our PhilWap community. We have over 400 members and the community continues to grow.

Now I would like to talk about our venture capital (VC) activities, which are handled by Ayala Venture Partners or AIVP. The first stage of the VC process is what I call the Origination Stage where we try to solicit ideas and business plans from entrepreneurs. iAyala does this because we

do receive a stream of business plans fairly regularly. We also do this through networking with other VC companies; suffice it to say we get a fair number of business plans at different levels. We have a dedicated staff to screen these business plans, which is our first pass review. In this stage we look at what the product or service is and whether due diligence is necessary. Due diligence is a more thorough and comprehensive review of both management and the business plan that is being proposed. We look very closely at the revenue model as well. Then we undertake an evaluation that will involve some negotiation with the entrepreneur and the sponsor; that we establish a viable shareholders structure. Lawyers become involved soon after as we complete our documentation. After we make the investment, we do not desert the entrepreneur; we monitor his progress against his business plan's milestones.

The challenge VC companies face, first and foremost, is that in this kind of market scenario, with the Nasdaq crash and the overall economic situation here in the Philippines, the sources of funding are quite scarce. That is probably not surprising, and yet investors continue to demand very high return. There is also stiff competition for the viable business plans being generated. We are presently undergoing rather volatile domestic market conditions even as we are affected by what goes on outside. We have to balance our investors' demand for high returns and provide a clear exit mechanism whereby they realize their gains as well as manage the investee relationship. Based on our early experience, entrepreneurs are very fragile individuals who require a lot of handholding.

Furthermore, the flow of deals is slow. We established our first incubation facility in Cebu and received a lot of business plans, but not surprisingly, we still do not have an incubatee in our facility. In part this is because we have high standards. Some of the business plans we receive are rather raw; to help them qualify for incubation, we provide advice, an area where I think a group like iAyala can add a lot of value. What I have just described is really a very risky business. We impose high standards but make no mistake: it is a very risky business.

Now what do we in AIVP look at in a business plan? Basically, we would like to see a business plan whose addressable market goes beyond the Philippines, something that would at least have regional or global potential. Hearing UP's initiatives this morning, I think many of them would certainly have that potential. It is also very important to have a strong management team. We look not just for experienced managers but entrepreneurs with a lot of passion, who believe in what their ideas stand for and are prepared to work full time on their ideas. We prefer to come in early rather than late; in other words, we try to get in at a relatively low level of evaluation. We would like to see recurring revenue streams, meaning the business model would not involve a "one-off" selling proposition but instead a revenue stream that is sustainable over a long period. Last but not least, investors do demand a very clear exit strategy and in our experience, that would be not just through an IPO but sometimes by means of an acquisition by a larger player.

What are our preferred areas of investment? Number one would be wireless applications and technologies, and I need not speak here about the dynamic growth that wireless has shown not just in the Philippines but throughout the region. We are also very interested in any broadband-related initiatives as well as the services side; along with Internet enabling, such as data centers and customer contact centers. We have seen a lot of recent interest in US companies establishing or outsourcing their call centers here in the Philippines. With our very strong technical and talent pool, multimedia is another interesting area as well as online communities.

Finally, we ask an entrepreneur four questions when evaluating a business plan. Very simply: What is the product or the service? Does the product or service address an existing problem or market need? Who will buy the product? And lastly, will they pay for the product? Before I talk about incubation, let me make a distinction between where a VC comes in relative to where an incubation facility comes in. The difference really lies in the stage of investment.

Incubators, angel investors or angels, refer basically to friends and/or family of the entrepreneur who provide the very earliest stage of

seed capital. They would tend to come in very early at the inception of the business plan or product, so they would either come in at the seed level, at the start up phase or in the very, very first round of fund raising. The VC firms normally come in at the second or third round, or the round immediately prior to a public listing or acquisition. Otherwise, they are very similar to incubation companies who just come in a little bit early; they get more involved with the entrepreneurs, which I am about to talk about. What they have in common with VCs is that both demand a return on their investment. I would like to stress this because a lot of good ideas are born but business models are seldom established. This is where a lot of business plans are flawed, and this is also where both a VC company and an incubator desire to establish a very strong link with the entrepreneur to help them in their business planning process.

I would like to define for you what exactly is incubation. Incubation is a form of enterprise development that is very much focused on an early stage of an entrepreneur's formulation of his business plan. The role of an incubator is really to guide young companies or entrepreneurs through the very critical start-up period where concepts are new, they have to be proven, products still have to be developed and a management team has to be built. If a VC does a lot of hand-holding, incubators do even more with entrepreneurs. Typically, incubation companies provide hands-on management or business consulting expertise. We also provide very early stage financing although that is not all we provide. In addition, we provide physical facilities such as the joint experimental facility here in UP. Idea Farm is the first lessee of the facility and technology infrastructure.

Bear in mind that the goal of incubation is really to produce financially independent companies that are then ready for investment by VC firms. Why should we incubate? Idea Farm was established, for example, because we saw a role for companies like it to increase our deal flow and strengthen our own R&D efforts. Again, this is one common area where a company like iAyala and the academic community can work together. We do not have an established R&D facility and we saw an

incubation initiative as providing one such link, which we would like to foster with the academe.

Obviously, by investing early in a company, we also hope to earn higher return. However, coming in early also entails a higher level of risk and as evidence, only a very small percentage of the business plans we receive actually pass through the screening process. Having said this however, our active involvement in the early stage of incubation and investment mitigates some of that risk because incubation provides a more controlled environment for product development. Incubation also allows a much higher degree of investor participation in the establishment of the company; as the business plan matures, it allows a matching of strength and optimization of resources from the incubation company.

Just a plug for our company Idea Farm: our objectives are really to invest in start-up or early-stage companies. Idea Farm looks for companies that concentrate on services, applications and other Internet-enabling applications. Our vision, I repeat, is to produce financially viable companies that can stand on their own and receive investments from venture capital firms or be acquired by larger companies. We established our first facility in Cebu last September and we will formally launch Idea Farm in UP in January.

Like our venture capital company, we have certain criteria for incubation. The most important would be the quality and the experience of the management team, the uniqueness of the product or the service being offered and the recurrence of those revenue streams. We expect that a business plan, at a minimum, would describe the addressable market, the product or service, the financing requirements and very important, the management team and any relevant experience or track record. Of all these, the quality of the people who will manage and execute the business plan is the single most important component. As I often say, I would rather work with class A people on a class B project than work with class B people on a class A project.

I thank you for inviting me to make this presentation today.

Multimedia Systems

MR. PAOLO LOPEZ

Business Development Manager
Intel Corporation Philippines

I am going to tell you a story of Intel in the semiconductor industry and along the way, I will weave in how technology plays a part in the educational process.

Intel is in the business of semiconductors. Semiconductors are just chips made from silicon, one of the most abundant elements in the world. The generic name of silicon is sand, and basically what Intel does is sell sand. Of course there is a business and technology process associated with that.

The business of semiconductors is packing as much into a small piece of silicon as possible. Every time we pack more transistors, we etch more paths into the silicon and make that microprocessor perform better. For every acre of sand that Intel processes, we can generate US$1.3 billion in revenue. How does that affect us here in the Philippines? Intel is one of the biggest exporters in the Philippines, employing 6,000 people in Manila and Cavite. We are a big part of that $1.3 billion of revenue generation per acre of sand for Intel.

Let me give you a bit of history on the computing technology. From 1951 to 1970, the total number of computers shipped out was about

80,000. Back in the 1950s, computers were already around but of course, only the most powerful, the richest corporations could afford them. In 2000, we shipped out about 300,000 computers a day, or four times the number of computers produced in the first 20 years of computing. If you take all the computers produced in the first 20 years and add up all their horsepower or computational capability, they would do approximately 100 million instructions per second. Today, with the number of computers shipped per hour, 15 billion instructions per second can be done—about a 15,000 percent increase. So whatever we can ship in one hour today, the computational horsepower is 150 times greater than the computational horsepower of everything shipped 20 years ago.

What has driven this vast and rapid increase? Economics, for one, has lowered the price of computational horsepower. In 1991, the average computer could do about 10 million instructions per second, which on the average is about 10 to 15 megahertz. The price per megahertz at that time was $200. Today, you are seeing Intel-developed computers that are approaching 1.5 billion instructions per second and the cost per million instruction per second is less than a dollar, or 200 times less.

How is the industry, in particular, Intel, doing this? Again, this is an industry with a very unique economy. Intel uses the best in technology to manufacture our semiconductors.

One last example before I continue. Transistors are basically the building blocks of semiconductors or memory chips of electronics. Back in 1959, one transistor cost about $6. Today, a 64 megabyte RAM chip that has millions of transistors costs $6. So you can see, there is a thousand times decrease in the size, 10,000 times increase in performance and a hundred million-fold decrease in costs. What do these changes imply? Well, Intel President and CEO CRAIG BARRETT puts it, "In the automobile industry, advance was rapid as the semiconductor industry. If a Rolls-Royce would get half a million miles per gallon, it would be cheaper to throw it away than to park it." Just think of the progress

Intel and the semiconductor industry in general has achieved in the past 20 or so years.

Today, we are seeing a society, the global society, moving from being resource-based (from farming, fishing, mining) to what we call a knowledge-based society. The fastest growing industries in the world, including the Philippines, include biotechnology, semiconductors in computing, the financial industry and the telecommunications industry. Forty percent of the growth in the past four years in the US alone has been powered by these four industries. In the Philippines, we are also seeing growth coming from the semiconductor and the telecom industries.

If you are talking about a knowledge-based economy, where the service relies a lot on value and the knowledge or information the user can put into it, think of the information explosion we are in the midst of. Consider a very simple example: 10 commandments, about 300 words; Bill of Rights, almost 500 words; a Federal directive from the US to regulate the price of cabbage, 26,911 words. Can you imagine the amount of information an individual has to process? Information overload! The best tool to process this information in the knowledge-based economy is the computer.

How can the computer help in education? Students are better prepared for the transition later in life to industries which demand a lot of IT knowledge if they have a strong foundation or experience with IT in school. I got my first computer at the age of 10. It was one of those Timex-Synclair computers with a membrane keyboard and had one kilobyte of memory. I was addicted to that computer for two or three years and I believe it really gave me a head start. I feel the rest should be given the same opportunity. Of course, the computers they will be exposed to nowadays would be a billion times better than the one I had. Technology is a learning tool in education, and can be used as well to help schools manage their work so they can focus more on the learning process.

We are moving to a world of about a billion connected computers and today, most of the roughly hundred million computers out there are

connected by the phenomenon called the Internet. Through the Internet, all of us can share information with one another. How can students be exposed to the Internet?

Basically, a computer enhances the learning experience of students through multimedia: reference encyclopedias, language tutorials and training, interactive lessons and long-distance learning through video conferencing or the Internet. These are just some of the practical examples of using IT in education.

If you are looking at products for the education market, you have to look at the user experience as a whole. When choosing the correct system, consider the productivity capabilities: 3D, multimedia and Internet capabilities.

Ten years ago, you were happy with the green screen and the floppy disk drive for your computer. Nowadays, the demands of software applications put a lot of stress on the hardware platform. Take a look at how fast your computer can perform the actions asked of it. Intel has three types of microprocessors sold as desktops: Celeron, Pentium 3 and the recently launched Pentium 4. Celeron is our lowest cost processor, meant to provide consumers basic task needs. For education, however, Intel recommends the higher performing platform because it gives you investment protection. There is a lot of technology in Pentium 3 and Pentium 4 that allow you to use the hardware platform for the next three or four years. The technology is also powerful; it gives you 3D graphics, speech recognition and video editing. To edit the video, a digital non-linear device will be used powered again by the Intel microprocessor. Finally, before you is an MP3 player. This device can hold 12 days of music without repeating a single song. It is a tiny device powered by four penlight batteries, another example of where Intel technology is moving to. For MP3s you will need a computer to transfer high-tech CDs into the device.

Provide students with the right computational tools and you will be able to assist them as they learn. Students will be the source of new ideas and will drive the economy of the future.

Industry-University Collaboration in the 21st Century

MR. ART PASQUINELLI

Manager, Knowledge Enterprise Group, Global Education Research
Sun Microsystems

I am a global manager at Sun Microsystems. I have been working in education for about six years. I originally started off managing our marketing efforts to libraries. Since I began working at Sun, I have seen what we call the education market shift from a campus enterprise to a knowledge enterprise.

Library automation systems are now digital libraries. Things that never used to exist—like classroom oriented learning managements systems—are now basically provided by third party vendors like Blackboard and WebCT. Now you have electronic learning management systems and distance learning capabilities. What I want to talk about is how the dot-com economy is affecting the university environment: how companies think and how they and the academe could collaborate.

I will draw from my discussions with international universities and government officials. TRICIA HALLARI is our sales person for education at Sun Philippines; we have about 300 people dedicated to selling education at Sun Microsystems. It is one of our strategic focuses.

First, I want to go over what is happening in the dot-com economy. We are in an economy where human capital has the most important value. Companies are no longer evaluated solely on physical assets. The big mutual fund managers in the US, Europe and Asia are now trying to figure out how to evaluate human capital, the people who are the core of a technology company.

In the world however, are three issues relating to the digital divide. The first divide is between developed and less developed countries. At one end is the US, with 850,000 unoccupied IT positions. Thousands and thousands of Indians are coming to the US to work. My manager is an Indian, 20 percent of the Sun Management Team is Indian. Germany needs 360,000 IT workers over the next three years to fuel their economy. To do this, they are looking to bring people in. So what is happening right now is a world where people follow jobs. However, I see changes arising from intense 24-hour collaborations worldwide. These cross-border collaborations will change the flow of people into different countries. At Sun, for instance, we have a design center in India and a software design center in Ireland. You are going to see that it is in countries with human capital investments, growth poles, infrastructure, bandwidth and hospitable government policies that companies will invest, and jobs will follow people instead of the other way around. The second digital divide issue is tied to this change in the direction of the flow.

In 1980, Meryll Lynch did a study and found that the difference between the college-educated and non-college educated salary was 55 percent. Today, it is 111 percent or double. So, if you are college educated, you are going to be able to make twice as much money as someone who is not.

Third, and this applies to government officials and UP faculty, we in the university environment encourage and support e-learning, the delivery of quality courses that are as good as what you get on campus. Delivering these courses however requires high bandwidth and the countries that really succeed in e-learning are the ones investing in infrastructure and

bandwidth. In 1995, when I started this job, my advice was to put your investment in your bandwidth, into your infrastructure. Do not worry about what is on your desktop; put the connectivity on the campus. The same thing applies to a wall-less campus and this is what I will talk about in the next 20 minutes: how to deliver services via the Internet to the wall-less campus.

The Sun vision is to deliver a dial tone for your computer or for any other type of device. We call it "webtone." It would run 24 hours daily, seven days a week, like picking up a dial tone without having to carry your phone with you. The dial tone will be on the network and will follow you all the time: it is ubiquitous, highly reliable and provides secure applications. Like Microsoft said, as technology evolves and the economy develops, services will be rented out to universities and small and large businesses alike. Thus, instead of putting all your hardware locally, you may have your hardware 500 miles away but that application would be delivered to you over the Net.

Gartner, a leading market research organization, foresees that by 2003, PCs will constitute only 40 percent of desktops; kiosks, telephones and PDAs will become increasingly significant. All these different products are evolving, some of which we do not yet have.

The Internet will give you all your services: registration, course catalogs, mail, portals, academic services. You will have your own password and encryption so that no matter where you go, your identity, your authorization level to access the services will be on the network. This is important and I think most universities that are forward-looking in terms of e-learning subscribe to these services.

Also, you now see most innovative thinkers in universities coming out of the field of continuous education. As the industrial era gave way to the information age, classrooms have come to the students. Up until 1995, the classroom was the place to teach; it was also the way to teach and the medium of teaching. But today, types of evolving educational media will probably intertwine and will not be mutually exclusive.

By the end of this decade, you will have online courses of the same quality as those taught in college campus classrooms. Advising, assessment and other tools to administer e-learning or certification will also be online. The Open University in the UK has been doing this for a considerable time and the quality of their courses is as good as anything you will get on a British campus.

The vision of Sun, Microsoft, Cisco and Oracle is the same: to provide delivery systems to anyone, anywhere, anytime, on anything. And this is where Sun is broadening its program of languages across platform applications and operation systems. I know there is a lot of research going on here. Most universities in the world have now replaced their Pascals and C++ courses and the basic computer science course now is Java.

I hope I do not ruffle any feathers here but the trend is worldwide convergence in knowledge-producing organizations: publishers, television networks, libraries, museums, universities. You will therefore have to figure out what business you are in as a university. For example, in the US and Europe, companies that have content are buying up companies to deliver the content and administrative capabilities to higher education. Why? Because everybody wants a direct connection to your students. As we talk about some of the B2C and B2B type of portals that are coming up, I will show you some of the trends.

Recalling DONALD KAFSCOTT's thoughts on the dissemination of information, campuses now take in information from companies as much as they deliver information to companies. Firms like Sun, Microsoft and Cisco use universities as channels to train human capital since we cannot fuel our company or hire competent teaching assistants. As this new model evolves, schools have to analyze the courses they give and review their overall institutional presence and identity.

The university is the most sensitive barometer of social change, having to deal with a customer-base of students who do things by the Internet. In some countries, some students have never been in a bank: they do everything by the Automated Teller Machine or ATM. In short,

the university will increasingly deal with young people who have a totally different mindset toward the Internet and technology than that of your faculty and administrators.

The other matter I want to point out is financial pressure. What is happening between business and universities is interesting and I think the technology R&D effort here demonstrates the logic of tighter financial links between the two. This is already happening. As an example, I refer to the alumni systems' development generation program, one of the fastest growing software programs used worldwide. Long used in the US, which has large number of private universities, the program is now being used in the UK and Europe. After talking to the University of Manchester and a few others universities in Europe, I found out that some of them obtain 50 percent of their funds from non-government sources. This is also happening in Hongkong. We can then expect the financial pressure to grow as bandwidth and infrastructure needs expand.

I used to be in the library administration area, which is now called e-learning. Academic and research organizations require a library automation system to manage its collection. From six digital libraries five years ago, thousands have emerged today.

How is UP going to develop its digital library? How do you digitize that content? You will have to deal with the same issues: security, high availability, bandwidth and scalability. You cannot get enough servers and storage for digital libraries. It is unbelievable how much data they take in. Add to that the placement of courses online in web-based learning paradigms and digital format.

We used to talk about administration and infrastructure in enterprise systems. The main effort of companies like Oracle, SAP and Peoplesoft is portals. This is the extranet, the application that is driving a lot of administrators in the world nuts because of the peak periods that are extremely difficult. What happens when your server goes down during registration because you lack the capacity? This puts a lot of strain on your campus enterprise, which in the back maybe doing batch processing.

Consider also the strain coming from other e-services and curriculum development management, which organizations like Blackboard and WebCT address.

Thus, what we have is a very complicated model involving video servers, digital media managers, firewalls and security. How do you work in a dot-com economy in all these areas? Since you cannot develop all these applications in-house, you would have a plethora of third parties to deal with. This puts a whole different pressure on the university: finding the right vendors and developing appropriate partnerships. What hardware do you run on? What databases do they run on? How do they scale as an application? Do they have the functionality you need to run your library? What are the high performance computing academic applications you need to educate your student body? As you deal with companies, you have to think about what motivates them.

Let me use Sun as an example. Sun gives the Java curriculum to schools and assists in Java research. Universities and private companies the size of Microsoft or Sun work together in a multi-faceted relationship. If you have a researcher, we link that person directly with our engineers, usually on a topical basis. If there is a link between one and the other, we have a group within Sun that facilitates the brokering process but it is on the selective technologies we want, or that you have, or things you want from Sun which you can help us co-develop. The collaboration is thus a very focused program. At the moment, Sun is focused on wireless Java development in which we collaborate with universities worldwide.

Universities are no doubt a source of revenue for us. We do make money from education, you should know that: it is an accepted practice. We buy things, we give you things, you give us things; we have to think of the totality of the relationship. Companies need universities: you produce our workers. We cannot get enough people to run our companies and grow our economies. It has a lot of impact in the national level in the Philippines.

What do you want to produce? What do you want to export? Do you want to export Java programmers or low-tech workers? It is your

decision to make, but if you are giving them Java education, I can guarantee they will be making a lot of money, whether they are working in the Philippines or abroad. Java and Unix are the types of technologies you can not have enough of, so we are actually taking courses we or third party universities develop and we are offering them to other universities. If UP develops something, we will take that information and re-supply it to other universities or colleges. That is where leading institutions like UP can help because other institutions follow the lead institution. That is the way Sun always worked: we have always worked with lead institutions because the follower institutions will link in to that institution.

Incubation programs will be an offshoot of what you are trying to set-up here. We have set up a program and we are scaling it. We have already scaled it in Hongkong and I think Singapore too. We have about eight data sites right now.

Everybody wants to keep in touch with the new dot com technologies too. Now, Sun provides a link with our other vendor relationships. We do not sell every technology you need. Some companies try to do that but we do not, we cannot; so we link you up with other third party dot com technologies. This is evident in digital libraries. From six projects in the US funded by the National Science Foundation, there are now hundreds that originally developed as IT departments and libraries. These would mostly be consortia or government-sponsored with some links into industry, for instance like an Oracle database. Oracle seems to be the standard for the high-level database work going on in libraries. This mixture, this cooperation, is exactly what you are trying to do here. Libraries were the first to do this and partly it is because the librarians have that mindset: they like to share information, it is a community that shares every bit of information they can. But when you look at it, they have online databases, storages, and multiple database searching. They have always worked as a consortium to buy products—online products. So, it is a small step to go ahead and actually co-develop products.

When you look at what is going on in the digital libraries, you will see that this is the best example of how the dot com technologies are helping higher education. You have new types of technologies coming up— security, text retrieval, object databases—these are the things Microsoft and Sun wallow in; these are the third party companies that come in. We see new technologies coming in because they are developing with Java. All these vendors are coming to us; we link them to our university partners.

At Cornell, a leading institution, is a project that is probably the leading digital library project in the world. We linked in to them because we are helping them develop their technology foundation and they are showing what they are doing to the rest of the world. Library automation applications are industry-specific applications developed by companies like Endeavor and Exlibras. These are innovative interfaces we worked very closely with to get into different countries, into different markets. We can help you with that but I will be honest, the Philippines is not the biggest market in the world. You have the University of Minnesota opening hundreds of millions of dollars with some of these software vendors. University of Michigan does the same. If we go in and we say "yes," we can link in all the universities with you. I can bring in these vendors. That is the way industry cooperates. We do this a lot of times with a lot of associations we deal with.

A group at the University of Mexico has linkages with 150 universities in Latin America. We brought other private companies into that organization. They deliver academic programs, portal and library services to 150 Latin American universities. Those universities want these services but unless you have some type of force like Sun that says "yes, we're in this organization, we support it, we will bring other institutions, other companies into this institution," it is not going to happen. We cooperate closely and we call it "powering the knowledge community." We did the same with the group of chief information officers throughout Europe. I brought in companies like SCT, Black Orb and Oracle—technologies that are needed by the community into that organization.

That is the way companies like the Sun can work with different institutions. If the institution has the energy and the direction, we can work with it in almost any case or technology basis.

The dot-com evolution is going to affect the economy in one way. IT is very expensive. What happens when you educate someone in Oracle? Well, that person has about a two-year lifespan. One of the things I have seen is that universities do not always invest in their people. It is very important to invest in your own IT staff but you have to plan for attrition. One of the things that will happen in the future, it may not be 12 months from now but it will be 24 or 36 months from now, is that you will start seeing a service provider model evolving. You will have all the back-in functions I showed you before tied in to the custom portal.

How many people have been working on portals here? A portal is an interactive web page, a way for universities to communicate on a customized basis allowing one to one marketing with your student, faculty, parent and alumni. It is very important, this is where things are going and this is where the dot com economy, where e-commerce ties in to education.

You will have a portal, you will contact group of very wide, broad-ranged audience. You will have different access levels, authentication levels, even authorization levels. There will be one web with different authentication levels. It is the same thing Microsoft, Oracle and Sun says: one web, different access capabilities that will all come together in a customized portal. Underneath, you will have application service providers again. Your hardware may not sit in campus and that will change the IT capabilities you have to have on campus: it maybe more of a selection process of vendors or solutions rather than administering thousands of PCs.

Foundation technology is where you will have people like Sun System delivering web-tone infrastructure; ISP technologies is where we will be supporting the university environment. An example is Campus Cruiser where a lot of custom portal development is being

done by leading institutions. In the US, some of the campuses, because they're private, have gone along and said "we will live with a third party product that shows advertising." The companies grant it to them so they do not pay for anything. They put it up, and this is not even housed at the universities but at Exodus, which is a remote hosting partner where a Sun server sits. The school does not have to administer it since it just takes the server over the Internet. You do not have to do it for every service. It is financially viable because there are companies behind this doing Internet commerce. With this, you have an opportunity to buy off-the-shelf products.

Now, imagine a student who can not get into a course he needs. You have his profile so when the course he needs to graduate opens up, you have it there and connectivity occurs. Imagine if the bookstore burns down and you can not get the books. Well, there is a direct B2B link right there between the university and vendors like Barnes and Noble and Amazon.com. That is what precipitated the development of these portals. I think it is great because worldwide, even in the Philippines, what is happening is that it takes six years now to get a four-year degree because students can not get all the courses they need. Students have to put a large amount of time to get the right courses to graduate. If this can help optimize their efforts, they will love it. This is student-centered since they want to do their own work on the web. The University of Minnesota did the same thing: they wanted a portal developed on a customized basis so they had 20 IT staff do it. There is a story about this on the Sun website.

To finish, you will have web-based technologies, you will have one Internet, extranet and different levels of authentication and authorization for a faculty, an administrator or a student. The portal will allow you to talk directly to the parent, to the student, to the administrator: it will be customized for that person. That portal will also allow you to do more decision-making; you will be able to analyze what is going on with the student.

The first portal that took off in the US is the Gettysburg College, with 2000 students. The first thing they did was to monitor what was happening to each student, grade-wise. If there was a drop in that student's grades, they took him for advisement immediately. It is funny but I won't dwell on it: they allow parents to access the portal and see the student's grades if the student allows it. Only 15 percent of the students even allowed their parents to look at their grades. From what I have seen, I do not think it would be different for any country.

To finish, think of how you want to deal with an organization like Sun. We can collaborate, we can link you with other vendors: we work with leading-edge institutions. I found worldwide that the government usually sets the framework, the skeleton, the overall direction on a long-term basis. But it is really the people at the universities that have the vision and the energy—the two things that come to us and we link in with at Sun. I have seen that over and over again. For over six years, all our efforts at Sun were into different technologies developed as a result of innovations at the universities. We talked to the government officials but again, they need to set the foundation that you can work in, the skeleton and the direction, the focus that you can take so you are working within their realm. I have always found that there is someone in the university—it doesn't always have to be a big university—someone with a vision who usually forces Sun to work with him and the technology areas. If you are doing administration in Java, we have set up the worldwide www. Java in administration special interest group. Princeton, University of Delaware, University of British Columbia linked in together with their efforts and brought Sun in. We have an application clearing-house, totally free for any university that wants to see it, with about 60 applications in administration all written up in Java. They wanted to see our best practices, and asked: "how do we do that nationwide with all the other institutions?" We set it up so there are about 150 major institutions all doing work in Java. Now, they are starting to get-off into Extensible Mark up Language or XML and other areas so we have actually developed a framework, a u-portal framework all in Java 2 Platform,

Enterprise Edition or J2EE Java technologies. The universities can now take that architecture and develop their own portal for free. Those are the ways we work with the academe. We have a high performance computing consortium that is a little bit more Sun-oriented. We are going to set up a wireless consortium very quickly. Wireless is the hottest topic taking place in the universities today. But that is how we want to work with you.

The last thing I will say is: if you look at where you need to go, do not just focus on the hardware. Sun is a hardware company. By simply saying that don't focus on just the hardware, I mean put in the people and put it in the infrastructures and you can develop the bandwidth, which is probably one of the key things.

The Technology Behind Next-Generation Solutions for E-Commerce

MR. GREGG P. MARSHALL

President and CEO, Lucent Technologies Philippines, Inc.

Let me start off by saying I agree completely with what our previous speaker, ART PASQUINELLI, was saying about the need for high-technology workers. One cause of the difficulties we are experiencing in the high-tech sector right now, especially in the US where companies like my own are recording slowing growth and slowing development, is the shortage of experienced, talented technology professionals.

I would like to give an overview of what is happening in technology, starting with an illustration of what has happened over the last 2,000 years. Then I will talk about what is actually at hand in terms of technologies that will make the broadband and mobile Internet possible. It is this infrastructure that must come first for e-commerce to work. Until this infrastructure is in place, no one will be inclined to use e-commerce solutions, because the wait is long and unappealing. But once we can get going at high speed, things will change and e-commerce will become quite attractive.

Think about the speed of change of telecommunications technology. Paper was invented around 4000 years ago, the graphite pencil some 800 years ago and then astonishingly the eraser, 400 years after that. Compare the 4000 years to develop the means to write and publish with the recent speed of developments in communications. In 1990, the first trans-Atlantic fiber-optic cable was laid. That was 10 years ago. Now we have enough cable deployed around the world to make the globe look pretty much like a ball of string. All of that was accomplished in the last 10 years. Lucent last year increased by nine times its ability to produce fiber optic cable and we are still short, still meeting only 10 percent of the market's demand. We will add enough capacity to catch up but at the moment, if you want to buy fiber optic cable, I can only quote you 60 weeks to deliver it. The demand to get going faster on the Internet is just intense and there are other solutions coming up. These include all kinds of transmission technologies in the telecom world which are combining with fiber to make it possible to finally be able to move faster in the Internet. We will discuss these later.

What is making this kind of progress possible? One of the things that you are all probably familiar with, those of you who are involved in fundamental research, are major changes going on in our ability to produce silicon chips. You probably have seen announcements in the last couple of days concerning successful large-scale x-ray lithography and other kinds of lithography on silicon. As a result of this new technology, it will be possible within the next couple of years to produce 10 GHz CPUs the size of a pinhead. In addition to this 20-fold increase in processing power that will be available over the next few years, it will all come at a low price. Disposable digital devices that are more powerful than any existing computer will be available within our lifetimes. In addition to what is happening with silicon, consider optical technology. Companies like Lucent are already able to put 80 wavelengths of light into a single strand of optical fiber, which is about the thickness of a human hair. The glass used in the cable is so pure that, if it was placed

on a flat surface, you could look through it without distortion for over 80 kilometers. With this glass purity we are now able to put—and we have actually tested it in our labs—1,024 colors of light over the same strand. Two years ago we could only send four colors of light over the same strand. That is a 300 times increase in capacity over a single fiber, with an average of 96 fibers to a cable. And all of this has happened in the last four years, not the last 4000. There is every reason to believe there will be more to come.

Despite the excitement over optical fiber digital transmission, all the buzz in the communications industry right now is about 3G, or next-generation wireless technologies. Thanks to a lot of fantastic work done with algorithms and other mathematical research, we are now able to divide the radio spectrum in such a way where we should be able to have wireless networks that will give everybody one-megabit speeds Internet access on portable electronic devices. The ability to do that over the air exists today. In fact, the world's first 3G wireless networks are being built today. It is not coming tomorrow, definitely within the next few years. All this is possible because of tremendous breakthroughs in fundamental technology.

Yes, it appears that MOORE's Law is not going to hold. The law states that the processing power of chips doubles every 18 months while the cost drops by half. It appears that we are going to increase the power much more quickly than every 18 months. At the same time, reduced power requirements are going to make it possible to power such chips on all kinds of sources.

Where is all this technology development leading? It will lead us to all kinds of things we cannot even imagine and which are still fantasies even to those of us working in the industry. An example may be a handheld PC with an integrated always-on camcorder in the screen, or a pair of eyeglasses that can teleprompt for you. These things are coming and they are possible now given the technologies that have been developed to date. First, however, it has to provide us the kind of infrastructure that will make all these devices truly useful.

There are really five broadband delivery options that are going to be prevalent, that are going to carry the data and are really going to be the foundation for next generation solutions and global communication through the Internet.

One relies on current copper wire technology. You may have heard some buzz in the marketplace about a technology that is called DSL or Digital Subscriber Line. It is available from a number of carriers now in Manila. It is an access concentration technology that makes it possible for us to move huge amounts of data over existing telephone wires. If you have a telephone in your house, you should be able to get very fast Internet access. And by the way, it should not be very expensive. If it is expensive, it is only because the communications companies that dominate the marketplace continue to want to charge too much for the services they are offering, but this is a separate subject. In other words, with virtually no upgrade to the technology you have in your home, anyone with an existing phone line should now be able to have very fast Internet access.

Another way of delivering broadband access is over coaxial cable, the kind that is used in cable TV systems. There are at least three companies in Manila that are offering fast Internet access over cable today. They are Destiny, Now, which used to be called Home Cable and which is a subsidiary of PLDT, and Sky Cable of the Lopez group. This technology has a couple of problems associated with it. One is that it runs on a serial principle, with total bandwidth divided among the users online. It is blinding fast if you are the only person on the block accessing it. If you go online between 7 and 11 p.m.—when everyone else in the neighborhood wants to be online–you get slower speed than dial-up. But we are working on solutions to that problem, and I hope they come soon, because I am about to jump ship and go to another technology — which is what we all do when we don't get the kind of service we want. We vote with our feet. We go somewhere else. Technology will not change this.

A very exciting technology that is coming soon is 'fiber to your home.' It has been possible to deliver fiber access to peoples' homes just as we do now to businesses, but it has been prohibitively expensive. More and more, as cable manufacturing capacity comes on line and as we develop the technologies to split-off those rays of light—those different colors of light over the fibers—we will be able to discreetly install fiber optic access into individual homes. That is coming within the next few years and should make it possible for us to get very high speeds of data over fiber into your home. This kind of capacity to the desktop will make it possible to watch movies in real time and have full-motion video on computer-mounted web cameras.

Two other access technologies are direct broadcast satellite, and as I mentioned earlier, the intense promise of next-generation wireless services. Any of these technologies should yield data transfer rates somewhere between one and eight megabits per second – 200 to 2000 times faster than dial-up modems. Using such technology, the Internet should be accessible on any PC at a rate of hundreds of pages per hour, instead of the 5-10 accessible using older technologies. These kinds of speed make all the difference in how the Internet and applications based on technology can apply to our lives.

I want to take just two minutes to close my discussion by talking about where I see the university community teaming up with industry, particularly here in the Philippines. It is not easy to do fundamental research in communications technology, to get into that business now as a university institution. It is just prohibitively expensive. Lucent Technologies alone spends $5 billion a year to bring research to telecommunications. The scale required to do this kind of fundamental research—the Ph.D.s, the labs, the infrastructure and the community to really make it possible—is not achievable on a smaller scale. We need to bootstrap ourselves in some other way. My suggestion is software. I am really a firm believer that software is the future of communication and a great promise for young people all over the world. All of the new devices and technologies require

new software to run; whether it is an operating system for an access technology, or an application that runs on the operating system, or a mediation device between discreet technologies that require interconnection or some sort of software interface. At the moment, the demand for software far outstrips our ability to supply. We do not have enough people who understand software. We do not have enough people who write code, or who can integrate systems. It's not easy to take technology from Lucent and Cisco, a box from Nortel, one from Alcatel, Ericcson, Siemens, Nokia or any of the hundreds of other companies that are producing powerful equipment in this industry space, and patch the software together so we realize the promised seamless network that we all seek.

My parting thought for all of you is reminiscent of a famous scene from the 1968 classic film, *The Graduate*, a movie that was made before many of you were born. During the scene a young college graduate asks a friend of his father's what he ought to do with his life, and the wise, if geeky gentleman says, simply "plastics." Some 30 years later I would say "software." Everyone needs it. Without it, there would not be any backbone for e-commerce solutions.

Summary

MR. FILEMON BERBA JR.

Senior Managing Director, Ayala Corporation

This affair is a landmark activity for UP and for industry. In these turbulent times, when politics, morality, issues of competence and national leadership (actually the lack of it) take center stage, we need to take a break. We need to move away from television, radio and the newspapers so we can take stock of our situation in technology: our strengths, how the rest of the world is moving ahead and so on.

We have so much human capital in this country, particularly here in UP that we can tap, but government priorities are still distorted and clouded by easy money and gambling, on unproductive endeavors. We have to get out of that mode and really be serious and talk about something more meaningful, more substantive. Today, we covered so much in so little time, but the affair is just a teaser, the first in a series of activities focused on technologies—most specifically on information and communication technologies that are crucial in this age dominated by the Internet.

The Internet is now so pervasive and will be more so in the future. Education and industry will ride on Internet technologies so that at this point, to be left behind is a prescription for self-destruction. We cannot afford not to be there. The world of business depends on the

Internet both for its efficiency and for its expansion. Adjusting to the new environment is a must. The academe also has no choice but to embrace the Internet and evolve new ways of making it even more effective for education.

Now, UP has always been a center of excellence, a place where bright, young (and even not so young) people and technology flourish despite the very critical shortage of resources. It is time therefore that industry recognize that helping UP is really helping itself. This is what linkages are all about. There is so much brainpower available here: the only thing needed is to put that brainpower to use here in the Philippines, here in UP and not abroad.

Do you know that it costs industry so much to tap imported brainpower, which in most cases are even inferior compared to what we have in UP and other local academic institutions? I have met expats who were brought here with much less capabilities or competencies and were paid as much as 20 times more than was paid a better local technical person. Unfortunately, that is a reality that still has to be corrected.

Let us summarize what we have discussed today.

We started with President NEMENZO reiterating his vision for UP anchored on technology, particularly, Internet-related technologies. He is confident we can do a Bangalore as India did if we do the right things now. Then came JAIME AUGUSTO ZOBEL DE AYALA II, who talked about the new economy and why industry will undergo major changes in the way it conducts itself. He talked about the role of the academe and UP in the process. I am happy that over the years, I have been able to introduce Mr. ZOBEL to UP and his attention now is not exclusively for Ateneo and La Salle. I have invited him here several times and I have introduced him to three UP presidents and now it has borne fruit. I think he is now committed to UP.

Director LILIA DE LIMA of PEZA talked about the IT parks and what she is doing about it. Again, Atty. DE LIMA is one of the government

officials I have a lot of respect for. She is also a hard working, hard-hitting promoter of the Philippines.

Let us go to the presentations of the people from the academe.

We started with Prof. LOUIS ALARCON who gave an overview of the capabilities of the Electrical and Electronics Engineering Department and the Materials, Metallurgical and Mining Engineering Department of the College of Engineering, the National Institute of Physics and the researches undertaken in their respective laboratories. Dr. ROWENA GUEVARA of the College of Engineering talked about digital signal processing or DSP– from analog, to digital, to analog. She also discussed the pervasive influence of DSP on our daily lives: in our cell phones, VCRs, DVDs, security and VoIP. Dr. MARK ENCARNACION talked about Internet technologies, its various applications, his "Gets Mo? Gets Me" e-mail web browser. Dr. ARNEL SALVADOR talked about the physics laboratory and his basic reasearch on wafers, lasers, photon detectors, fiber optics, various wireless broadband access and solutions relating to wireless applications.

In summary, let me say that the academe presenters talked about the exposition of competencies and the initiatives being undertaken in the university's laboratories.

At this point I would like to say that we can actually do a repackaging of the academe group's presentations, and at some point early next year, make a presentation to industry groups selectively. In particular, I propose the Semiconductor and Electronics Industry foundation (SEIPI) that has about 400 plus membership. They do need the kind of things that academe can offer, but they do not know what are available. If we can make some kind of arrangement, this awareness can actually trigger relationships and sponsorships: Intel and other companies already know but there are others who do not. The moment you talk about availability of these competencies in Japan, the US and even Europe, tremendous interest can be generated and they will come to visit us. Can you imagine if we can show the capabilities that are available here and if we can polish up what we can offer? I think we can move forward.

Now let me go to the industry presentations. I think under the circumstances, the industry presentations are fair. They told us what they were doing. I do not think they were doing any hard sell, they were just telling us what they were doing given the circumstances. With the time available, I do not think there was enough prior interaction for them to really link up, but they had to show what they were doing.

We started with iAyala's JACK MADRID. He talked about Ayala Corporation's e-commerce initiatives, through iAyala. He talked about entrepreneurship, the incubators, how they started in the Philippines with a little venture capital. He talked about iFarm, established to help start-ups. We are in that very early stage that we cannot compare ourselves, our initiatives with those being done in Silicon Valley. One of the first things here of course, is the non-availability of venture funds. We need a few successes that will stimulate interest from both the proponents and the funders, but we have to start somewhere.

Atty. RUDY SALALIMA, president of the Philippine Electronics and Telecommunications Foundation, traced the telecom industry from the inefficient monopoly of the 1960s, the 1970s to the current deregulated environment. Those of you who are old enough will notice that 10 to 15 years ago, when you applied for a telephone line, you were lucky to get one in 10 years. You were extremely ecstatic if you got it in five years. Of course, by that time, you would have paid P 30,000 just to get a line. Now everybody is trying to get you to put a telephone line. That is what deregulation does. Teledensity went up, from one per 100 in the 1970s and now over 15 per 100, which is a very substantial increase. But it is still behind what you would have in Malaysia, Singapore or even Thailand, which is probably double ours. He talked about some aspects of the legal systems, how convergence will affect telecommunications here because there are some legal impediments and this is why he is making representations with the National Telecommunications Commission.

PAOLO LOPEZ of Intel talked about silicon and sand. Can you imagine that an acre of sand that is less than one half of a hectare can sell for

$1.3 billion? That sand of course, will need a laboratory worth $1 billion to manufacture a wafer. Basically, what he is saying is: sand makes wafers that gives you the chips. He talked about the explosion in the use of computers, in terms of the number of computers that were shipped and more importantly, the explosion in the capacity of the computers. The computers in the 1960s and 1970s were as large as a room; now they are the size of a matchbox. That is what progress is about. He also talked about the MP3 player, which many of us do not recognize. He says it can run for 12 days without repeating a song. One CD has actually 16 songs which plays for one hour. Now I can imagine how many songs you have in one MP3 player. That is quite a lot.

Microsoft, represented by Mr. RITCHIE LOZADA, repeated what Mr. LOPEZ of Intel said: that the Internet will dominate everything. He introduced us to concepts like B2B or business to business, B2C or business to consumer and ASPs or the Applications Service Provider. The ASP again, is a very pervasive thing. It is already in the US. Our honoree, DIOSDADO BANATAO, has gone one step ahead of that. He has New Moon, an ASP that will deal with service providers. Basically, service is a very important development; thus he proposed a consumer-centric unified language.

ALBERT MANLULU of Siemens talked about IT Telephony, voice over the Internet protocol (VOIP) and the IT promise of a unified multimedia, single network interface, mobility, and so on.

Bayantrade actually is a B2B business that was put together by six companies. These are not just six companies; they are the six leading companies in the country: the LOPEZES, the ABOITIZ, the ZOBELS, the GOKONGWEIS , United Laboratories, and PLDT. They think this initiative will actually lead to something beneficial to all the participants and may eventually become a model that can make us participate in the regional or global B2B type of business. From the given information, they can save anywhere from five to ten percent of your transaction cost, which is very substantial if you are talking in billions. He thinks that based on

the initial successes or indications, we can be a participant in the regional or global B2B market place.

Sun Microsystems, represented by Mr. ART PASQUINELLI, talked about the impact of dot coms on education. He talked about distance learning and the possibility of having to restructure the educational system in line with the new Internet environment. He talked about teaching anyone, anywhere, anytime, anything. What is important, what is meaningful is what he said and it is something we should seriously think about. So far, the Philippines has been sending people to where the jobs are, that is why we seem to be doing body shops and we send people all over. But with the Internet, with the IT environment and with the competencies that we can develop here, it is possible that the jobs will go where the knowledge people are. There is a little caveat here which I think we should all work for very closely to happen: this will only happen when we have broadband high-speed access. If that were not possible with our telecommunications system, if we do not have that infrastructure, then getting the jobs, doing the jobs here is still not going to happen. That infrastructure is a must. When that thing is here, what Mr. PASQUINELLI predicts is going to be a reality.

GREGG MARSHALL of Lucent talked about disruptive technologies. I read a book, *Innovator's Dilemma*, by CLAYTON CHRISTENSEN of Harvard about disruptive technologies, which actually are technologies that make existing technologies obsolete and can therefore cause the bankruptcy even of currently successful companies if they did not respond. These are the new and cheaper technologies that come in and change the way we do things and change the way technology or businesses are conducted. This development came about from the research laboratories.

MARSHALL talked about disruptive technologies that would lead to very substantial cost reductions in the alternative technologies that will be in use by industry. This is also related to PASQUINELLI's predictions that jobs will follow where the knowledge workers are. MARSHALL said let us develop software, and yes, I agree with him. We should really take

that very seriously. That is to be taken in concurrence with the other things that I mentioned on infrastructure.

When I was talking with GREGG, I suggested they nominate an adjunct professor to work with the College of Engineering and he was very receptive to it. I had him talk with the College's Prof. LOUIS SISON. I think you can get a high-powered professor for no cost to UP. All you do is give the guy the title Adjunct Professor. The Board of Regents has already approved this position. We are doing it in the manufacturing sector. The company gets to say it is a good corporate citizen, the person gets to say that he is a professor in UP, and UP gets this benefit free. So I think that is something industry and academe will work out very well.

We have to break the barriers between industry and the academe, between industry and UP. UP is here in Diliman, it is far from where executives conduct their business, which is mostly in Makati. The factories are mostly in Laguna and Cavite. Given that reality, UP must take some initiatives to go out of its way. You cannot just be here and say "Come here because we are good." You have to show them you are good, that is why I am also suggesting a follow through to this kind of an arrangement. The academe, we here must be exposed to what the market realities are, what the needs of the market are. Similarly, industry must be exposed to the capabilities that are available here. I know that when they come here they will be impressed. But unless they see, there is no way that reality, that awareness can take place.

To sum up, let me just say that markets are the main drivers of technology. But the market is tapped by the people in the industry, so industry taps that market and develops technologies and then needs the academe to complement the technology initiatives of industry. And this is where UP comes in: academe can supply the main manpower and brainpower. Companies and industry actually get their employees from the schools. The rationale, the justification when we approach industry is not "We need you." We go to industry and say "You need us because if you do not help us, we may supply you with half baked-graduates. And what will you have?" But if they help academe, they will benefit

from good graduates and therefore, it is an investment and not an expense on their part since the academe supplies the brain power.

There is also another thing. Generally, the market drives technology. In many cases, the technology, be it basic or applied, develops through the R&D in the academe. This becomes something industry can use to create a market. Some of the markets that now exist never existed before; these just came about because something was there. As an example, although not in IT: did you know that 3M's Post-it is an accidental development? The same is true with Ivory soap. There are others in the technology field. When I was in Silicon Valley, I visited Stanford and talked to those who set up Stanford Technology Park. They were telling me stories about certain people who looked like they were going nowhere but became multi-millionaires from the unexpected success of things they produced. So while markets drive technology, some technologies can actually be developed into markets. Thus, industry and academe must constantly talk and work with each other.

I can say, not in criticism but more of a reminder, that I have been working with people in the College of Engineering for many years and I have admired some of the products some people have developed. But you know, when I am able to get somebody from industry to get interested and do a beta test on the products they have developed, it just does not ring a bell with the people here because they seem to be concerned with just developing a product. You cannot just develop something and let it stay there. If it is good, there is a market, especially if you start with some need.

With that, I would like to wrap up and say I think this symposium is a very good initial step, the first industry-academe linkage on the subject of information and communication technology. Let us not make the mistake of stopping here. This is the beginning. Let us get the interest of decision makers in business and industry.

Closing Remarks

CHANCELLOR EMERLINDA R. ROMAN

I can actually make life easier for all of us by simply saying thank you and good bye. But we in the university have this talent of giving messages in so many words. And that is what I am going to do now. As we close today's conference, we would like to extend our appreciation and thanks to a number of people. First, our sincerest thanks go to Mr. FILEMON BERBA who was given the most difficult assignment in this conference. He just gave us a summary. To be able to give a summary, one has to stay and listen to all the presentations. He did this for the benefit of those who were not able to attend or listen to all the sessions. So, thank you JUN for that very good summary. We would also like to thank you, the participants, for staying with us the whole day. Your presence here speaks well of the future of industry-academe cooperation, and this is something that we, in the university, would really want to cultivate. We would also like to thank our speakers from industry as well as our colleagues from the university for their presentations, which somehow gave us glimpses of what each one is doing.

Now, Pres. NEMENZO in his speech this morning said this is the first ever conference of its kind. JUN BERBA describes it as a landmark activity which brings together industry and academe to discuss the future of

ICT and for us to show each other what we are doing. We hope this conference has really paved the way for future cooperation and collaboration.

Thank you and good afternoon.

MindLink II

Industry-Academe Conference on Biotechnology


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Industry-Academe Conference on Biotechnology

SEPTEMBER 7, 2001
APEC CENTER, UP LOS BANOS

PROGRAMME

8:00 am	**Registration**
8:30 am	**Welcome Address**
	Dr. Francisco Nemenzo
	President, University of the Philippines
	Keynote
	Dr. Estrella F. Alabastro
	Secretary, Department of Science and Technology
8:45 AM	**Overview of Biotechnology: Challenges and Opportunities**
	Dr. William Padolina
	Deputy Director General for General for Partnerships
	International Rice Research Institute
9:15 AM	**Intellectual Property Rights Licensing and Special Issues**
	Atty. Jose Ma. Ochave
	Member, National Committee on Biosafety of the Philippines
9:45 am	**Open Forum**
10 am	**Break**
10:15 AM	**TAPI's Experience in Government-Industry-Academe Tripartite Collaboration in Biotechnology**
	Mr. Tomas B. Brinas
	Division Manager, Technology Commercialization Division
	Technology Application and Promotion Institute
	Department of Science and Technology
10:35 AM	**Animal Biotechnology**
	Dr. Angel L. Lambio
	Director, Institute of Animal Science
	UP Los Baños

	Dr. Salcedo L. Eduardo *Dean, College of Veterinary Medicine* *UP Los Baños*
10:55 AM	**Plant Biotechnology** Dr. Evelyn Mae Tecson-Mendoza *Program Leader, Institute of Plant Breeding, UP Los Baños*
11:15 am	**Industrial Biotechnology** Dr. Teresita M. Espino *Director, National Institute of Molecular Biology and Biotechnology, UP Los Baños*
11:35 AM	**Health/Medical Biotechnology** Dr. Nini Gloriani Barzaga *Director, Institute of Biotechnology, UP Manila*
11:55 am	**Lunch Break**
1 PM	**Marine/Aquatic Biotechnology** Dr. Lourdes J. Cruz *Head, Biochemistry and Toxinology Laboratory* *Marine Science Institute, UP Diliman*
1:20 PM	**Developments in Sugarcane Biotechnology** Mr. Leon M. Arceo *Director General* *Philippine Sugar Research Institute*
1:40 PM	**Developing the Frontiers of Biological Industry** Mr. Wilfredo Rivera *President* *Tryco Pharma Corporation/Riverdale Industries*
2 pm	**Open Forum**
2:20 pm.	**Parallel Sessions**
4 PM	**Break**
4:15 pm	**Plenary Session: Summary** Dr. Benigno P. Pecson *President* *Biotechnology Association of the Philippines*
4:45 pm	**Closing Remarks** Dr. Wilfredo P. David *Chancellor, UP Los Baños*

Keynote Speech

DR. ESTRELLA F. ALABASTRO

Secretary, Department of Science and Technology

In this air of liberalization, in this knowledge-based world economy, biotechnology is one of the more important topics where a healthy dialogue between key sectors of our society such as the academe and the industry is needed.

Recent advances in knowledge and techniques in molecular biology have brought the technology at the cutting edge of agricultural and industrial applications. Biotechnology has enormous potential for enhancing agricultural productivity and food quality, energy production, health and medical applications, and environmental management and protection. Thus, it has stirred excitement not only among scientists and technologists but also among informed citizens, including business people and policy-makers.

Presently, there are genetically engineered products such as crops with built-in resistance or tolerance to insects, diseases and herbicides, and fruits and vegetables with delayed ripening and other desirable handling characteristics. Cooking oils and food supplements with health-promoting qualities are also now available off the shelf.

It is predicted that in 50 years, biology would itself provide the means of production, and industry may go the way of distributed biological

manufacturing based on a living industrial infrastructure. Much like a spider producing high-strength spider silk at low input cost, such future economy will showcase decentralization and democratization of production, energy and resource efficiency, as well as inherent flexibility. Indeed, the twenty-first century is the age of biology.

While biotechnology is regarded as a cutting-edge technology of the new economy, it is also widely considered an "abling tool," particularly for cash-poor but resource-rich countries.

The variance in levels of sophistication in biotechnology gives it an attribute of flexibility in applications that suit the needs and capabilities even of developing economies. Thus, the Philippines can develop its own niches in the global biotechnology industries according to its strengths and resources.

Let me share some information on our national capability and comparative advantage in biotechnology.

In the 1990s, the Asian Productivity Organization ranked the Philippines among the top three in Asia (together with China and Korea) in research capability in biotechnology, particularly in the fields of agriculture and livestock research. Moreover, the Philippines is an acknowledged leader in the development of microrisal and biological in nitrogen fixation systems and strains that promote efficient utilization of water and soil nutrients.

The Philippines institutionally embarked on biotechnology in the early 1980s with the establishment of the National Institutes for Molecular Biology and Biotechnology at UP Los Baòos (UPLB). In 1987, the Philippine Council for Advanced Science and Technology Research and Development (PCASTRD) was organized in the Department of Science and Technology (DOST) to coordinate and manage research and development (R&D) in biotechnology and other advanced science and technology (S&T) fields. PCASTRD has been overseeing the implementation of a five-year biotechnology S&T plan, drafted in consultation with the academe, industry and government sectors. Likewise, there were planning councils for other sectors such as

agriculture, health, aquatic and marine resources, as well as for industry and energy.

Public R&D institutes and state universities have been active in the pursuit of biotechnology research, human resource development, institution development, and other capability-building projects. Since 1989, PCASTRD alone funded and saw to completion 20 biotechnology research projects.

In recent years, our national infrastructure for biotechnology has been strengthened through DOST initiatives and Presidential Proclamation 526, signed in 1995 by then President FIDEL V. RAMOS. The proclamation constituted relevant research centers in four campuses of the UP System into the national network of National Institutes of Biotechnology and Molecular Biology.

From 1994 to 1998, DOST implemented its US$150 million Engineering and Science Education Project (ESEP) to upgrade our national capability in priority areas of science and engineering, including biotechnology. ESEP aimed to develop a critical number of highly qualified S&T personnel—masters and doctorate degree holders—and at the same time upgrade laboratory and library resources to bolster our country's technological capability in an emerging global economy.

At present, our bio-sciences research sector is strongest in terms of human resources and facilities. As of 1998, data collated by PCASTRD at DOST showed the bio-sciences accounted for 62 and 83 percent among MS and Ph.D. holders, respectively, in the advanced S&T sector, corresponding to 255 and 301 warm bodies.

While our facilities and research centers are certainly not at par with those of developed countries, the basic requirements for many biotechnology applications such as tissue culture labs, genetic transformation tools and equipment, and green house facilities are available in key research centers, particularly those at several UP campuses.

Our national biotechnology research and development program yielded outputs and information with commercial potential. Non-capital

intensive, low and mid-end biotechnologies like bio-fertilizers, inoculants, virus-free seeds, tissue cultures, vaccines and diagnostic kits comprise the first wave biotechnology products from UPLB's Biotech and other research centers. These products enhance crop yield while promoting soil fertility. Second wave products include monoclonal antibody kits, industrial enzymes, flavor esters and tailored fats from coconut oil. Biotech has also worked out the microbial production of lysine, an industrial amino acid for the food and feed industries.

Currently, DOST's medium-term agenda is geared toward ensuring better production of key agricultural crops and livestock to provide for our domestic needs and to meet the exacting standards of the export market. Likewise, it aims to establish local capability in the production of high value industrial chemicals and products. Our plan also promotes wider access to drugs effective against widespread debilitating diseases, as well as to biologicals for disease prevention and health maintenance.

For industrial and other advanced applications, our thrusts are to develop and produce new, advanced and high value added materials and products like tin films, magnetic materials, biodegradable plastics, separation members and others from indigenous resources.

In high-end biotechnology research, efforts have been focused on key commodities and key crops, namely banana, mango, papaya, coconut and corn. Among our research objectives are the development of research on resistance to the banana bunchy top disease, papaya ring spot virus, and the Asiatic corn borer. In addition, we seek to attain delayed ripening characteristics in both mango and papaya and higher proportion of medium chain triglycerides in coconut oil. These products are intended to give our agricultural and industrial sectors a comparative edge in the global market.

In health, a banner project targets the development of anti-cancer drugs from indigenous sources to combat breast cancer. We have also developed simple and rapid diagnostic kits for schistosomysis, hepatitis and blood disorders.

The government has long recognized the crucial role of biotechnology for global competitiveness and sustainable development and has provided the policy framework for biotechnology development in the country.

Starting from President CORAZÓN C. AQUINO to President GLORIA MACAPAGAL-ARROYO, four presidents have approved national policies intended to pursue the development and utilization of biotechnology for the good of the Filipino people.

Executive Order 430 promulgated in 1990 by President AQUINO constituted the National Committee on Biosafety of the Philippines as a multi-sectoral and interdisciplinary body to review and approve activities related to genetic manipulation.

In 1991, the Philippines became the first Asian country to adopt bio-safety guidelines for laboratory research and other activities related to genetic engineering or modern biotechnology. In May 1998, guidelines on planned release of genetically modified organisms and potentially harmful exotic species were published.

The Department of Agriculture has drafted commercialization guidelines that are presently going through a series of consultations among various stakeholder groups.

The immense potential of biotechnology as an empowering technology has been widely recognized. Moreover, along with information and communications technology, biotechnology is regarded as a force that can reshape our society and the future. Yet, for most of the developing world, the principal challenge is how to realize biotechnology's promise of benefits and advantages, particularly for addressing the critical concerns of food security, environmental degradation and mass poverty.

The potential for realizing benefits from biotechnology is premised on adoption and widespread diffusion. As it is, the absence of a robust bio-industry is a negative factor.

Another critical factor is the public perception of modern biotechnology. If the public is conditioned to associate with phrases

like "Frankenfoods," genetic pollution, playing god, etc., then the wide-scale use of biotechnology will be slow in coming. In this regard, the reported uprooting by farmers and civil society members of experimental BT corn plants in field sites in South Cotabato is lamentable, as the incident preempts science-based evaluation of this new technology. Lack of accurate information, mostly negative media publicity and even global trade issues have actually muddled the whole biotechnology debate. It is my hope that we all would actively and proactively engage in the essential public education and dialogue on biotechnology. Accurate and balanced information should be part and parcel of decision-making and consensus building on biotechnology.

Undoubtedly, each country has the prerogative to formulate policies and strategies for the safe and wider use of biotechnology appropriate to their particular socioeconomic, political and cultural context. There is need to devise strategies that would optimize the delivery of benefits from technological breakthroughs of biotechnology to the most disadvantaged sectors, such as small farmers and indigenous communities who have economically useful information on local plants.

To accelerate the appropriate utilization of biotechnology, our strategies could include the following: 1) promoting private-public partnership; 2) forging corporate alliances; 3) encouraging enterprise development; 4) building capacity and biotechnology through research and training programs; 5) creating institutional networks of knowledge and information exchange; and 6) strengthening of regulatory capacity.

The forging of strategic alliances, a phenomenon widely seen in the US pharmaceutical sector, merits serious attention. Basically, research alliances have three important players: universities, small entrants and the large incumbent firms. Strategic research alliances are formed to bring the players' complimentary competencies together with the goals of advancing the technology and introducing commercial products to the market. Universities and research institutes are viewed as the source of knowledge and talent, potentially important breakthroughs and

intellectual property, and access to the large number of subjects for clinical trials.

Start-up firms embody the commercial application of university knowledge, while large companies possess experience in large-scale production, marketing and distribution. In the Philippines, the public sector has historically borne the torch for scientific and technological work in biotechnology.

As the private sector slowly assumes this responsibility, government can move out of this area to focus more on its prescribed role of ensuring a favorable policy environment in an adequate regulatory framework.

We hope this conference will provide the spark that will ignite an enduring academe, public and private sector collaboration where the private sector clearly takes the lead in the responsible application of a technology, for the benefit of the Filipino people.

Overview of Biotechnology: Challenges and Opportunities

DR. WILLIAM PADOLINA

Deputy Director General for Partnerships
International Rice Research Institute

What I would like to do is to benchmark and show the prevailing global trends in biotechnology.

Let me start by reviewing the definition of biotechnology: the application of scientific and engineering principles to the processing of materials by biological agents to provide goods and services.

Biotechnology is a field of study, not a discipline. There is no such thing as a 'biotechnologist.' Biotechnology puts together a team of people who are molecular biologists, geneticists, biochemists, food technologists, engineers—and not one of them can be called a 'biotechnologist.'

The hallmark of modern biotechnology is recombinant DNA technology. It involves procedures used to join together segments of DNA, and in a reaction outside the cell and under appropriate conditions, introduce the recombined DNA into the cell and make them part of the heritable make up of that cell. Because of this very important discovery, the applications of biotechnology have become wider.

In agriculture, many developments are taking place in varietal improvement of plants, animals and fish. These developments also introduce cultural management techniques that will allow sustainability or sustainable production.

In industry, bio-transformations dominate the scene in terms of enzymes which are used in many of our daily needs such as detergents, textiles, beverage, alcohol, pulp, paper and in baking. There is also bio-remediation and waste treatment.

In the area of plant, animal and human health, developments have really been very interesting in the field of diagnosis, new drugs and in the use of gene therapy in some of the more difficult diseases to treat.

The biotechnology market is large. In the US alone, bio-pharmaceuticals accounted for about US$13 billion in 1997. US botanicals (medicinal plants) accounted for US$16.5 billion and globally, genetically modified crops (mainly soybean and corn) accounted for US$1.5 billion.

With these developments, new tools and a new science emerged. The tools are designed to enhance the expression of desirable traits. For example, you may want an insulin-producing organism to produce more insulin, or to introduce or combine desirable features.

These new tools are characterized as high throughput, large-scale, systematic and automated. They detect, identify, quantify and monitor.

High throughput are systems that can analyze from 15, 000 to 30,000 samples per day. We are talking about a laboratory that can finish the analysis of 100,000 blood samples in five days. Through a time series, the system can detect, identify, quantify and monitor whatever has already been worked out in terms of a drug or a particular metabolite.

These tools can also analyze gene products, sub-strains and activities in the cell. This is the more interesting development because these tools can determine the events taking place in the cell at the molecular level at any one time. For example, a person can take an aspirin and these tools can determine what happens to the chemistries in the body at any one time.

These techniques are accurate, reproducible, sensitive, non-invasive and can tell what is happening in real time.

These new tools cover high throughput genome sequencing (HTGS), an example of which is the 6,000 protein encoding genes already discovered in yeast. If conventional methods were used, it would have taken 50 years to discover all these genes. All genes were discovered and deciphered within the last decade using these new tools. Furthermore, genomes have been completely decoded and sequenced in many plants while 36 microbial genomes are already completely sequenced.

These new tools are rapid. They have high throughput chemometric methods for analyzing biological molecules. In other words, the classical methods have been adapted and reconfigured to analyze and immediately give the results for thousands of samples at any one time.

These new tools are also based on high speed, high capacity computing. You can see here a merger of biotechnology and information technology.

Some of the more interesting new sciences that have emerged are Genomics, Transcriptomics, Proteomics, Metabolomics, Structural Biology and Bio Informatics.

Genomics involves studies leading to the discovery of new genes, gene sequencing, gene mapping and other new genetic technologies. Functional genomics involves determining the functions of genes.

Genomics is applied, for example, to find out the genes that are active in mutants. In the case of rice, we generate 20,000 mutants and look at how the genomes are arrayed. Very high throughput and rapid systems are needed to do that. Otherwise, it will take about a century to finish the analysis and by that time, the results will already be useless.

The second field is Transcriptomics, the study determining the generation of messenger RNA (mRNA), which is part of the sequence where the gene is expressed. The gene has to be transcribed into RNA, which is then translated into proteins. Transcriptomics can look at the RNA levels at any one time. For example, a plant infected with a particular fungus may be analyzed for the RNA made at the time of the infection and the information is presented in real time.

Proteomics proceeds from the mRNA to the protein. This is a high throughput study of protein expression as well as protein function, protein-protein interactions, quantification and comparisons of protein expressions. A database is built and advanced protein function methodologies are developed. It provides information not only on gene coding but also on what happens when it is transcribed into RNA. You can also determine what proteins are being made at any one time for a particular event.

The next area is Metabolomics, the study of determining the total picture, especially of the low molecular weight molecules present, in the cell in a particular physiological or developmental state. Suppose that you again have a diseased plant and would like to know if the plant is producing resistance factors. Some of these resistance factors may be low molecular weight resistance factors. Through Metabolomics, you are able to analyze and determine whether such events are taking place. The study uses very powerful methods—pyrolysis mass petrometry, Fourier Transform Infrared spectroscopy or FTIR, raman spectroscopy and electrospray mass spectrometry. These are very rapid and high throughput technologies that are all connected to computers. The computer processes the information so that you get pictures of the trends and an analysis of the events.

The next area is Structural Biology, the study of biological macromolecules from a structural perspective in order to understand how the biological function of a protein nucleic acid and other biologically important molecules is determined by its structure. The tools used are Nuclear Magnetic Resonance or NMR, x-ray defraction, electromicroscopy and computational biology, a structure function type of a study.

Bio Informatics is the development and use of computational and mathematical methods for the acquisition, archiving, analysis and interpretation of biological information to determine biological functions and mechanisms as well as applications in user communities. All these methods are rapid, high throughput and allow integration of information to characterize, manipulate and model entire genomes and metabolic pathways.

What are the new challenges given these very powerful tools?

These are in human diseases (especially in stem cell research), diagnostics of diseases, and of course, the development of new drugs. The area of pharmacogenomics is a fast growing area where one can tailor-make drugs to fit one's physiological system.

There is a debate taking place today on stem cells, which are cells that have the ability to divide for indefinite periods in a culture and give rise to specialized cells. The stem cell starts as an undifferentiated cell, but given different conditions of culture, it can develop into a brain cell, a nerve cell, or different parts of the body. Stem cells are important in research because they help us understand complex events occurring during human development. They delineate the fundamental errors that cause fatal diseases and they are important in drug development and testing. Eventually, only those that pass the cell line testing would graduate to animal and human subjects.

Stem cell research is important because of cell therapy, where we may have renewable sources of replacement cells and tissues to treat diseases, conditions and disabilities such as Parkinson's, Alzheimer's, diabetes, osteoarthritis, heart disease and a whole line of other diseases.

The next challenge is in the area of agriculture and includes plants, animals, and marine animals.

Varietal improvement is the particular activity that gives rise to genetically modified organisms or GMOs, diagnosis of diseases, disease-control (especially vaccines for livestock), the study of storing nutrient availability, degradation of agricultural chemicals and the use of inoculants.

In bio-remediation, which is a very promising area, a lot of new information on the degradation of toxic chemicals can be applied to design management techniques for the sustainability of agricultural and industrial operations. We have yet to understand much of the earth's ability to absorb and process waste.

Anybody who talks about sustainability must be well skilled in these processes. Otherwise, it just remains a philosophical thought. How

much fertilizer should you apply for your practice to be called sustainable? How many times should you buy rubber shoes every year for your consumption to be called sustainable? That has not been worked out I am afraid. We can work that out if we understand the many cycles that take place in the earth.

In the case of industry, we have new materials coming up. They can be materials as sophisticated as Kevlar which is now used for jet planes or for bullet proof vests or materials as fragile as *nata de coco*, which is used as a membrane in the vibrating portion of a US$4,000 head phone sold by Sony. The membrane that is used to make superior sound comes from especially cultured *nata de coco*.

Nanotechnology is another interesting development and this takes advantage of biological systems of molecular motors. Nanotechnology involves development of technology in the molecular and atomic levels. These are very small machines. There are many events in the cell that involve movement and there is a very strong effort in trying to understand all of these phenomena.

What are the issues that have emerged in all of these efforts? One is the consideration of the gene as an independent material, because you can now cross species barriers. People have started to questions whether a fish gene transferred to another organism can still be called such. Or if an insulin gene extracted from a human and moved to another organism could still be considered a human gene.

The gene can only be called a human gene or a fish gene if it is a part of a genome. Otherwise, when you are moving it, it is just a gene. You cannot attribute any identity of the source, otherwise we will be moving back to the time when we considered organic molecules as having life attributes.

This is an interesting development because people keep telling us "You are putting an animal gene into a plant genome. But how would you know that it is an animal gene?" Humans have some genes that are similar to the fruit fly. Would you consider it a human gene or a gene of the fly? If you consider it a gene of the fly, then we must be related to flies.

The second issue is the safety of GMOs. I think this is a very well debated topic. Science-based assessment will be the most useful basis for determining the safety of GMOs.

The third point is the ownership and control of life forms. You now can see many tools that have been the result of human ingenuity. Human ingenuity is a requirement for invention, and invention means you can own it. There is a lot of debate also on whether these systems should be put in place.

Why are we all involved in this exercise? I suppose we would like to see the following: research results to increase understanding of major problems; new tools to increase interaction between the bio-sciences and researchers; increase in interdisciplinary interaction between biological sciences, physical sciences and engineering; and enhanced output of Filipino trainees in advanced technologies.

If I were to put together a biotech agenda for the Philippines, I would do it this way.

The first would be the diagnosis of the most important plant, animal and human diseases. We have to use immunochemistry, the technologies that have emerged from monoclonal antibodies and focus on tropical parasitic diseases. Schistosomiasis, phylariasis—these are the great neglected diseases and yet they affect a big portion of the tropics, where most of the people are. They don't get as much funding as cancer research, or research in cardiovascular diseases.

Next is vaccine production. We undertake very active research in the production of vaccine for livestock diseases and a selected number of human diseases. There is no substitute to using microorganisms that are Filipino citizens because they elicit a different kind of immune response.

The vaccines that we use are all imported. They may be Swiss, English or American citizens, and their immunogenic characteristics are different, that is why you have to vaccinate 10 times. If you were to use a Filipino citizen, you will probably be able to elicit a very good

immune response and a longer protection time. This is a very sensitive matter because this is big business.

Next is varietal improvement. The crops that should be given priority are rice, corn, coconut, bananas, mango and papaya. These crops are now being covered by a number of researchers who are present here.

There should also be varietal improvement for livestock (poultry, pork, beef and carabao), aquatic and marine resources (tilapia, milkfish, the grouper and the cefalopods—octopus and squids, crabs and prawns and seaweed).

There should also be varietal improvement in value added and high value products which fall under food processing (tailored fats and other oleochemicals which are ceuticals from Philippine medicinal plants). In the US, the botanicals business is worth US$16 billion. If we could even get one-sixteenth of that as the Philippine participation, that is US$1 billion straightaway. And we have the resources.

Bio-transformations provide very interesting opportunities for commercial production. Enzyme production is a growing industry and its uses are also growing. When you use detergents, you have enzymes there. Whenever you wear blue denims, that denim was processed using enzymes to look stone-washed. There are very interesting applications.

Fine chemicals through fermentation is again one area where we can delve into because the Philippines does not have a fine chemicals industry. Our pharmaceuticals industry consists only of packaging and formulating, we do not produce the raw materials here. That is traceable to our very weak petrochemicals industry. We however, have other sub-strains. The coconut, for example, is a very rich source of fine chemicals. Other plants that we have may be planted and harvested for production of fine chemicals.

The next area is product standards and bio-security, which is an important component of competitiveness. Unless you can certify and determine your product standards (on both imported and exported products), you cannot really leverage very much in a negotiation. It is just like our Philippine chromite ore, which is being sold as ordinary

chromite, although it contains niobium. Niobium is a very important rare earth for the microelectronics industry. It is passed as chromite because we cannot analyze it for niobium.

You may have other valuable products you are passing on at a very low price. If you do not have the capability to look at it, you will be unable to leverage your negotiation.

Why did I put in bio-security when we are importing tons and tons of food? Take the epidemics that have taken place in nearby Malaysia and Hongkong, where a very big population of chicken and goats were infected. If we keep importing without any screening system, you can just imagine how much it will cost a factory in terms of down time if its employees were fed with infected chicken. So, because of the global trade regime, I think we should have to put all of these in place.

Environmental applications concern bio-remediation and waste water and water treatment.

I read the other day that a company has started drawing water from Laguna de Bay for domestic purposes. Of course, 20 percent of Ayala Alabang's water supply already comes from Laguna de Bay, which is going to be a major source of potable water. That is why it has to be rehabilitated. It is very close to the population centers and there are more and more factories being built around it. Biotechnology offers some solutions for that.

Forensic applications involve DNA finger printing, which is not only for paternity suits. It can also be used to solve crime scientifically.

And lastly, we can provide worldwide genomic services by setting up laboratories, which are like call centers set up in Clark that service the needs of MasterCard members all over the world. If we can set up services that can do sequencing, Proteomics and Metabolomics at very competitive prices, scientists and researchers will send the samples here and we can generate income from that.

These are the suggested priority areas. I hope this presentation succeeded in at least giving a benchmark of the global developments where we might determine our niche as Philippine institutions in the global agenda of biotechnology research and development.

Intellectual Property Licensing: Dispelling Myths and Unlocking Promises

ATTY. JOSÉ MA. OCHAVE

National Commission on Biosafety of the Philippines

I would like to brief the audience about where I am coming from.

First, I see intellectual property (IP) law as an instrument of policy. If you are, ideologically, a lover of intellectual property rights or are ideologically averse to intellectual property rights, then I am not the person to talk to because I see IP law or IP rights as just an instrument of national policy to pursue national policy goals.

Second, basically, I am a science optimist. I do not share the pessimism being peddled by some groups on science and technology.

Third, evidence first: true to form, my background is chemical engineering and law, and in both these disciplines, evidence is very important. Therefore, if you are going to talk to me about slogans or ideological positions, I think it would be a waste of time.

And fourth, in the entire debate about biotechnology, I think the real critical issues are ownership and access and the debate about biotechnology being waged in the newspapers and in other forms of media is very much misplaced.

This is how I intend to continue the presentation. First, I would like to discuss some of the dogmas of the IP law. From there, I will discuss patents in theory and practice. Next are patent issues relevant to biotechnology, and I have chosen three: the anti-commons problem in biomedical research; Article 27.3-b of the TRIPS Agreement; and patent rights versus social good. I will cite as example the pharmaceutical industry. Next, I would redefine the national interest by biotechnological patents, then go into the fundamentals of licensing and finish off with some points to ponder.

There are two theories that serve to justify IP rights. One is a natural rights theory which basically says the right of property was conferred by God upon all men in common, and a free person controls his labor and a loss of the right to the product of that labor means a loss of freedom. Therefore, property rights are a means of protecting that freedom. You have a freedom to your labor and therefore, whatever you produce should be given as a right by society to you.

The next theory is very much present in the common law system. It is the incentive theory, which says the creator assumes time and other costs associated with the creation process, and he can never compete on equal terms with copiers whose costs are low because they do not include costs relating to the creation process. Otherwise, the creator would therefore have no incentive to invent.

Why are you granting IP rights? In this particular view, it is to encourage creators to continue with their creations, their inventions, etc. For instance, audio CDs take so much resources to produce. You pay Filipino composers, artists, etc. a huge sum and you invest a lot in marketing. But if the same CDs can be reproduced at a minimal cost, then the incentive on the part of the artist, on the part of the composers to continue producing creative works might be severely restricted.

There is an incentive access dilemma when it comes to IP rights because information is basically something intangible. It is something that you cannot hold on to, something that you cannot see. Without property rights, the producer of information will find

it difficult to appropriate information's value in the market place. Remember that IP has no value unless it is placed in the market: the market determines its value.

But if the IP holder gives it to the market, he exposes that same information to the public, including to competitors who can replicate and sell it to the public at a lower price due to minimal investment. So there is that particular dilemma on the part of the creator.

On the other hand, information is also indivisible, meaning an unlimited number of users can consume it without depleting it. So if he puts it in the market, theoretically, the IP owner is not deprived of the property as much as let us say the owner of a tangible property, because that IP may be replicated several times without its owner.

In the Philippines, the term of patent protection is the same as in many other countries in the world: 20 years from the filing of the application. I would like to emphasize that it takes years to get a letter's patent. It is not something that you go to, let us say to an IP office, submit it and get the letter's patent today. It takes from five to seven years to get it. Why? Because they look at whether this particular application or invention really conforms to the requirements of novelty, innovativeness and industrial application.

They will have to search for similar inventions not only in the Philippines but also in the global database system. Usually, the Philippine Intellectual Property Office (PIPO) will do a patent search in three major offices: the US Patent and Trademark Office (PTO), the European Patent Office and the Japanese Patent Office. The process is extremely expensive because you have to pay for the lawyers and the patent to purchase.

It may be expensive now and it is because there is no such thing as a global patent. You have to file a patent in every jurisdiction in every country for that matter. If you have a patent in the Philippines, it does not mean that you will have a patent in the US. Or if you have a patent in the US, it does not mean it is patented in the Philippines. What patent owners usually do is just select the countries where they will file a patent. The selection of these countries is on the basis of commercial terms: will

that particular country be a good market for us? Therefore, we have to protect our patent rights there. If it is a miniscule market, do not bother.

For researchers, let me just mention a few provisions here on Inventions Pursuant to Commission. If you were commissioned to do research work on an item and you came up with a product or a process which is patentable, the general rule in the Philippines is that the person who commissions the work will own the patent, unless it is otherwise provided in the contract.

So when you scientists sign contracts involving commissioned works, make sure the contract specifies that you will own the patent. Otherwise, the patent will belong to the one who gave you the commission.

The patent belongs to the employer if the invention is the result of regularly assigned duties, unless there is a contrary agreement expressed or implied. From a litigation standpoint, implied agreements will be a problem. But the rule is that if you are an employee, and what you did was within your regularly assigned duties, that patent belongs to the employer.

The patent belongs to the employee if the inventive activity is not part of his regular duty, even if the employee used the time, facilities and materials of the employer. The critical point is that part on the "regularly assigned duties." If it is part, then it belongs to the employer. If it is not, the patent will belong to the employee even if he or she used the employer's time and resources.

In so far as the University is concerned, there has to be clear patent policies and these should be in writing to prevent any future disputes. Any policy on the part of the University will have to take into account what the rights of the action inventor (the scientist or the investigator) are, the rights of the University with respect to that particular invention and the rights of the ones who commissioned the work, or the funding institutions. Most of the time, researches in the University are not really funded by the University itself, but by an outside institution, for instance, like the Department of Science and Technology. These things will have to be settled.

There are limitations to patent. Even if there is a patent, there is no infringement if it is placed in the market by the owner in the Philippines. Let me just insert a footnote—the issue of parallel importation when it comes to medicines.

Ventolin, one of the biggest drugs here, is being parallel imported from India, where its price is probably a tenth or a ninth of the price in the Philippines.

There are some cases where our medicines are even more expensive than the ones in Singapore and sometimes those in Japan. There are medicines that you can buy from drugstore.com, have it delivered to you the following day by parcel and will end up less expensive than those you can purchase here.

So what did the Department of Health (DOH) do? The DOH parallel imported. But we are only parallel importing branded generics and not the patented products. Why? Because there is a provision in our IP Code which says the right to import belongs to the patent owner. There is no similar provision in our trademark law. What is being imported is a trademarked product, *Ventolin*, which is found in government drugstores in India.

It is not *Ventolin* per se but *Ventorlin;* but it is the same material, it is the same product, it is produced by the same manufacturer, produced by the same company, except that it was manufactured in India. Chances are, the efficacy will be the same.

The question is: why do we not import the patented products since they are the ones that are really expensive?

The problem is that our patent law has this provision: there is no infringement if the product has been placed in the market by the owner in the Philippines. This is where the doctrine of exhaustion comes in. The doctrine of exhaustion means that once I sell you a patented product, then I have exhausted all my rights over that product and therefore, even my patent rights. So, if I exhausted it and passed it on to you, then you can sell it to some other person and I will have no patent rights over that particular product.

There are three kinds of exhaustion: international, regional and national.

In the international exhaustion principle, if somebody in India sold the product to person A, then all the rights of that particular company in India, let us say Glaxo, will have been exhausted when it sells that particular product to person A globally. This means that if person A now sells that wherever, then Glaxo will not have any rights over that.

There is regional exhaustion in the case of the European Union if you sell the goods within the European Union. Take note that under the TRIPS Agreement, there is no requirement as to the type of exhaustion principle you will adopt. But lo and behold, we adopted national exhaustion—meaning there will be no infringement only if that particular product was sold in the Philippines. So if that product was sold, say in India, and then imported by the Philippines, then that is an infringement because it was not placed in the market in the Philippines by the patent owner. This is another classic case of shooting ourselves in the foot.

Another limitation to patent is on non-private and non-commercial scale or for non-commercial purpose. Another is exclusively for experiments. You will not be infringing on the patent if you use that particular product or process exclusively for experiments relating to the subject matter of invention.

Take note that there is no such thing as a Bolar Provision here. The Bolar provision was named after Senator BOLAR of the US and it is present in the Japanese patent law, in a number of European countries' patent law but we do not have it in the Philippines.

Bolar is TRIPS compliant, meaning it does not violate the TRIPS agreement. Under the Bolar provision, or the Bolar amendment in the US, if a party submits an application for drug registration that is not considered a patent encroachment with the FDA (Food and Drug Agency), that will enable the generic manufacturer to manufacture that product and sell it to the market immediately a day after the patent expires.

In the Philippines, if you want to manufacture a product after its patent expires, you have to file for drug registration with the local FDA, the BFAD (Bureau of Food and Drugs). How long does it take before any manufacturer or a generic distributor can market the generic product after the patent expires? It takes at least two years. Why? Because BFAD will have to look at its safety, efficacy and its registration documents as well. So the objective is always to make sure when the patent expires because that is a grant given to the scientist, to the innovator by society to encourage him. When that particular patent expires, society should be able to benefit more from that particular invention. But in our case, there is no Bolar provision. Therefore, a drug manufacturer or any of us who would want to produce drugs and file for drug registration prior to the patent expiring can expect a lawsuit from the multinational corporations.

A government agency or authorized third person may use an invention without the consent of the patent owner if public interest so requires—meaning national security, nutrition, health or development of other sectors. What development of other sectors means, I do not know. But our judicial/administrative body has determined the manner of exploitation by the owner to be anti-competitive. If the government can use the patented invention under these circumstances, there has to be a declaration by the agency involved. The high price of medicines in this country could merit the public interest exception, except that we are not using it.

In theory, a patent system provides an incentive to invent by offering the possibility of reward to the inventor which we have already said stimulates investment of additional capital needed for the further development and marketing of the invention. It also encourages early public disclosure of technological information. Public disclosure is something that we in the scientific community can take advantage of. The scientific community will have to look at the patents not only in the Philippines but worldwide. The US and European patent offices' databases can be accessed through the Internet. The Japanese Patent

Office database is already in English and can be accessed through the Internet. The objective now is to look at all those patents and find out which ones are relevant to our field, which ones can we use, for instance, because that is the purpose of patent system—that the inventor will disclose to the public whatever the invention was. Take note that if it is patented there and not here, you can actually use it here. So let us take advantage of the patent databases which you will find even in the Internet –which is really very easy to access—in order to push forward our own researches. We may be working on researches that have already been done several times and which are already subject to patents abroad. To prevent duplication and to zero in on researches that are really useful to us, we have to make use of the patent databases.

What is the reality on the Theory of the Provost Beneficial Exchange of products, services and technological information of cross-national boundaries? Does the existence of a patent system attract investments in research and development? It is generally inconclusive. For many technologies, other forms of protection can act as a substitute. In many types of technology, a trade secret acts as protection. Surveys show business leaders place low ranking on patents as stimulants for research and development investment. But there is evidence to show that patents are important for technologies which can easily be copied and are expensive to develop such as pharmaceutical and biotech products. In pharmaceuticals, it takes at least US$600 billion to develop one particular drug and 13 years to finish the clinical trials. In pharmaceutical products, it is logical, it is sound to have a strong patent system.

The patent system may also be well worth it for biotech products since these products need extensive field testing, which can be very expensive because the experiment may get destroyed every now and then.

Let me just dispel some myths. One, there is no such thing as an international patent. If anyone of you heard, or if anyone of you read of the patenting of the *Ilang-ilang*, it cannot be patented in the Philippines because discoveries cannot be patented. I am telling my

friends in civil society groups that next time they do advocacy, they make sure that they are familiar with the facts and that they have at least read the IP law.

There is no such thing as an international patent on *the Ilang-ilang* because it cannot be patented (even assuming it was patented in France, which I doubt). Perhaps what can be patented is the process of getting, let us say the extract from *Ilang-ilang*. But even if the *Ilang-ilang* is patented outside, so what? Instead of pure advocacy (and I am allergic to pure advocacy), there has to be some services involved. My challenge to people, to my friends who are concerned about the patenting of traditional knowledge for instance, or knowledge which is part of the Philippine system is: instead of just pure advocacy and issuing press releases, let us do what the Indians did and go to the jurisdiction where a particular product has been patented and oppose or seek the cancellation of that patent.

No amount of press releases will enable us or will result in the cancellation of that particular patent. If we are serious about protecting our biological resources, then we do something about it. Also, the issue is not really in terms of royalties. The discussion now really focuses on sharing of benefits—benefit sharing mechanisms. This does not only involve inventions but biological and genetic resources. How do we now make sure that in whatever biological and genetic resources extracted from us, obtained from us, our scientists and our communities are able to obtain some benefits from its development? That is the real issue; it is not a typical issue of closing the door to all bio prospectors. That is not only silly but is downright irrational.

Patents are not a pot of gold. Only 15 percent of patents are ever commercialized and not all of them are really successful, commercially. Financial rewards come from the market and not from the patent. It is not that because you have the patent, you will be rich. It is not a get-rich quick scheme. The patent is only good as long as the market wants the invention. So if you are involved in patenting and are considering the cost of obtaining a patent or if you are trying to get a patent and

there is no sure market for it —if you do not see any commercial value, then why patent? It becomes an exercise in vanity. Remember that the patent is not a permit to use the invention. The use may be controlled by regulations.

Even if you are granted a patent, you may be prohibited (for instance by the government) from making use of that particular patent in certain cases (for instance, in biotechnology) if there are biosafety concerns. If you were given a patent by the PIPO, you cannot just go to the National Commission on Biosafety of the Philippines (NCBP) and say, I have a patent and therefore I should be allowed to make use of this particular invention in the Philippines. This is because if there are grave biosafety considerations, then you would not be allowed to do so.

Protecting IP is primarily a strategy for defense of existing or future business opportunities. It is not a means of obtaining additional income. If you are into patenting as a means to additional income, forget about it.

Patents are really a tool for the defense of existing or future business opportunities. That is why even companies, when they do patenting, select only the countries which have promising business potentials. You do not go, for instance, to Afghanistan or to Sudan to patent it because chances are, your product will probably not be used there anyway. And they have no capability to produce that particular product. Even in pharmaceuticals, you choose the countries with business potentials: the US, Japan, Korea, the European Union and from time to time, the Philippines. But take note that patents being filed here in the Philippines are not for purposes of licensing but only to protect the market: that nobody else can import or produce that particular product in the Philippines and therefore they will have sole and exclusive control over the marketing of that product here during the term of the patent period.

Let us talk about national interest. Our IT Code says processes for the production of plant varieties and animal breeds shall be excluded from patent protection. If you are looking at patenting life forms other than microorganisms, forget about it because it is not allowed in the Philippines. The debate against patenting of life forms is barking up at

the wrong tree because there are no patents granted by the Philippine government on biological process for the production of plants or animals, or plant varieties or animal breeds. But patents are being granted in the US for this. Each jurisdiction will determine its own patent policy. You just do not follow the US or the European or the Japanese or even the Malaysian model for patenting.

Our provision makes mention of a system of community IP rights protection which, up to now, I do not know how they plan to do. This particular provision is a copy of the TRIPS agreement we simply copied, which I agree is a minimum compliance.

Let us look at the current situation. How many patents were granted in the Philippines? In 1998, 563 total patents. Of that, we have granted 558 to foreign, five to local, or a huge 0 .9 percent. In 1999, we maintained it at five (0.8 percent) but the foreigners increased the number of patents to 643. So if you are looking at the patent system, this is the situation: we are not getting a lot of patents. It can be because not many people are filing for patents, or simply because we are not producing innovative products.

In Germany (of course, it is unfair to compare ourselves to Germany) the local patents comprise 57 percent; in UK, 35 percent. This is the situation now: if you are going to develop an IP regime in the area of patents, you have to take this into consideration.

Most of you are familiar with GARRETT HARDIN's The Tragedy of the Commons. It is when people overuse resources they own in common because they have no incentive to conserve.

In biomedical research, the US Federal Government used to sponsor pre-market or upstream research and encourage dissemination of results in the public domain. In 1980, the US government encouraged universities to patent inventions from federally supported research and to transfer technology to the private sector. That is good, but there is a flip side to that, of course. The resulting proliferation of intellectual property rights may result in what MICHAEL A. HELLER and REBECCA S.

EISENBERG called The Tragedy of the Anti-Commons. This is the reverse of The Tragedy of the Commons.

The Tragedy of the Anti-Commons says a resource is prone to under use when multiple owners have a right to exclude others from a scarce resource and no one has an effective privilege of use. Remember, a patent is basically the right to exclude others, it is not a positive right, it is a negative right.

If your intellectual property right (IPR) on a gene fragment (or whatever, although we are not into that now), is distributed to several people, then there is a tragedy of the anti-commons because ownership now rests with a number of people and it is extremely expensive for you to get licenses from all of them. Instead of developing a particular product, you say, "No way. I'd rather abandon it because I do not have the money to pay up all these patent owners."

Patents for upstream inventions may fortify incentives for risk research, but privatization can go astray when too many owners hold rights in upstream inventions and thus constitute obstacles to future research. Now, how can this happen?

The creation of too many concurrent fragments of IPRs in the potential of future products have, as examples, patents of gene fragments and receptors for screening potential pharmaceutical products. The long delay between the filing of an application and issuance of a patent compounds the problem due to substantial uncertainty as to the scope of the patent rights that will be granted. Take note that when you start doing the experiment, some of those people who are doing research relevant to yours may have already applied for but may have not been granted the patent.

You do not know now if they will eventually be granted the patent, and therefore, how do you deal with them? Do you deal with them as a patent owner or as a mere applicant for a patent? Again, licensing is just basically a game of negotiations. It is your bargaining position vis-à-vis the bargaining position of the other party.

Permitting too many upstream patent owners to stock licenses on top of future discoveries is like reach through license agreements. You will probably see this or you have seen this in a number of agreements. When you are conducting research and you need a license from a particular entity, there is a reach-through provision which means that for any product that you develop using a licensed technology, the licensor will have some say on how that product is to be disposed of or will have some benefits from the disposition of the product that you may have. That is a reach-through agreement.

Article 27.3-b of the TRIPS agreement is again a controversial issue. The issue is one which constitutes effective *sui generis* and there are some provisions here that if you comply with the Union for the Protection of New Varieties of Plants, that is already effective *sui generis*. But what is controversial is an attempt to expand patent coverage to include plants and animals.

I have nothing against patents. I am an IP lawyer, a member of the Intellectual Property Association of the Philippines, but I think in terms of a national policy, our policy of patents will have to look at our own situation. Again, I go back to my initial statement that I see IP as an instrument of national policy. It is but rational and very logical and understandable for, say, the US to push for patent coverage to include plants and animals because they already have a solid biotechnology sector. Now, are we in the same situation? Do we want to expand it at this time? Remember, I mean at this time when our biotechnology sector may be just starting, and at a time when only five patents are being granted to Filipinos.

Patents should be a tool of national policy. So how do you increase your competitive advantage in the world using your patent policies in this country? Now, I am averse again to all this victim talk, that we are victimized by these particular countries, that we are being exploited, etc.

The reason we are being exploited is because we are shooting ourselves in the foot. One is by coming up with patent provisions instead of

complying with the minimum requirements of the TRIPS Agreement. Instead of deferring compliance—and AFTA (Asean Free Trade Area) is an example— we said, "We will comply earlier than the others." So instead of supporting our scientists develop our own technology, we destroy field testing, the field trials. Instead of allowing our scientists to develop our genetic resources, we stop them from doing so. Why? We issued a bio-restricting executive order which may be implemented but defeats our local scientists and not the foreign scientists. Thus, we only have ourselves to blame.

We are not being victimized, we are not being exploited because they are inherently evil. They are just acting on the basis of their own national interest. Our problem is, we do not know where our own national interest lies so we end up just listening to what is, for instance, the fad in the European Union, the fad in the US and start copying from there. Even our own advocacy projects are using the agenda of the groups in the other countries. So stop it and let us start acting on the basis of our national interest.

At this point, my personal position is not the position of the NCBP. All I am saying here is to not agree with the expansion of Article 27.3-b under the TRIPS Agreement on patent issue number 3—patent rights versus social good. We have no pharmaceutical industry here. What we have is just compounding, packaging, some research, probably the drug delivery aspect, but we have no pharmaceutical industry. Why? Because we do not have the resources, we do not have capital to fund it. One drug will cost about US$600 million at least, and you are not even sure if that will be allowed commercially. And the market is very, very small.

The issue of the hyped-up prices of monopoly rights, the transfer pricing by mother companies to subsidiaries and extension of monopoly rights beyond the patent term are done every now and then.

Take note that licensing is a business strategy. For us scientists who are averse to the term "business," let go of that because licensing is really a business proposition. It is a strategy for both the licensor and the licensee. For the licensor it is a viable way for entering or holding

markets. Some of us, when we have the invention, think: I am the god, you see it my way, my terms, etc., without realizing that without that particular invention being placed in the market, it is absolutely nothing.

For the licensee, it is a means to develop a business without the cost associated for developing the technology. It has to be a win-win type of thing.

Patents do not easily translate into licenses. The acid test always is the market, because nobody will approach you for licenses unless there is a market demand for it. Licensing of technology in the Philippines is governed by the Intellectual Property Code (IPC). Failure to register with the technology transfer registry may make the license contract unenforceable.

The IPC contains a provision that says there are some mandatory provisions you have to put in the licensing agreement. There are some prohibited provisions that you cannot put in the license agreement. Let us make use of those provisions to increase the bargaining position of a licensee and not of a licensor, so even in our own IPC, we always see ourselves as the licensee, as the takers of technology instead of us giving the technology. There is the paradigm problem again but if you are the licensee, you have to make use of the IPC to increase your bargaining position. Licensing is essentially contract law, it is not patent law.

Licenses are exclusive, semi-exclusive, non-exclusive. Then we have royalties, access to market and sales data, non-complete provision, etc.

Let me just leave you with a few points to ponder.

One, do we have enough biotech inventions which need to be protected? Are our biotech inventions sufficiently valuable? Will IP protection result in more R&D? If it does, then fine. Will it result in better access to technology? If it does, then let us go ahead.

Do we have the support systems to ensure that our scientists are able to take advantage of the patent system and the licensing mechanisms?

If we have the PDP bill, make sure that our scientists have the resources and have the network to make sure, to be able to avail themselves of its benefits. I am a little skeptical about registration systems, because usually, those who benefit from any registration systems are those who have access to the system, who have the resources to be able to register their rights. Unless we have that, and I think there has to be for the scientists, then we might again end up being patented out.

And then, will an expansion of existing IP rights lead to our advantage?

These are some of the questions we have to ponder when thinking about IP and licensing. Patents by themselves, let me just stress, are useless without the value placed on it by the market.

We have to start thinking about how we can now increase our bargaining positions using our knowledge about IP and using our regulations here in the Philippines.

And let us stop talking the victim talk.

The Experience of the Technology Application and Promotion Institute in Government, Industry and Academe Tripartite Collaboration in Biotechnology

TÓMAS B. BRIÑAS

Division Manager
Technology Commercialization Division
Department of Science and Technology

My discussion will dwell on the technology development and commercialization mechanism existing at the Department of Science and Technology (DOST).

It will touch on some of the issues already discussed by previous speakers but I will not dwell on these anymore. What I will be presenting is a simple framework for the opportunities in biotechnology in terms of its commercial application.

I would like to introduce my institution, the Technology Application and Promotion Institute (TAPI) at DOST, see what services it can provide to the industry, in particular, in transferring the technology from the academe to the industry.

Most of the presenters already indicated the different challenges to biotechnology. I think we are all aware of the globalization of

markets and this also applies to products of biotechnology and biotechnology itself.

As far back as 1995, we actually said that biotechnology will be one of the competitive sectors that will be given support and promoted by at least the science and technology (S&T) community. Biotechnology has been with us since 1995 but unfortunately, up to now, we have not really availed of its benefits.

We are also faced with the increasing challenges of a knowledge-based economy, and we are looking at a competitive S&T innovation system that includes not only biotechnology but the whole aspect, from technology generation to technology commercialization and utilization. We are also very much concerned with how we have fared in terms of economic advancement.

Even biotechnology will have to deal a lot with information and communications technology, which the sector should be aware of and should take a serious look at to make it competitive.

The need for a strategic alliance with industry and the academe is another challenge indicated by Secretary ALABASTRO. I noticed for example, that in the title of our conference, we did not indicate government. Therefore, we are looking at government as either an intervenor or as a facilitator. That is precisely why I am a little detached about this presentation, because we are trying to look at where DOST, particularly TAPI, would fit into this scheme.

As everybody knows, the need to support S&T advancement in the country is indicated in the constitution, and the DOST was exactly created for the purpose of providing central leadership and direction in S&T.

DOST was created and upgraded to a cabinet level department through Executive Order no. 128 in 1986. The same Executive Order created TAPI to address complaints of the industry that we are not making use of or we are not benefiting from the results of research. Therefore, TAPI was created exactly as DOST's marketing arm, focusing on how the results of research and development (R&D) could be

translated into output that may be commercialized. We are actually infusing some sort of a profit motive in R&D efforts.

In 1992, the Institute was expanded to include inventions, but Republic Act 7459 focuses on individual and not on institutional inventors. It does not really address the needs of institution-based inventors.

We at TAPI developed what we call the comprehensive technology delivery program or approach in terms of technology commercialization.

The organization is very lean. We have four technical and one administrative unit. We only have 59 regular employees, complimented with contractual manpower.

TAPI, as indicated by our mandate, is actually concerned with contract research not at the R&D level but at the pilot and semi-commercial stage. So immediately we are separating R&D from technology transfer.

We are also concerned with providing technical consultancy, including engineering design, patenting and licensing services.

We also provide some grants or venture financing for new and emerging technologies. The expanded function simply added that the Institute should assist technology generators, inventors and researchers at the laboratories and other facilities of RDIs (research and development institutes) including regional offices and instrumentalities. All we have to do is endorse some of the inventors' needs so they can avail of laboratories to further develop or to test their inventions.

Another concern is to accredit and recognize inventors' associations in the Philippines, since RA 7459 focuses on individual inventors.

We have a very simple S&T support and development framework where supposedly, R&D results are transformed into goods and services that will benefit the people. The main actor in this framework is actually the government, which sets the policies and the programs-what they call the public good. We are expecting that through these policies, priorities and programs, the R&D results would trickle down to the people in terms of economic benefits and enhancement of well-being.

But in the process, we have the Research and Development Institute creating the technology and the National Research Development System the process itself. There is a need for somebody to translate R&D results into products and services.

Another player in that framework is the investor-entrepreneur who is basically concerned with profit. He will produce, use or sell the products. Where is TAPI in the process?

Supposedly TAPI is involved in the delivery of the goods and services and not in R&D. When TAPI was created in 1987, we tried to go into some of the activities that are supposed to be part of our mandate. And in that period, from 1987 up to 1999 at least, there were some observations on technology transfer not only from us, but also from the industry players.

One observation was the problem of research for research's sake. If the technology is coming from the academe, it seems there is a problem in balancing the interests of the researcher, whether that researcher will focus on the research or on the profit. As a result, the adoption of technologies is very low precisely because the private sector is not sure whether the technology generator is willing to transfer the technology—not only the product but the knowledge itself.

Atty. OCHAVE said you are not protected in terms of knowledge, only the patent. You are actually being protected in terms of your rights. But even once you get a patent, the knowledge itself is not protected.

This is why some of the researchers hesitate: they say they are afraid of transferring the knowledge because we are not sure if the adaptor will use the technology properly, or they will have the capability to translate the knowledge into products and services.

The problem with academe-based research is the researcher's assessment of the market: we sometimes do not know the value of intellectual property rights. And as indicated by Atty. OCHAVE, you only determine the value of your patent when the product itself reaches the market.

We also have problems in technology transfer negotiation.

In 1995, we commissioned a consultants' group to make a market and feasibility study of some of the biotechnology products generated from UP Los Baños. The consultants preparing the feasibility study encountered problems because what was being indicated by the researchers, the owners of the technology, is the clarity of the technology transfer arrangements. How will it be if it is supported by government funds? How do we negotiate? How do we determine the terms of the transfer? As a result, we were only able to complete two of the six studies. This is not actually a consequence of limited management capability but rather the capacity to translate the research results into production and financial terms.

Another problem is the unverified technical viability of the technologies. As far as biotechnology is concerned, we are presently focusing most attention on technical viability in terms of its environmental impacts. This attention on the aspect of environmental impact has been a hindrance to the complete verification of the technical viability of technologies. This deters the transfer of the knowledge, the transfer of the products or the possibility of negotiating in terms of technology transfer.

Another problem is the lack of test and support facilities. The available testing and support facilities are not actually at the technical level but more on the commercial level. In most cases, investment is very large, and therefore, investors would first like to pilot test the product but most of the institutes for research in biotechnology do not really have the capacity to undertake the pilot test.

Most of the problems industries are also facing are on the other side of the coin. They would like to make use or avail of the technologies but they are also hampered by certain logistical problems or even policy problems like access to credit. Most of the programs are actually very broad and could not be accessed in terms of specific needs.

At the Institute, we have a comprehensive technology delivery program. It is an approach where we try to make a comprehensive analysis of the problems or the needs of transferring the technology.

We identified certain programs like packaging and promotion, which we hope will facilitate technology transfer.

The program involves the preparation of feasibility or business studies, where we try to translate the potentials of risks into investment opportunities. We hold forums where the technical and the investment aspects of the technology are actually discussed by both the user and generator to determine the parameters for investment.

The other aspects of the program involve prototype development, pilot plant assistance and the staging of technology fairs, which is part of DOST's initiatives to promote biotechnology.

We have also prepared brochures and fliers for promotional purposes. Many institutes are requesting information so they can easily disseminate and promote these products.

The second component is on S&T enterprise development. We also provide limited venture financing and we have linked with commercial institutions to develop special financing programs specifically for certain sectors. We have very close linkages with the local government because we have been encountering problems of implementation when the local government is not consulted. We do it through the state colleges and universities; sometimes we do it directly through the local governments.

We have experts who may be consulted on such matters as productivity, trainings and very importantly, intellectual property rights. The institute is mandated to provide assistance in terms of intellectual property rights protection. So, if you want to determine the patentability of your technology, we can provide that kind of service. And if we believe that the technology or the product is patentable, we actually provide financial assistance so this can be submitted to the intellectual property office for registration or for patenting.

We actually provide services to facilitate technology commercialization. If you think we can be of service to you then you can always contact us.

Animal Biotechnology

DR. ANGEL LAMBIO

College of Agriculture, UP Los Banos

I am going to present the first part of the topic on animal biotechnology.

Animals are broadly classified into food and non-food, but because our concern is food security, what its more interesting for us is livestock including poultry that provides us food—meat, milk and eggs. From 1983 to 1993, there was a general increase in the trend for the consumption of meat and milk except for milk, which for developed countries, decreased in the same period. In terms of distribution for the livestock animals, you will find that the large percentage of the livestock and poultry species is in the developing world, where three fourths of the cattle and the buffalo population and two thirds of the pigs, poultry, sheep and goats are located.

We have learned that the demand for food of animal origin is increasing and will increase in the future because of population growth, urbanization and increased income. It has been identified that livestock and poultry are the keys in our efforts to alleviate poverty and contribute to environmental sustainability.

Presently, the call is for small-scale producers to link vertically with processing and marketing sectors of perishable products by 2025. A publication I read said that the world's population will have increased by 60 percent, an additional 8.5 billion people with about 90 percent of this increase in developing countries. Because of the increased pressure on land, environmental degradation will result and unless food production improves through sustainable intensification, we will have a problem. What solution do we foresee? We need revolutionary methods of agricultural production in terms of animals. Up to this time, a large percentage of our livestock population is in the hands of small holders: 99.79 percent for carabaos, 99.59 percent for goats, 92.22 percent for cattle and 59 percent for chicken.

In terms of hog production, young hogs contribute a large percentage of the volume of commercial products in terms of thousands of metric tons. This is followed by poultry, which include chicken and ducks' meat and chicken and duck eggs. In terms of value, hog production contributes P74 billion; chicken is at P48 billion, carabaos at P4 billion and goat at P3 billion. Dairy is only P130 million, so there is a big difference.

Biotechnology is the use of microbial animals or plant cells to synthesize, breakdown or transform materials into a new product or for varietal improvement.

The goal of biotechnology is to make or modify products, to improve animals or to develop microorganisms for a specific use. Because of the interest on biotechnology, the integrated national livestock and poultry research and development program identified the following agenda: genetic improvement of poultry, conservation of farm animals, the development of production management systems, animal health program for economically important pests and diseases and post production technology development. These will help livestock enterprise development at the villages.

Just like in crops, there too are issues, ethics and risks in the acceptance of biotechnology applications in animals because there is a

very strong movement for animal welfare protection. There too are issues on the benefits accruing to the technology's application and on its socio-economic impacts on production.

In a developing country, the animals are in the hands of the small farmers. This can be used to compensate for the lack of breeding infrastructure because developed countries can afford to have ranches and big farms. The use of biotechnology in the Philippines can compensate for the lack of that breeding infrastructure, especially when we contemplate on establishing a longer breeding program. Dean EDUARDO will discuss controlling animal diseases.

We have been saying our country is very rich in genetic diversity but we are not doing anything to conserve our resources. These animals are already close to extinction and animal biotechnology could probably stop, if not prevent their extinction. It could also be used to establish synthetic processes between local breeds and high performing breeds.

We have the passion for importing supposedly improved animals to improve the productivity of our local animals, which we call upgrading. If properly used, animal biotechnology can help in the genetic stabilization of this synthetic process by minimizing antagonism between performance and adaptation. It has been said many times that improved breeds from other countries have adaptation problems. The use of biotechnology will probably minimize the antagonism of being adapted but we have to improve their performance. Dean EDUARDO will also discuss the preservation of healthy genetic constitution and reduction of mortality of animals.

In-breeding programs could be aided by biotechnology in some of these areas: qualitative and statistical genetics, biochemical and psychological genetics, molecular genetics and also reproduction.

In qualitative and statistical genetics, selection is a very powerful tool in improving the productivity of these animals. Cross breeding is also one.

The aim in the identification of major genes and genetic evaluations, biochemical and psychological genetics is to search for markers that

could locate traits of economic importance and breeding for resistance to diseases. We have identified some markers through some techniques and we are trying to relate or associate that with traits of economic importance through molecular genetics. This is definitely one component of modern genetic engineering—permitting direct changes in genes or genotype of the progeny, or changes in the characteristic or the life history of the individuals or their gametes through the introduction of foreign pre-identified and pre-isolated DNA.

Through reproductive biotechnology, the rate of genetic response in national breeding could be enhanced. It improves both male and female reproductive traits. The reproductive biotechnology techniques that are being considered at UP Los Baños are artificial insemination (AI), multiple ovulation and embryo transfer (MOET), estro-synchronization, embryo splitting and freezing.

Reproductive biotechnology is also used to alter reproductive processes through the use of artificial incubators, in site culture, in vitro fertilization, production of chimeras and cloning.

AI improves the productive rate of males. If you have identified one superior bull or rooster, you could extend its benefit through AI. The field success rate of AI depends on technologies related to the collection and storage of semen, estros detection, AI of females and detection of pregnancy.

MOET and ET (embryo transfer) based technologies increase the reproductive rates of females in large farm animals. If the superior animal is the female and the traits you want extended is from the female, then MOET and ET-based technologies are appropriate. We use ET-based technologies at pre-pubertal and juvenile stages. It greatly reduces the average age of breeding of females. We do MOET at a younger age to increase the generation interval. Embryo production in vitro involves all site maturation, fertilization and embryo culture.

You can already do the processes of maturation, fertilization and embryo culture in the laboratory. MOET and ET based technologies can be also manifested in embryo splitting and cloning, which could

result to monozygotic twins and quadruplets. This increases the accuracy of selection by having two or more individual genotypes. When other family information are not available, this is used to monitor traits that cannot be measured on the individual's chart.

Determining sex of the offspring has been the preoccupation of livestock producers ever since because we know that certain sexes are beneficial in a certain production system. This involves the sex choromatin or the *y* bodies, identification of sex chromosomes, detection of male specific antigens or hormonal analysis. This reduces the number of embryos. MOET saves time and costs of embryo splitting, and in conservation this could be used exclusively to produce replacements of a specific sex.

Cryo-preservation is direct freezing or what we call vitrification. This is a technology that allows us to freeze embryos for use in a later date. We could preserve the material through technologies such as direct freezing or vitrification, the thawing and transferring of embryos and the establishment of an embryo and gene bank.

These technologies may be used to compensate for the lack of breeding infrastructure and a long term breeding program.

Dean EDUARDO will again discuss embryo transfer, in vitro fertilization, early sexing, DNA marker aided selection and embryo cloning applied to the control of animal diseases and parasites.

Embryos could also be very useful in genetic stabilization of synthetic crosses between local breeds and high performing breeds. Genomic marker oriented selection, embryo transfer, invitro fertilization and sexing are the technologies that could be used to minimize the antagonism between performance and adaptation of identification of marker genes. Markers or genes for performance fitness and tolerance will be very helpful.

Preserving the animals' healthy genetic constitution, reducing mortality of young animals, and minimizing health costs is the main concern of animal health people like Dean EDUARDO.

At UPLB are ongoing studies related to the development of animal production biotechnologies financed by the Department of Agriculture's Bureau of Agricultural Research since 2001.

One project is the evaluation of MOET technology in cattle implemented by the Institute of Animal Science (IAS) through its program leader Dr. ORVILLE BONDOC. The study seeks to evaluate the production of pure breed meat and dairy cattle through MOET technologies and to recommend winning strategies that should incorporate MOET technologies in a national cattle breeding program.

MOET and vitrification are the technologies are being tried here. The other is the production of high quality Philippine dairy animals, which is being conducted by the Dairy Training and Research Institute to preserve and enhance the gains of the re-breeding program of the government. The program seeks to establish a nucleus herd of superior dairy type cattle with the use of reproductive technologies such as MOET and vitrification.

Another project is the characterization, improvement and conservation of goats, also under the leadership of Dr. BONDOC. The project seeks to characterize, improve and conserve goats to ensure and improve the availability and sustainability of a superior breeding base in the country and to conserve and use these genetic resources.

Another project involves the identification, processing and utilization of proven bypass protein sources for cattle and carabaos, also being implemented by the IAS under the leadership of Dr. CESAR SEVILLA. The project involves semen manipulation. Still another project is the cryo typing of the carabao under the leadership of Dr. BONDOC.

We recognize that population growth, urbanization and increased income increases pressure to improve animal production. New methods are required to improve animal production efficiency and animal biotechnology can be explored to address this problem.

R&D on animal biotechnology in the Philippines is still very limited. R&D on animal biotechnology at the UP System is just starting, but neglect in this area would harm the improvement of livestock. There is

another caution. Drastic reduction in resources devoted to conventional researches to finance biotechnology may be equally dangerous. Our suggestion is side by side with conventional researches, we need biotechnology to improve our livestock production efficiency.

Animal Biotechnology: Present Status & Prospects of Veterinary Vaccine & Diagnostics Research & Development in the University of the Philippines Los Baños (UPLB)

SALCEDO L. EDUARDO, **DVM, MS, PHD**

Dean, College of Veterinary Medicine, UP Los Baños

This paper does not deal with the whole biotechnology industry in the Philippines. Rather, it will present the current status as well as the prospects of biotechnology research and development in the University of the Philippines Los Baños (UPLB). It is also limited to veterinary vaccines and diagnostics since these are the more important applications of biotechnology in veterinary medicine.

Animal diseases are major constraints to animal production in the Philippines. Some diseases, however, can be controlled by vaccination and treatment. The former will prevent infection and the latter will cure it. For treatment to be successful, it is highly dependent on appropriate diagnostic technology that could detect the infection most

especially at its early stage. Vaccines and diagnostics are therefore very important in the control of animal diseases.

Animal biotechnology research and development in the Philippines however is still in its infancy when compared to plant biotechnology. Few works have been done most especially on vaccine and diagnostics development. This is partly due to inadequate facilities and lack of financial support to these activities.

However, some veterinary vaccine products developed at the BIOTECH, UPLB are now available which the private sector can take up for commercialization. These are the following:

1. Bio-HS vaccine – This contains Pasteurella multocida group B. It is a vaccine for protection against haemorrhagic septicemia or shipping fever in cattle and carabaos (water buffaloes). It is administered subcutaneously at 2 ml/animal of age six months and above. It should be followed by a booster dose two weeks after and will provide protection for one year. It comes in a 250 ml bottle which is good for 125 animals. This product is already licensed by the Bureau of Animal Industry (BAI No. VBPR 3777).
2. Bio-FC vaccine – This product contains Pasteurella multocida group-A antigen (from ducks in Pateros). It protects chickens and ducks against fowl cholera. It is and administered subcutaneously at 0.5 ml per bird of ages 2-4 weeks. A booster dose is necessary two weeks after the initial dose. It comes in a 250 ml bottle which is good for 500 birds. BAI license is being obtained for this product.
3. Bio-SP vaccine – This another Pasteurella multocida group-A vaccine but is for the protection of pigs against swine plague. It is administered subcutaneously at 1 ml per piglet at four weeks old and a booster dose is required two weeks after the initial dose. It comes in a 250 ml bottle which is good for 250 piglets. BAI license is still to be obtained.
4. Hemorrhagic septicemia oil adjuvanted vaccine – This product contains killed, oil adjuvanted and double emulsion Pasteurella

multocida G1. It is for the protection of cattle and carabaos against haemorrhagic septicemia or shipping fever. It is administered subcutaneously at 2 ml per animal and given only once. It comes in a 250 bottle that is good for 125 animals. This is the work of Dr. HELEN A. MOLINA with funding from the Department of Agriculture – Bureau of Agricultural Research (DA-BAR). This product is still under field clinical testing.

5. Haemophillus paragalinarum-A vaccine – This product contains killed Haemophillus paragallinarum-A and aluminum hydroxide adjuvanted. It is used for the protection of poultry against infectious coryza. It is administered subcutaneously at 2 ml per animal. It is also under field clinical testing.

The above products cater to four food animals namely cattle, carabao, poultry and swine that are also mentioned in Dr. ANGEL LAMBIO'S presentation. It should be noted that poultry and swine are very important sources of meat in the Philippines.

While vaccine research has been attended to, nothing has been done in the past on veterinary diagnostics, which is also important in disease control. A research project on veterinary diagnostics which would deal with the development of effective immunodiagnostic test kits for the detection of Infectious Bursal Disease (IBD) virus and antibodies is already approved for implementation with funds from DA-BAR but the fund is still to be released. This three-year project is under the leadership of Dr. HOPE ROVIRA with a proposed budget of P5.75 million. However there are still some problems as regards the required equipment for the project.

The Animal Biotechnology Program at UPLB has the following components:

1. Vaccine Research & Development— Emphasis will be on food animal diseases and priorities based on BAI Administrative Order No. 12 Series of 1992 which include the first and second priority diseases, emerging diseases and diseases of farm concern.

2. Diagnostic Technology will deal with the development of immunoassays or diagnostic reagents for the detection and surveillance of animal diseases following the priorities of BAI, namely: those already mentioned in the preceding item plus companion animal diseases, exotic diseases and food borne diseases.
3. Reproductive Biotechnology – this includes frozen embryo, embryo transfer, cloning, etc.
4. Applied Biotechnology in Animal Breeding/Genetics & Nutrition – this includes development of breeds resistant to diseases.

The government's priority program is the prevention, control and eradication of the following: communicable diseases which have potential for very serious and rapid spread; are of serious socio-economic and/ or public health consequences; and are of major importance in the international trade of animals and their by products.

The program's outputs include vaccines, diagnostic technology and frozen embryos of superior breed of goats, sheep, swine, beef and dairy cattle and water buffaloes.

The implementing units of the Animal Biotechnology Program at UPLB are the following:

1. College of Veterinary Medicine (CVM)
2. National Institute of Molecular Biology & Biotechnology (BIOTECH)
3. Institute of Animal Science (IAS) of the College of Agriculture (CA)
4. Dairy Training & Research Institute (DTRI) of CA

The human resources at UPLB capable of undertaking research and development in animal biotechnology are presented below according to specialized groups or teams.

A. Vaccine and diagnostic technology group:

College of Veterinary Medicine

- Helen A. Molina, DVM, MVSt, Dip. Path. (diagnostic pathology & antigen characterization)
- Hope G. Rovira, DVM, PhD (vaccine & immunodiagnostics kit development)
- Josefina C. Santos, DVM, MS (virology & vaccine quality control)
- Mildred A. Padilla, DVM, MPH, DrPH (parasite antigen purification & monoclonal antibodies)
- Edward F. Barroga, DVM, PhD (tumor viruses, cancer cell biology & tissue culture).
- Billy P. Divina, DVM, MSc (helminth immunology & diagnostics)
- Romeo E. Sanchez, Jr., DVM, MSc (virology & tissue culture)
- Waren N. Baticados, DVM (protozoan immunology & diagnostics)

Biotech:
- Ma. Immaculada P. Toress, DVM, MS (vaccine development)

B. Reproductive Biotechnology Group
College of Veterinary Medicine
- Conrado A. Valdez. DVM, MVMSC, PhD (theriogenology, embryo transfer)
- Eduardo B. Torres, DVM, MS, PhD (theriogenology)
- Jezie A. Acorda, DVM, PhD (large animal medicine & surgery)

Dairy Training and Research Institute
- Antonio A. Rayos, DVM, MVSc, PhD (theriogenology)
- Jose Arceo N. Bautista, DVM, PhD (theriogenology)

Institute of Animal Science
- Severino S. Capitan, BSA, MS, PhD (reproductive physiology)

C. Applied Biotechnologies in Animal Breeding Genetics & Nutrition Group

College of Veterinary Medicine
- CHESTER D. SOLIS, DVM, MAgr.

Institute of Animal Science
- ORVILLE L. BONDOC, BSA, MSc, PhD
- NINFA P. ROXAS, BSA, MS, PhD
- ANGEL L. LAMBIO, BSA, MS, PhD
- EDWIN S. LUIS, BSA, MS, PhD

D. Laboratory Animal Support Group
College of Veterinary Medicine
- JOSEPH S. MASANGKAY, DVM, MAgrSc, DrAgr.Sc
- REA VICTORIA P. ANUNCIADO, DVM, MAgrSc, DrAgrSc

Laboratory-raised animals are essential components in any vaccine research and development venture, thus a group of scientists has been established to deal with this. This will ensure the use of "clean" or pathogen-free animals for the various experiments.

The animal industry particularly in the private sector can support in terms of funding for research and development of vaccines and diagnostics. Dr. PADOLINA said "Why not a Filipino 'citizen' vaccine?" Indeed, we should be able to do this especially that we have the human resources. But we should first have the necessary facilities for these activities. For example, if we have to work on foot and mouth disease, which is a priority disease in the Philippines, facilities appropriate to contain the virus should first be established. This disease is different from the rest of the animal diseases because of its unique epidemiology. At present, the foot and mouth vaccines that are being used are all imported. Diagnostics for early detection of important animal diseases are also lacking. For those diseases with available diagnostic kits, the latter have also to be imported. As previously stated, UPLB has the human resources properly trained for these activities.

It happened in many cases that the equipment outlay in some research proposals was reduced when funding was approved. This is not a good practice because it will compromise the quality of the research results and its expected output. It should be all or none.

The UPLB Animal Biotechnology Program needs financial support especially from the private sector to attain its objectives. With its world class human resources capable of undertaking animal biotechnology R&D and existing facilities, the animal industry can only benefit by linking with it.

Plant Biotechnology: Prospects for Philippine Bioindustries

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Abstract

Among plant biotechnologies, tissue culture of banana and orchids, as well as sugarcane, pineapple and makapuno, is the most widely utilized and commercialized in the Philippines. Plant tissue culture especially for micropropagation is also the most advanced in R&D. Thus, tissue culture technologies form the starting core of a biotechnology industry or bioindustry in the country. Such bioindustry involves not only the technology providers but also suppliers and service organizations. There are other plant biotechnologies which, in the future and with proper assistance, can be commercialized. These are markers for identifying crop varieties or hybrids, diagnostics for economically important plant diseases, unique or novel plant genes, and transgenic crops. The rich genetic bioresources of the country can provide biopharmaceuticals, genes for high value traits for crop improvement and for biofarming. The Philippines can still be involved in the extremely expensive drug

development venture, at the discovery stage where we have capabilities such as biological activity screening, isolation, identification and characterization, gene cloning etc. To promote the development of a sustainable plant biotechnology-based bioindustries, the following are important: strengthening of sciences in the country's schools and universities, strengthening of the research base and facilities, promoting appreciation for and protection of intellectual properties, promoting entrepreneurship among researchers, promoting closer interactive linkage with private sector, encouraging private sector to invest in R & D, promoting clustering, encouraging partnership and alliances. Further, strong government leadership is critical in assuring progress and success for such bioindustries.

Key words: plant biotechnology, bioindustry, clustering, tissue culture, markers, gene cloning, transgenic crops, bioprospecting

1.0 Introduction

Many countries in the world, including developing ones like the Philippines, have recognized the potential of biotechnology and have adopted biotechnology as a strategic tool to enhance productivity and sustainable development in agriculture, industry, health and environment. As early as 1979, the Philippine government had already exerted efforts to develop modern biotechnology with the establishment of BIOTECH (then, the National Institutes for Applied Microbiology and Biotechnology) at UPLB. In 1990, the Philippines established the National Committee on Biosafety of the Philippines (NCBP) through Executive Order No. 430 to formulate and review policies regarding biosafety and to regulate R&D involving genetic engineering and genetically modified organisms (GMOs), among others. Since then, all administrations of the government have adopted biotechnology as a major programme to advance S&T, modernize agriculture and contribute to industry, health and environment (Table 1).

Plant biotechnology covers tissue and cell culture technologies, markers and diagnostics, genes and bioinformatics and transgenic crops. In the Philippines, tissue culture of plants started at UPLB in the 1960s and thus among the plant biotechnologies, tissue culture is the most well developed in the country and has actually started a biotechnology-based industry or bioindustry in the country. Bioindustry includes "companies involved in research, development and manufacture of materials such as cell cultures, catalysts, genetic materials, immune response materials, biochemicals, enzymes, proteins and equipment used in biological and genetic research on humans, plants and animals." Bioindustry also includes service and support organizations that perform consulting, testing, processing and storage of such products. While others define bioindustry to pertain only to technologies which involve recombinant DNA technology, this paper will adopt the more inclusive definition which will include biotechnologies that do not use recombinant DNA technology, and is more appropriate to the Philippine situation.

Bioindustries are one of the fastest growing industry sectors throughout the world, with annual growth of up to 20 percent and higher in other parts. The United States leads in bioindustries followed by United Kingdom and Germany. Bioindustries are characterized by the predominance of small companies; less than 10 percent employ more than 250 people.

Table 1. Biotechnology Research and Policy Initiatives in the Philippines

1960s-70s Propagation of mutant makapuno coconut using embryo rescue developed at UP College of Agriculture (CA)

1970s Micropropagation and embryo rescue techniques for orchids, including indigenous orchids developed (UPCA)

1979 National Institutes of Biotechnology and Applied Microbiology (BIOTECH) established at UPLB by Presidential Decree during the term of President FERDINAND E. MARCOS

1980s Micropropagation techniques for banana varieties developed (UPLB- Institute of Plant Breeding (IPB))

1986-1992 Department of Science and Technology (DOST) identified biotechnology as "a strategic tool for achieving sustained economic development" during the term of Pres. CORAZON C. AQUINO

1990 National Committee on Biosafety of the Philippines (NCBP) created by Executive Order No. 430 to formulate and review biosafety policies and regulate R&D involving GMOs, among others

1990s Marker technologies for crop improvement developed at IPB and PHILRICE

1992 IPB is mandated by the Seed Industry Development Act of 1992 to lead in plant biotechnology activities

1992-1998 Biotechnology remained as a major program of DOST

1993-up Facilities and manpower for cloning plant genes and transformation developed at IPB, PhilRice

1995 National Biotechnology Network in the University of the Philippines System created by Pres. RAMOS

1997 Pres. Ramos approved 5-year Crop Biotechnology Program under DOST-PCARRD

1997 Agriculture and Fishery Modernization Act of 1997 included a provision for biotechnology in its budget for R&D

2000 Institutionalization of biotechnology in government programs approved by former President JOSEPH E. ESTRADA

Dec 1999-March 2000 First field testing of Bt corn in General Santos by Monsanto Philippines

2000 Papaya transgenic plantlets at IPB; screenhouse testing of XA-21 rice at PHILRICE

2001 Policy Statement on Modern Biotechnology issued by President GLORIA MACAPAGAL ARROYO

2001 Multilocational field trial of Bt corn by Monsanto Philippines and Pioneer-HiBred

Among the sectors of biotechnology, health products (therapeutics pharmaceuticals and vaccines) and diagnostics comprise more than 80 percent and bioagriculture and industrial enzymes comprise the rest.

Countries all over the world have recognized that biotechnology-based industries would be the next big industry, even bigger than ICT. Thus, even in Asia, the governments of Japan, Taiwan, South Korea, Singapore and Malaysia have poured huge investments in biotechnology R&D and into the development of bioindustries. The Philippine government with its limited resources has also given support to biotechnology R&D in the past two decades. To what extent has bioindustry been developed in the country? What are the locally developed biotechnology products that have been or can be commercialized?

This paper aims to: (1) briefly provide a historical background of plant biotechnology in the country; (2) discuss plant biotechnologies that are being used in bioindustry and (3) analyze prospects of and conditions to promote bioindustry in the country

2.0 Historical Background and Technology Generators

Plant biotechnology in the Philippines has its roots at the UPLB-CA where in the 1960s, Dr. EMERITA V. DE GUZMAN with students and staff developed the technique to propagate makapuno coconut. Makapuno nut does not normally germinate and just rots away. By getting and culturing its immature embryo on synthetic nutrient medium, Dr. DE GUZMAN (of the Department of Agricultural Botany and afterwards, Department of Horticulture) was successful in growing makapuno trees with potential yield of 100 percent makapuno. This was followed by the development of tissue culture technologies for orchids led by Dr. HELEN VALMAYOR and sugarcane by Dr. RAMON C. BARBA at the Department of Horticulture.

In 1975, the Institute of Plant Breeding (IPB) was established in UPLB-CA by Presidential Decree with Dr. EMIL Q. JAVIER as founding director who created different laboratories that support the breeding

activities for various crops. Many of these laboratories have utilized biotechnology techniques for their researches. In the 1980s, the tissue culture of banana was established at IPB by Dr. RC BARBA and his group. The use and/or development of other biotechnologies followed suit: tissue culture of other crops for propagation, generation of variability and for gene banking; serological diagnostics in the late 1970s, protein markers in the 1980s, markers and diagnostics using DNA technologies in the 1990s, cloning of genes, bioinformatics and plant transformation or genetic engineering in the late 1990s. IPB is mandated by the Seed Industry Development Act of 1992 to provide *leadership in plant biotechnology activities related to plant improvement, genetic resources conservation and in vitro mass production of planting materials.* In 1996, the IPB Plant Biotechnology Program (formerly the Cellular and Molecular Plant Biology Program established in 1989) was reorganized to lead and coordinate the various divisions and laboratories of IPB in an interdisciplinary and team approach manner to more effectively apply biotechnology tools in crop improvement.

Other institutions and departments at UPLB have also developed tissue culture techniques: orchids at BIOTECH; selected forest species at the Forestry Biological Sciences Department of the College of Forestry. The Department of Horticulture continues its researches on orchids, banana and abaca.

Serological, protein and/or DNA markers are also now developed and/or utilized by different groups: BIOTECH, under the College of Arts and Sciences —Institute of Biological Sciences and Institute of Chemistry; College of Veterinary Medicine, under CA—Dept of Plant Pathology, Institute of Animal Science, Department of Agronomy, Department of Horticulture; and the College of Forestry.

Outside UPLB, strong plant biotechnology R & D exists at the Philippine Rice Research Institute (PhilRice) in Central Luzon and the Philippine Coconut Authority (PCA) in Bicol and in Zamboanga.

More detailed and comprehensive reviews of plant or crop biotechnology in the Philippines have been written by this author (Tecson-Mendoza, 1995; Tecson-Mendoza and Villegas, 1999).

3.0 Plant Biotechnologies for Philippine Bioindustry

This section will discuss the plant biotechnologies which are now being commercialized and those that have the potential for commercialization.

3.1 Plant tissue culture technologies

The tissue culture techniques of propagating orchids, banana, makapuno and sugarcane the most well utilized and commercialized biotechnologies in the country.

Makapuno. With tissue cultured makapuno trees, the yield of makapuno increases to 75-100 percent from only 2-20 percent yield from makapuno-bearing trees. The present demand for makapuno cannot be met by the current production from 20,000 makapuno trees planted in different parts of the country. PCA through the leadership of Scientist ERLINDA P. RILLO has developed satellite laboratories in Mindanao (5), Southern Luzon (1), and Northern Luzon (1) to increase production of makapuno. The Philippine Coconut Research and Development Foundation (PCRDF) also has its own laboratory. However, there is still a long way to go before the demand of the local and export market can be met.

Orchids. The private sector comprising both small or cottage type and large laboratories has adopted the commercialization of tissue cultured orchids, utilizing different orchid genera such as *Dendrobium*, *Phalaenopsis*, *Vanda*, cattleya, *Renanthera*, etc. In addition to micropropagation, in vitro culture of orchid seeds has permitted creation of artificially induced interspecific and intergeneric hybrids. The Department of Horticulture-CA of UPLB has conducted summer short term courses on tissue culture of orchids for hobbyists and entrepreneurs for the past thirty years.

Banana. Large banana plantations in the Philippines have adopted the use of tissue culture technique of micropropagation because this results in the production of clean and uniform seed materials. Even

small farms have discovered the advantages of using tissue cultured banana seedlings. This technology, developed at the IPB in the 1980s was made available to the private sector free of charge through a workshop. First developed for the banana var Saba (Damasco and Barba, 1984), the procedure was modified for fifty other cultivars (Damasco et al, 1984).

Several companies sell tissue cultured banana seedlings: Davao Musatech Corp. , and affiliate of Stanfilco which is a division of Dole Philippines Inc., based in Davao, Dolefil Tissue Culture Lab based in South Cotabato, Lapanday BioTrends in Davao City and Marsman Drysdale Biotech Research Corp in Davao del Norte. Davao Musatech is one of world's largest producers of tissue cultured seedlings of banana with an annual capacity of 23 million seedlings. Dolefil serves the needs of different subsidiaries of Dole; it produces pineapple for Dolefil, banana for Stanfilco and asparagus for TropicFresh. Dolefil has the capacity to produce three million seedlings of pineapple and up to six million seedlings of banana per year. Other smaller laboratories are Intelligent Agro-technical Resources Inc, Tropical Research and Technology Center Inc and Secura Plant Genetics Inc in Davao. Secura Plant Genetics produces up to 80,000 banana meristems per month and caters to small banana planters.

DOST has assisted local governments, colleges and universities and private sector in setting up laboratories for tissue culture in different parts of the country. There is certainly a market for tissue cultured banana seedlings in the country which should be tapped. The use of tissue cultured banana seedlings can also promote better production of this major fruit crop.

Sugarcane. Micropropagation of sugarcane has the potential of producing 640,000 three-eye canepoints from one shoot tip in 11 months. The Philippine Sugar Research Institute Foundation Inc (PHILSURIN) produced more than 800,000 plantlets for the crop season of 1999-2000 which were distributed to participating growers. This process

assures the rapid distribution to farmers of clean seed pieces of new varieties which are free of ratoon stunting disease.

Other crops. Procedures for micropropagation of other crops have been developed and optimized such as for forest species like *Albizzia falcataria* Bach, *Eucalyptus camaladulensis*, bamboo and rattan; for vegetables like potato, garlic and shallot; fruit crops such as pineapple, strawberry, pummelo, papaya; root crops such as yam, sweet potato and ornamentals like mussaenda, anthuriums, chrysanthemum, lilies, gladioli, etc. Some of the laboratories mentioned above provide tissue culture service for pineapple and root crops. However, the micropropagation of said crops has not caught on with the private sector. Attempts to commercialize production of white potato seeds by tissue culture failed not because of the technology but because of lack of market and government support through incentives and protection from cheaper import (Patena, pers comm.). The micropropagation of ornamentals and selected fruit crops should be pursued to provide certified seed materials for growers as this will ensure good quality, uniform and disease-free materials.

Tremendous efforts and resources have been poured into the development of micropropagation technique for coconut by the PCA team of scientists since 1989 with funding from international and local agencies. Limited success has been obtained by using inflorescence, immature flowers and embryos and more recently from plumules excised from mature zygotic embryos. They have obtained seedlings which is already a big breakthrough; however, hardening and establishment of the clonal plantlets in the screenhouse remain difficult to accomplish.

3.2 Diagnostics and molecular marker technologies

Immunological or serological-based diagnostic kits. Diagnostic kits based on immunological or serological technique are used to screen or detect pathogens and viruses in crops. There can be a local market for diagnostic kits for some of the more important plant diseases if farmers will recognize the importance of using disease-free planting materials. The immunological diagnostic kit for ratoon stunting disease adopted and

standardized at IPB is now being used by sugarcane growers all over the country through PHILSURIN. Immunological or serological-based detection techniques have also been developed for other plant diseases like bacterial wilt, papaya ringspot virus, leaf mottling disease of citrus, bunchytop virus of banana and abaca etc.

Molecular markers. Molecular markers such as protein or enzyme and DNA markers, are utilized by plant breeders in crop varietal improvement to increase selection efficiency, identify, characterize and select desirable genotypes. Protein markers are usually profiles of total protein or isozymes while DNA markers are profiles of fragments of DNA called restriction fragment length polymorphism (RFLP), randomly amplified polymorphic DNAs (RAPDs), and microsatellites or simple sequence repeats (SSRs). These markers are useful tools in research. However, there are some markers which can be useful in industry and may be commercialized. Some examples of such markers are the isozyme pattern markers specific for popular rambutan varieties (Bernardo et al, 1999), DNA markers for hybridity testing of PCA hybrids (Hautea et al, 2001) and detection of the coconut cadang-cadang viroid or CCCVd in the meat and water (solid and liquid endosperm) of young and mature coconut and in coconut products using molecular hybridization assay (Rodriguez and Estioko, 2001).

3.3 Gene discovery, drug discovery and bioprospecting

Gene cloning. Interest in cloning specific genes from various major crops and pathogens arises from their use to improve traits of these crops using genetic engineering. Because such genes can also be used in crops different from their respective sources, other research groups within and outside the country might also be interested to use them. Thus, if the gene and/or its function is quite unique, it might be beneficial to have it patented.

Isolation and cloning of genes from local bioresources started only in 1997 with the DOST and the Australian Centre for International Agricultural Research (ACIAR) supporting the project at IPB to develop

long shelf life in papaya and mango. Ripening-related ACC synthase genes were cloned from papaya var Davao Solo Kapoho and from the hybrid Sinta. The ripening-related ACC synthase gene from the mango var Carabao was also cloned. The partial cDNA sequences of these genes of ACC synthase from papaya and mango have been registered with GenBank.

Several genes such as those for the C12-thioesterase, a-D-galactosidase, oleosin and b-mannanase from coconut are in various stages of cloning and characterization. The coat protein genes of papaya ringspot virus and banana bunchytop virus have also been cloned and are being characterized. At PhilRice, efforts are focused on cloning the tungro resistance genes from rice.

Drug discovery and bioprospecting. Our country has one of the highest biodiversity in the world; such rich bioresources can be a source of drugs for various diseases and disorders. With the cost of developing drugs exceeding US$600 million per drug, it simply is not possible for any government institution or even a local company to finance the total costs of such activities. However, the Philippines can still engage in the development of drugs in the following specific areas where we have the expertise and facilities: screening for specific biological activities, isolation, identification and characterization of active principles and isolation and cloning of gene of active principle. These bioresources can be sources of important biopharmaceuticals, genes for high value traits for crop improvement and biofarming (Figure 1). For such activities, we need to further develop and strengthen our capabilities in high throughput screening, proteomics, genomics and bioinformatics. Active principles can be licensed to other parties for further development and testing. Many biocompanies thrive in this type of activities. Millennium Pharmaceuticals Inc of Cambridge, Massachusetts started with 30 researchers in 1993 and has grown to more than 700 scientists, managers and technicians. It is a leading edge drug discovery and development company which has made partnerships with big companies like Monsanto, Eli Lilly, Hoffman-La

Roche and Bayer AG. Millennium has been paid millions of dollars by its partners for drug discovery, targets and leads and technology transfer services. Wall Street has recognized the value of companies like Millennium to be based on the "innovative interplay of partners and platforms, processes and technologies" (Jonash and Sommerlatte, 1999).

A Senate bill that supports bioprospecting and drug discovery activities has been filed by Senator MANUEL B. VILLAR JR. Senate Bill No. 953 entitled "An Act Declaring a National Framework for the Protection of Biodiversity in Terrestrial, Aquatic and Agricultural Resources and Creating the Institutional Mechanism for its Implementation" aims to increase the coverage of protected areas in the country and also provides support to the conduct of biotechnology activities on the rich genetic resources for drug discovery, mass utilization and eventual commercialization.

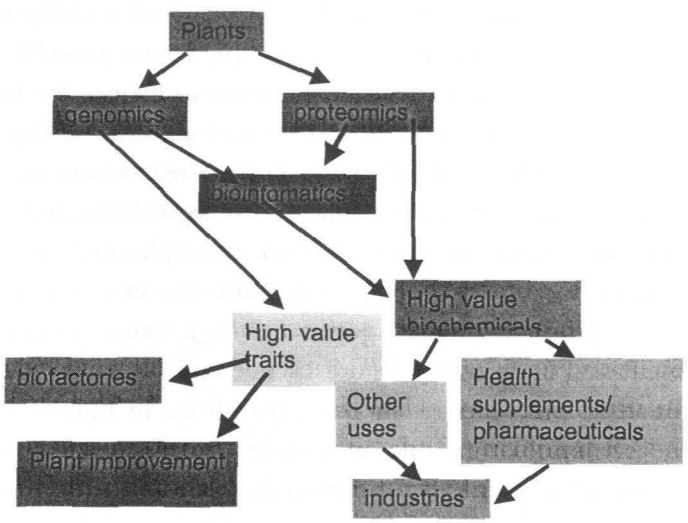

Figure 1. Biopharmaceuticals and high value traits from plants through biotechnology.

3.4 Transgenic crops

Development of transgenic crops with improved traits difficult to attain using traditional breeding techniques is ongoing at UPLB and at PhilRice. At IPB-CA UPLB, at the most advanced stage of development is papaya with longer shelf life supported by both DOST and ACIAR and this is being done by our research team in collaboration with Dr. JOSE RAMON BOTELLA of the University of Queensland. Putative transgenic plantlets are now being grown out in a second level of biosafety screenhouse. Similar efforts are being done on developing delayed ripening trait in mango var Carabao or Manila Super Mango. The conditions for somatic embryogenesis of mango var Carabao have been optimized (Pateña et al, 1999). The constraints now of the mango tissue culture are on the regeneration to complete plant, hardening and eventual growing out.

There are also efforts to develop resistance to papaya ringspot virus in papaya using the local PRSV coat protein gene and resistance to banana bunchytop virus (BBTV) in banana using the BTV coat protein gene. We have, on the other hand, developed BBTV resistance in banana var Lakatan using radiation technology; putative resistant clones are now being tested in the screenhouse and the field.

IPB has cooperated with Monsanto (formerly Agroseed Co.) and Pioneer Hi-Bred in the screenhouse testing of Bt corn (Mon 810) which was done at the facility in the International Rice Research Institute (IRRI). Both companies are now requesting approval from NCBP to do limited field tests of their Bt corn in General Santos and other parts in southern Philippines.

PhilRice is also doing screenhouse testing of the XA-21 transgenic rice with resistance to bacterial blight in its main headquarters at Muños, Nueva Ecija. PhilRice is also involved in genetic engineering activities on the incorporation of exogenous genes conferring resistance to sheath blight (*Rhizoctonia solani*), blast (*Pycularia oryzae*), stemborer and tungro.

BIOTECH-UPLB, in cooperation with the Institute of Biotechnology of UP Manila is developing edible vaccines against local strains of *Salmonella* using banana and tomato.

While the current thrust in developing transgenic crops is to improve their traits, there are other applications of transgenic crops which can be looked into: (1) production of high value biochemicals, pharmaceuticals or health products; (2) extraction of pollutants; (3) extraction of high value metals and (4) production of biodegradeable plastics.

4.0 Prospects of Bioindustries

4.1 Worldwide

The United States leads the world in bioindustries which generated a total of 437,000 jobs and $47 billion in revenues while plowing back $11 billion in R&D and providing the government $10 billion in tax revenues (Figure 2) (Ernst and Young, 2000). Agricultural biotechnology generated about $2.3 billion in revenues while generating 21,900 jobs.

Fig. 2. Contributions of biotechnology to the US economy in 1999

- 437,000 jobs
  - 150,800 jobs in biotech companies
  - 286,600 jobs in companies supplying inputs to industry
- $47 billion in additional revenues
  - $20 billion by biotech companies
  - $27 billion by support companies
- $11 billion in R&D
- $10 billion in tax revenues

From Ernst and Young, 2000.

In Asia, China leads in the adoption of transgenic or genetically modified (GM) crops with an estimated 1.5 million ha of Bt cotton and

with other transgenic crops at various stages of development and semi-commercialization. India has also been field testing Bt cotton at different sites. Both China and India have biocompanies involved in the production of recombinant pharmaceuticals and vaccines such as recombinant insulin, interferon, growth hormone and erythropoietin. Singapore launched its US$34 M Genomics Program to study the diverse genetic make-up of Asians in June 2000. The island state is also developing novel drugs by high throughput screening and genomics. Although several biocompanies in Japan have huge revenues in billions of dollars for recombinant pharmaceuticals, the Japanese government considers itself behind in bioindustries. Thus, in 1999, it allocated US$18 billion for biotechnology R & D for five years in addition to the $4.6 billion annual budget to spur the further development of bioindustry (Asiaweek, 2000). Malaysia, since 1988, has had five-year national biotechnology programmes. It has a collaborative set-up with Massachusetts Institute of Technology focusing on two research programs, one on the tissue culture and chemical fingerprinting of the active ingredients in Malaysia's top herbal plant called "Tongkat Ali" and the other on the tissue culture and metabolic engineering of the oil palm.

From the above, it can be seen that biopharmaceuticals constitute about 80 percent of the total bioindustry market with bioagriculture comprising only 10-15 percent.

4.2 In the Philippines

Among the locally developed biotechnologies, the tissue culture of orchids and banana is the most widely utilized at the commercial level by both small and big companies. Table 2 summarizes the different plant biotechnologies and their stages of maturity are indicated. Unfortunately, there are no statistical data on the number of biocompanies, their products or their revenues in the country. Thus, we cannot explicitly state their contributions to the economy. While we find tissue culture of orchids and banana to be the most widely commercialized, we believe

that the market is not saturated yet. A visiting expert, Dr. CHAI MAK of University of Malaya, in 1997, noted that tissue cultured seedlings of banana were not utilized at all by banana growers in Cavite. He commented that in Malaysia, all banana plants are from tissue cultured seedlings. Farmers order them ahead of time from companies that produce tissue cultured banana seedlings.

It should also be emphasized that with the commercialization of the tissue culture technologies for orchids and banana came the rise of supporting companies which include those that supply biochemicals and supplies used in tissue culture, those that sell or manufacture equipment like laminar flow hood, shakers, ovens etc, as shown in Figure 3. This figure also emphasizes the "clustering" of similar or related companies and and others which can support the commercialization of the technology. Industry clustering as defined by the Philippine Export Development Plan (PEDP) is the "grouping of firms in an industry through the provision of goods, services, machinery and specialized inputs (eg., knowledge) and the buyers, all operating under an environment shaped by government, the physical and cultural heritage and available infrastructure." This clustering concept as a collaborative model of governance has been strongly advocated in the country (Follosco, 2001). Clustering has been an important strategy in the successful launching of information and communications technology and in the development of bioindustry in the US and in Europe.

Table 2. *Summary of plant biotechnologies in the Philippines*

TECHNOLOGY	PRODUCT[a]	STAGE
1. **Tissue culture**	a. Orchids	Commercial, High
	b. Banana	Commercial, High but only in Mindanao
	c. Makapuno	Lab to semi-commercial, Low

TECHNOLOGY	PRODUCT[a]	STAGE
	d. Sugarcane	Institutional (c/o PHILSURIN)
		Semi-commercial, low
	e. Pineapple	Institutional (eg, Dolefil produces for Dole's needs)
	f. Asparagus	Institutional (eg, Dolefil produces for Dole's needs)
	h. strawberry	Institutional (eg, BPI Baguio produces for its own use)
	i. various ornamentals	Lab or semi-commercial
2. **Markers**		
a. Serological	a. for ratoon stunting disease (RSD)	Institutional (c/o PHILSURIN)
	b. PRSV	Lab
	c. BBTV	Lab
	others	
b. protein markers	a. for identification of rambutan varieties	Lab
c. DNA markers	a. For hybridity test of coconut hybrids	Institutional (PCA & IPB), and buyers of hybrid coconut seedlings
3. **Genes**	a. From papaya ACC synthase, ripening related	Lab
	b. From mango ACC synthase, ripening related	Lab
	c. From sugarcane maturity-related	Lab

TECHNOLOGY	PRODUCT[a]	STAGE
	d. From coconut oleosin C12-thioesterase α-D-galactosidase β-D-mannanase promoter cocosin others	Lab
4. **Transgenic crops**	a. Bt corn	Monsanto and Pioneer
	b. papaya with delayed ripening trait	Hi-Bred, field testing Screenhouse; growing out
	c. papaya with PRSV resistance	laboratory
	d. rice with bacterial blight resistance using XA-21 gene	Screenhouse test; for field test

[a] The protocol or technique may be commercialized.

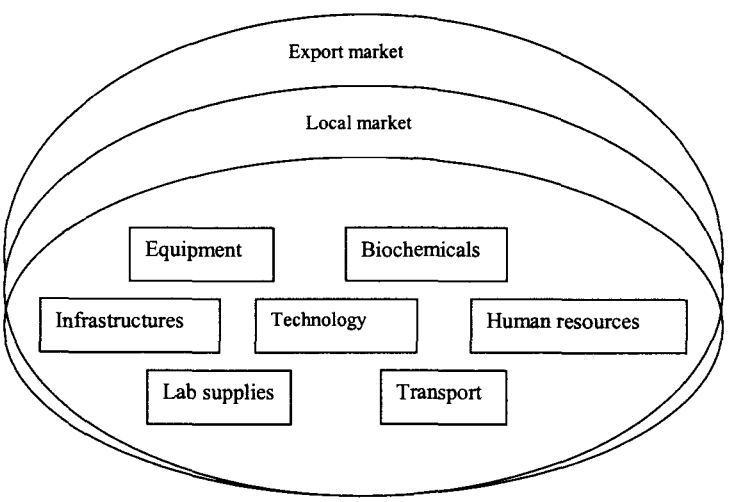

Figure 3. Technology commercialization promotes growth of support industry sectors

Aside from the commercialization of the product of the technology, the technology itself can be a source of revenues for the technology generator. In this regard, protection of intellectual properties is a key factor for economic growth and advancement. Patents provide incentives to private sector investment in technology development. Even for universities and publicly supported institutions, their commercialized technologies have become an important source of funding. One can imagine the resources which the micropropagation of banana could have brought to the institution and the researchers that developed the technology if royalty is paid by users of the technology!

As discussed earlier, the Philippines can also engage in the development of drugs in areas where we have the expertise and facilities: screening for specific biological activities, isolation, identification and characterization of active principles and isolation and cloning of gene of active principle. Our rich genetic bioresources of flora and fauna can be sources of important pharmaceuticals, or genes for important or high value traits which can used in crop improvement or transferred to other crops which can serve as biofactories (Figure 2).

Thus, bioindustry in the country is just at an early stage and has all the potentials to grow.

5.0 Promotion of Bioindustries in the Philippines

To be able to promote the utilization and commercialization of plant biotechnologies developed by local research institutions, I wish to offer the following for consideration by concerned parties and agencies:

- Further strengthening of the sciences
- Strengthening of research base—manpower and facilities
- Promotion of appreciation for and protection of intellectual properties
- Promotion of entrepreneurship among researchers
- Promotion of strategic planning and closer interactive linkage with private sector
- Encouraging private sector to invest in research

- Promotion of clustering
- Encouraging and promoting partnership and alliances

Needless to say that **strong government leadership** is needed to push the commercialization of biotechnologies for a sustainable and profitable bioindustry.

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Industrial Applications of Biotechnology Research

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Bio means life, technology means a tool or technique used to achieve a particular purpose. Therefore, biotechnology is any technique that uses living organisms or part of organisms to make or modify a product, to improve plants or animals or to develop substances for specific uses.

Techniques in biotechnology include recombinant DNA technology, tissue culture, protoplast fusion, monoclonal antibody technology, protein structural modification (protein engineering), enzyme biotechnology and biosensors.

What are some of the products of biotechnology needed by the industrial sector?

- Solvents e.g. ethanol and acetone which BIOTECH produced before.
- Organic acids e.g. citric acids, lactic acid and gluconic acid and
- Methane as fuel.

- Amino acids used by both human and animals include lysine, cysteine, methionine.
- For the pharmaceutical industry, products such as antibiotics, vaccines, proteins and peptides (insulin) and vitamins are important.

My topic for today will focus on enzyme biotechnology.

What are enzymes? They are proteins consisting of amino acids held together by peptide bonds. What is the importance of enzymes? They can act as catalysts for a given reaction. Enzymes can speed up chemical reactions that would otherwise run slowly if at all. An inorganic chemical which is used as catalyst in a given reaction produces side products. Enzymes do not and as such are well-suited to a wide range of industrial applications because of their efficiency and specificity.

For enzyme production, two methods of cultivation/production can be used. One is solid substrate cultivation in which trays are used and incubated in a room or cabinet. For liquid culture fermentation, the most advanced fermentors or a fabricated fermentor could be used. Actually, we have one 1,000 liter and three 600 liter fermentors which are all fabricated because we do not have enough funds to buy the most expensive ones. A 1000 liter-fermentor costs more than 10 million pesos. The Japanese government through the Japan International Cooperation Agency (JICA) donated two fermentors (200 L, 30 L) more than 15 years ago. Right now, we cannot even buy the spare parts in Japan because these equipment are already obsolete. The centrifugal separator which is used to separate biomass and microbial cells from the culture supernatant was also donated by JICA.

Industrial enzymes currently produced at BIOTECH are cellulase, ligninase, lipase, proteases (acid, neutral and alkaline), pectinase, a-amylase and glucoamylase.

For example, alpha-amylase and glucoamylase can be used for the production of maltodextrin and glucose from local starches such as cassava and sweet potato which are used by the food industry.

In his opening remarks, President NEMENZO mentioned that we should not only be an exporter of raw materials but should export high value products from raw materials that are produced in the Philippines.

In one of the seminars of EUROMED at PCARRD, the speaker mentioned that the dextrose being used by the pharmaceutical industry in the Philippines can also be produced locally by conversion of cornstarch into glucose. In the case of cassava, sweet potato and potato, maltodextrin and glucose used by the food industries can be produced through the enzymatic process.

Alpha amylase can also be used as feed additive since it can promote faster growth, lesser feed consumption and promotes better feed efficiency. It hydrolyzes starch into smaller units that can be digested by broilers or swine to hasten digestion to get the required energy for growth and development. It is also very important for coconut oil extraction in obtaining higher yield and better oil quality. All these application studies of a-amylase are being conducted at BIOTECH.

The use of the wet process for coconut oil extraction as an alternative method instead of using copra will solve the problem of aflatoxins. High grade coconut oil known as "virgin" oil will be produced and could be substituted for mineral oil in producing baby oil. The coconut starch could then be readily extracted from the coconut meat without the problem of aflatoxins.

Alpha-amylase can also be substituted for potassium bromate (a carcinogen) in pandesal making. We found out that by using even only 0.03 percent a-amylase, browning of the bread crust was enhanced and staling of the bread was retarded.

Cellulases are being used as feed additive for broilers. This group of enzymes is very important in the digestion of cellulose. In feeding trials being conducted in cooperation with the Institute of Animal Science, cellulase promotes lesser feed consumption, better feed efficiency, and higher income for the poultry growers.

In layers, feeding trials showed more egg production, better feed efficiency and therefore higher income for poultry raisers. Again, cellulase is also used for coconut oil extraction by the wet process.

The next enzyme is lipase and the most important application in the Philippines is in the production of beta-monoglycerides from coconut oil. Why? Beta-monoglyceride is used by the food industry as a coating agent and as an emulsifier. Actually, a private company has already tested the BIOTECH produced beta-monoglyceride as an antimicrobial substitute for triclosan/triclocarban (carcinogens) for soap and toothpaste. The b-monoglyceride has a very wide range of antibacterial property.

Triclosan and Triclocarban are used in the manufacture of soap and toothpaste as antimicrobial agents. However, these two chemicals are carcinogens. The companies are very silent about this because they have not found a good substitute and b-monoglyceride is a good substitute. This can also be a possible treatment for AIDS since the group of Dr. DAYRIT has been testing monolaurin at San Lazaro Hospital for AIDS patients.

A drawback in our ability to produce b-monoglyceride on a pilot scale for further testing of the product is the non-availability of a molecular distillation apparatus which would separate the different components of the products. I am still working to get some money for the molecular fractional distillation set up.

Medium chain triglycerides (MCTs) can also be produced by lipase-catalyzed reaction. MCT is being used by adults and young people who can not digest fats. MCT consists of C8 and C10 fatty acids which are easily digestible.

We also produce acid protease which is comparable with commercial protease based on feeding trials conducted on broilers and layers at the Institute of Animal Science, College of Agriculture, UPLB. This enzyme promotes faster growth, lesser feed consumption, better feed efficiency, more eggs and higher income for farmers. Acid protease hydrolyzes proteins into amino acids which are used for growth of broilers and

layers. Extraction of omega-3-fatty acid is also possible using acid protease to increase oil yield. I would like to collaborate with UPV on this study since there is group working on fish processing. Omega-3-fatty acid is a health food supplement.

On the other hand, neutral protease can be used for the wet processing of coconut oil and for bread making. There are two enzymes involved in bread making, one for the hydrolysis of starch and the other for the hydrolysis of the proteins to get a better dough.

Pectinases are gum removers. The use of this enzyme is more efficient, requires low energy and is environment friendly. In the degumming of ramie, a chemical such as sulfate is used that pollutes the environment.

Extraction of essential oil by the enzymatic process is being done at BIOTECH. Through this process, higher yield, better quality, fresher and more intense fragrance are obtained. The traditional method of steam distillation usually gives an average yield of about one percent or lower of essential oil. With the enzymatic process, the yield can be improved from two to three percent, thus a 100 percent increase or more.

Pectinases are also applied in the production of wine and juice puree for higher yield, faster reduction of viscosity and more intense natural flavor of fruits.

I would also like to mention another specialty product that BIOTECH produces which is the PCR-based diagnostic kits against food and water-borne pathogens. We already have a collaboration with the National Meat Inspection Commission (NMIC) for the validation of the test kits versus other methods of detection. Technical personnel from the regulatory agencies are being trained on the use of this kit.

The industrial enzymes and those enzymes for recombinant DNA work are all imported. I hope all these enzymes can be produced locally to save the much needed dollar reserves and to generate employment.

Our contribution to the health sector is animal vaccines which will be discussed by Dr. MASLOG. The Immunology Laboratory has already

produced monoclonal antibodies for 18 plant diseases. We are helping the Department of Agriculture (BA) in the rehabilitation of the banana as well as the abaca industries. Two training sessions for all the DA regulatory agency personnel to use the immunologically based diagnostic kits have been conducted. Diagnostic kits against mycotoxins and red tide toxin have also been developed. An alternative method of determining these food toxins is very important because the solvents used in the chemical analysis pollute the environment. Our diagnostic kit is environment friendly. The kits use very little solvent so as not to pollute the environment.

At BIOTECH, we also do tissue culture and transformation of banana to produce GMO banana containing edible vaccine and resistance to banana bract mosaic virus. Virus-free banana planting materials which are free from banana bunchy top, banana bract-mosaic and banana mosaic virus are also produced in collaboration with the UPLB Department of Horticulture.

Biofertilizers are also produced at BIOTECH. We are proud of BIO-N, because the institute will get P14 million from the DA and Technology and Livelihood Resource Center (TLRC) to mass produce BIO-N and to be distributed all over the country. BIO-N is good for rice and corn. It is being tried for other crops also. The DA would like to use this for rice and corn because it reduces the use of chemical input which also pollutes the environment. An amount of P3,800 per hectare can be saved with BIO-N while P2,617 per hectare can be saved using Biogreen and Cocorich.

There is a big back order for Mycogroe and we have sourced some funds for the mass production of the product. We are doing something about this. We also have Mycogroe and Mykovam for forest trees and NitroPlus for legumes, peanuts and soy beans.

BIOTECH is also involved in the production of bioactive compounds as possible anti-cancer agent. We have very capable technical personnel who have been working with Mrs. SAJISE to do this

type of research. Tissue culture of sanggumay and sandal wood is also being done to extract the essential oils.

For the industries, BIOTECH researchers under the Environmental Program found that distillery effluent can be recycled as fertilizer. We have microbial inoculants for deodorization of waste specially from poultry and swine farms, decolorization of colored industrial effluents and filtration membranes from *nata de coco.* We should do more research on the production of high value products from *nata de coco.*

Microbial exopolysaccharides (EPS) have been tested for bioremediation of heavy metals. EPS can be used for monitoring and evaluation of products for environmental management similar to the chips being used by Sony Corporation.

BIOTECH offers a number of services which include chemical analyses (proximate analysis, metals, vitamins, etc.) microbiological analyses, electron microscopy and fermentation engineering services for the government and private sectors. Last but not the least, the BIOTECH Microbial Culture Collection and Services Laboratory is a national repository of all microorganisms and we are working for its recognition as an Internationally Depository Authority.

Health/Medical Biotechnology

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The Institute of Biotechnology and Molecular Biology in UP Manila is really for health. We are supposed to develop vaccines, diagnostic reagents or therapeutic reagents. We are also involved in the development of biological control agents or vectors of human diseases.

We are involved in developing materials—substances in support of macro and micro nutrients. Since we in the medical field, vaccine development should be a priority, but we need good manufacturing processes (GMP) facilities and we are not capable of that at this time. We do not have the resources to do that so we are currently focusing on diagnostic reagents and therapeutic agents. We are trying to harness our local fauna for possible biological activity, in particular, immuno modulatory activities.

In the first year of the Institute of Biotechnology's establishment at UP Manila (which was only six years ago) we helped in identifying molecules that could be used as vaccine components especially for *Schistosoma japnicum.* Dr. WILFRED TIU will expound on that later this afternoon, along with the characterization of virulent isolates of local *Plasmodium falciparum* strains, antigens or structures that may be useful as immuno therapeutic agents.

We also studied the different ciades or sub-types of HIV that could be used as a cocktail of vaccine molecules for HIV infection and AIDS.

Right now, our collaboration with UPLB may have potential commercial value but not in the next five or 10 years. The regulatory framework for edible vaccines will probably be very difficult but at this time we are doing it for academic purposes. We have extracted and purified the gene coding for the *Salmonella typhio* flagellar antigen and have given these genes (the DNA) to UPLB so they can inject the DNA into bananas or tomatoes. We have pure DNA already.

Hopefully in the next year or in the next few months, UPLB will be able to bombard the callus of bananas and tomatoes with this gene. In fact, this is where the UPLB group is involved. They have the banana (scalp) in the (CS) medium; they are also trying the tomato.

This is where we are now. It will probably take another five or 10 years to really put all of these into something tangible.

Following vaccines, we are also trying to develop immuno modulatory agents, maybe immuno therapeutic agents. We are working on ampalaya - the immuno modulating effect of both the crude and purified extracts of *Momordica charantia* which is ampalaya. Ampalaya is now being used for diabetes and many other ailments.

In terms of control agents, we had one project that tried to grow and mass produce the spores of *Culicinomyces clavisporus* as a mosquitocidal agent, but it met with a lot of problems. The more promising work is on the avocado extract against mosquito larva in the Philipines by Dr. OLIVEROS from the Institute of Pharmacy. Right now it is under patent application but Dr. OLIVEROS said it has been a year and nothing has come out of it. Atty. OCHAVE does not think we should patent - just go ahead and sell. It is actually the lead that she extracts for mosquitocidal activity.

Dr. LILIAN DELAS LLAGAS is also very much involved in mosquitocidal agents.

As far as UP Manila's thrusts are concerned, we will go for diagnostic reagents. We funded a few research projects to modify the existing anti-

hepatitis C-virus agglutination assay and that will be discussed later this afternoon.

These were two projects that actually did not work very well, mostly because of lack of infrastructure. We did not have the set up and the equipment. This should have been promising because we need diagnostic reagents for tuberculous menigitis.

The work on *Bacillus subtilis* spore is not really that highly technical. It was very easy to propagate except that we need fermenters to upscale. The spores are used for population screening for *Phenylketonuria.* Later, I will discuss the project of the Institute of Human Genetics (IHG) where most of these diagnostic reagents will be needed. My project is on the development of polyclonal and monoclonal antibodies serotyping reagents for vibro cholera. We continue to have outbreaks of vibro cholera despite efforts at sanitation, prevention and so on. We already have some materials and some products here.

We used the rabbit to produce polyclona antisera, but we are also aiming at using monoclonals. However, we are having some problems with the monoclonal antibody production.

We have come up with hyper-immune sera against the *Inaba* type of vibrio cholera. We have enough antisera and we have tested some of it. We are still optimizing some of the assays. It took us three years to generate these antisera. We still have a lot of problems with animal facilities and we hope we can get somebody to help us with that. The monoclona antibody production continues to be a problem, and we hope we can find partners there.

As far as newborn screening is concerned, the IHG at the National Institutes of Health (NIH) in UP Manila is the largest provider of medical care for genetic disorders in the Philippines. They provide services for newborn screening, meaning all babies, a few days after they are born, are brought to NIH for blood testing. We have this heel-prick method and they undergo several tests. We provide other services but this is where biotechnology will come in.

The area with potential for biotechnology will be in the development of kits for use in the newborn screening laboratory.

In the Philippines, newborn screening is only five years old but is not offered nationwide, only in 198 hospitals. There is a potential to screen 1.5 million babies per year for different disorders. One condition being tested is congenital hypothyroidism. This is present in about one in 4,000 babies and can cause mental retardation. If diagnosed promptly, supplementary thyroxine hormone can be given to prevent mental retardation. This is the priority for diagnostic kit development and we have Prof. DE GUZMAN to discuss the results of this kit development later this afternoon.

Another condition is Glucose-6 phophate dehydrogenase (G-6-PD) deficiency where one in 66 babies has this condition. Because of congenital hypothyroidism's effects, this is a priority. Then there are many others like *phenylketonuria* and *galactosemia.*

The thyroid stimulating hormone (TSH) assay is what we hope to develop which we will compare with commercially available ones. It is enzyme-based.

To summarize, the projects that have commercial potential are biological control agents. The avocado extract is under patent, there is one potential immuno modulatory agent which has been semi-purified. The ampalaya extract works on macrophages and some of our immune cells. We now have rabbit polyclonal anti-sera, which we could use as a serotyping agent. They are available in limited quantities at this time, for further testing. The monoclonal antibodies need further optimization and we hope to have them available soon.

For the newborn screening test we have the TSH assay for congenital hypothyroidism, the assay for G-6-PD deficiency and the assay for phenylketonuria.

Developments in Sugarcane Biotechnology[1]

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Abstract

The International Consortium for Sugarcane Biotechnology (ICSB) is largely responsible for the development of biotechnology in sugarcane. The Hawaiian Sugar Planters Association (HSPA) and the Centro de Technologia Copersucar (CTC) of Brazil were the prime movers in the creation of ICSB. There are now 17 member institutions of ICSB. Since its inception in 1989 to the present, the consortium has undertaken 16 research projects costing more than US$3,700,000. The biggest contributor to ICSB is Brazil followed by the US. Of the 16 projects, nine were on genome mapping, three were on map-based cloning and two each on transformation and diagnostics. There were four transgenic sugarcane clones that have been produced through transformation: 1)

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those resistant to sugarcane and sorghum mosaic viruses, 2) those tolerant to bialaphos and glufosinate ammonium herbicides, 3) those showing resistance to sugarcane borers and Mexican borers, and 4) those that have shown resistance to lesser cornstalk borer.

The ICSB has shown the way for international cooperation and collaboration in sharing resources to fully exploit the benefits of biotechnology. Several institutions that have participated in conducting the research projects are now recognized as being at the leading edge of sugarcane biotechnology.

Introduction

Don Heinz et. al. of HSPA demonstrated in 1966 that plantlets could be developed from sugarcane tissue culture. The plants grown from these plantlets were similar in characteristics to those grown from conventional seed pieces. Today, many countries are utilizing tissue culture, a branch of biotechnology in propagating newly introduced sugarcane varieties.

Current research projects on sugarcane biotechnology cover several branches. These include genome mapping, map-based cloning, diagnostics, and transformation. Ultimately, these projects will result in sugarcane that can better resist insects and diseases, have tolerance to herbicides, and have higher yields.

The ICSB is largely responsible for the development of biotechnology in sugarcane. The HSPA and CTC were the prime movers in the creation of ICSB. Since its inception in 1989 up to the present, the consortium had undertaken 16 research projects costing more than US$ 3,700,000 (Richard, 1999).

The International Consortium for Sugarcane Biotechnology

The ICSB was formally organized on March 15, 1991 in Beltsville, Maryland, USA during the First International Workshop on Sugarcane Genome Analysis. (Moore, 1988) The charter members were: American

Sugar Cane League of Louisiana, USA (ASCL), Bureau of Sugar Experiment Stations, Australia (BSES), CTC Brazil, HSPA, South Africa Sugar Experiment Station (SASEX), Texas A&M Ag Experiment Station (TAES), and the US Department of Agriculture (USDA).

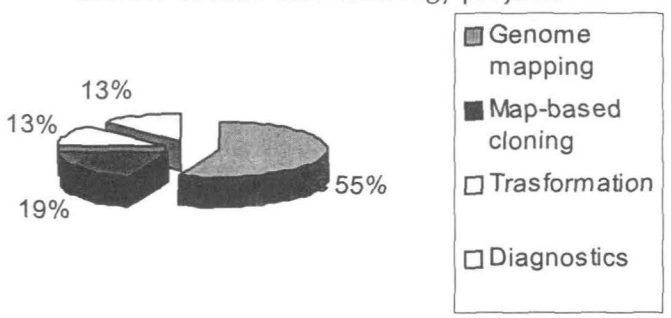
Today, membership has grown to 17 which includes: CENCICANA of Columbia, Florida Sugar Cane League (FSCL), Mauritius Sugar Industry Research Institute (MSIRI), Australian Consortium for Sugarcane Biotechnology replacing BSES, Centro Azucarero Regional de Norte Argentino of Argentina (CARNA), Centre Francais de la Canne a Sucre of Reunion (CFC), Philippine Sugar Research Institute Foundation Inc. (PHILSURIN), Unidad Integrada Paea El Majoraniento Geneticoo De La Cana de Azucar of Argentina (UIMCA), West Indies Central Sugar Cane Breeding Station representing Barbados, Belize, Guyana, Jamaica, St. Kitts and Trinidad, Vasantdada Sugar Institute of Maharastra, India and Cengicana of Gautemala.

The ICSB is unique blend of private and public research organizations that has succeeded in advancing sugarcane biotechnology without government sponsorship (Moore, 1988). It has served as a vehicle for international collaboration on sugarcane biotechnology (Irvine, 1996). By spreading the funding among members of the Consortium, the cost to each member has been kept to a minimum (Richard, 1999).

ICSB funded projects

From 1989 to 1999, the Consortium has funded 16 projects at a cost of more than US$3,700,000. Many of the projects have been completed, others are still on going. Chart 1 shows the number of projects by categories. Nine projects were on genome mapping, three on map-based cloning, and two each on transformation and diagnostics.

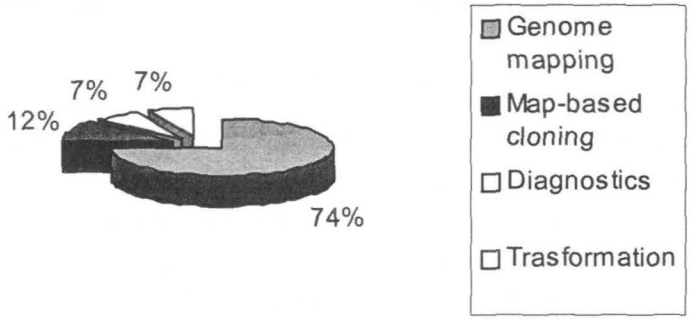
CHART 1. ICSB biotechnology projects



Source: Paul Moore

Chart 2 shows the cost of 14 projects by categories from 1989 to 1998. The cost of 1999 projects is not yet available. Based on the chart, US$ 2,570,000 had been spent on genome mapping, US$ 420,000 on map-based cloning, US$ 240,000 on diagnostics and US$ 230,000 on transformation.

CHART 2. Cost of ICSB projects by category in US$ M from 1989-1998



Source: Paul Moore

Twelve countries and states have contributed to the funding of these projects up to 1998. Data on contributions from new members are not yet available. The biggest contributor was Brazil with US$1,652,1105. Combined US contribution was US$ 945,328. Next was Australia with US$290,000 and South Africa with US$247,000. Other countries contributed varying amounts from US$5,000 to US$193,000. Contributions are based on the country's gross production and capacity to pay. The Consortium accepts proposals from research providers of member countries for funding. A proposal is funded if 75 percent of the members agree to support the project. The next hurdle is to get full funding from members of the Consortium.

List of ICSB funded projects

Genome mapping:

1. Application of RFLP technology to Saccharum (William Burnquist and Jorge da Silva of CTC Brazil & Cornell University and K.K. Wu of HSPA, 1991)
2. Construction of a genetic map and a map-based cloning system for sugarcane using the arbitrary-primed polymerase Chain Reaction and Pulsed-Field Gel Electrophoresis. (Bruno, Sobral and Michael McClelland, California Institute of Biological Research, La Jolla, CA, 1991-1993)
3. Identification of molecular markers linked to agronomically important traits in sugarcane. (Bruno Sobral and Michael McClelland, CIBR, 1992-1994)
4. Genetic mapping in sugarcane using single-dosed RAPD molecular markers. (Ralph Andersen and Dan Fairbanks, BYU, 1992-1994)
5. Comparative mapping of the gramineae for sugarcane improvement. (Mar Sorrells and Steve Tanksley, Cornell University, 1993-1995)
6. Molecular genetics of sugarcane: Phylogenetic dissection of sucrose-related traits, development of PCR-based pathogen

diagnostics and gene mapping in SES 208. (Bruno Sobral, CIBR, 1994-1996)
7. QTL mapping of sugar content in sugarcane. (Andrew Patterson, Texas A&M University, 1993-1996)
8. Genetic and molecular analysis of Expressed Sequence Tags (ESTs) implicated in sugarcane growth and productivity. (Andrew Patterson, University of Georgia, 1997-2000)
9. International Sugarcane Microsatellite Consortium projects. (Robert James Henry and Giovanni Cordeiro, Southern Cross University, Australia, 1999)

Gene-based cloning:
1. Development of a map-based cloning system for sugarcane. (Rod Wing, Texas A&M University, 1995-1998)
2. Fine tagging of a major rust resistance gene in cultivar R570 with a view towards its cloning through map-based chromosome walking. (D'Hont, Grivet, and Glaszmann, CIRAD, 1997-1999)
3. Map-based cloning of rust resistance in sugarcane. (Rod Wing and Jeff Tomkins of Clemson University, Jean Chrissstophe Glaszmann and Angelique D'Hont of CIRAD, Erik Mirkov of Texas A&M University, 1999-2000)

Diagnostics:
1. Development of methods for pathogen identification and non-conventional strategies for the control of Yellow Leaf Syndrome of sugarcane. (B.E.L. Lockhar, of University of Minnesota and E. Mirkov of Texas A&M, 1996-1998)
2. Genetic diversity within sugarcane Yellow Leaf Luteovirus. (Grant Smith and Kathryn Braithwaite of BSES, Australia, Erik Mirkov of Texas A&M Agricultural Experiment Station, 1999-2001)

Transformation:

1. Genetic transformation of sugarcane. (James Irvine, Texas A&M Experiment Station, Texas, 1992-1995)
2. Engineering resistance to Sugarcane Mosaic Virus and Sorghum Mosaic Virus in Sugarcane. (T. Eric Mirkov, Texas A&M University, 1995-1996)

Many projects were considered to be in the pre-competitive phase. E. S. WALLIS (1996) defines pre-competitive phase as the stage of R&D prior to the development of technologies or products, which could provide a competitive advantage to one or more research providers. This phase provides leads to the solution of difficult problems. The competitive phase comes after the pre-competitive phase when a solution requires further R&D.

Genome mapping is considered to be in the pre-competitive phase. The genome is referred to as the total hereditary material transmitted from parents to offspring. It consists of molecules of DNA arranged in chromosomes. Sugarcane has a complex genome and it will take years before it is fully mapped. Expressed sequence tags and microsatellite sequencing will facilitate identification of favorable and desireable genes that can be moved or transferred to widely grown cultivars.

Diagnostics, map-based cloning and transformation are already in the competitive phase. These studies will result in commercial products for the industry. The fine tagging of a rust resistance gene has progressed to a map-based cloning and this will lead to the development of a commercial product. DNA-based diagnostics are now widely used in the industry. Transgenic sugarcane clones resulting from the work of J. IRVINE et. al are now undergoing field trials. It may be relevant to mention here that all the results generated from these studies are available to members of the Consortium.

WALLIS (1996) noted that many members of ICSB have developed or are developing expertise in sugarcane biotechnology. Texas A&M University, CIRAD, SASEX, BSES, CSIRO, University of Georgia,

Clemson University, Southern Cross University in Australia, and HARC in Hawaii are recognized as being at the leading edge of sugarcane biotechnology.

Transgenic sugarcane

There were two transformation projects funded by ICSB members:

Project No. 5—Genetic transformation of sugarcane conducted by Dr. JAMES IRVINE of Texas Agricultural Experiment Station at Weslaco, Texas. This was started on July 1, 1992 and completed on June 30, 1995.

Project No. 10—Engineering resistance to sugarcane mosaic virus and sorghum mosaic viruses in sugarcane conducted by Dr. T. ERIC MIRKOV of Texas A&M University. This was started in 1995 and completed in 1996. The cost of the project was US$ 59,055.

These two projects resulted in several transgenic sugarcane clones:

1. Clones resistant to sugarcane and sorghum mosaic viruses. ERIC MIRKOV propagated and purified seven sugarcane and sorghum mosaic virus strains. Plants transformed with an untranslatable form of coat protein (CP) gene proved to be resistant to SrMV-SCH.
2. These transformed plants were regenerated from a culture medium rich in bialaphos. The result was sugarcane that was not only resistant to sugarcane mosaic virus but also tolerant to bialaphos or glufosinate ammonium herbicides. (Moore, 1997)
3. Sugarcane was also transformed with the gna gene from the snow drop lily (Galanthus) for the control of a lectin that is toxic to insects. Feeding studies with these plants showed adverse effects on sugarcane borers and Mexican rice borers. (Moore, 1998)
4. Sugarcane was transformed with a gene (cry la © HD-73) from Bacillus thuringiensis which resulted in transgenic plants with varying resistance against the lesser cornstalk borer. (Mendoza, 1997)

There have been no commercial products released from these projects yet. NCO 310 was one of the varieties used in the herbicide tolerant trials. The researchers were unable to make a transgenic NCO 310 flower. The parent clone is a profuse tasseler. Many more trials are needed to make sure that the insertion of new genes will not have negative effects on other agronomic traits.

There were other field trials of trangenic sugarcane outside of ICSB. According to C. JAMES and A. KRATTIGER (1996), the Centro de Ingeneria Genetica Biotecnologia (CIGB) of Cuba was the first research institution to transform sugarcane. They reported field trials of trangenic sugarcane with insect resistance in Cuba from 1992 to 1995.

Building biotechnology capacity in South East Asia

Biotechnology is an expensive undertaking. Significant results have been achieved in sugarcane biotechnology through international collaboration. Countries in South East Asia need to collaborate to fully exploit the benefits of biotechnology. It can follow the model of ICSB. The regional project on sugarcane variety improvement project aims to foster regional collaboration in germplasm exchange, variety development and sustainable agriculture. Conventional breeding programs in the region will be supported through the development and adoption of biotechnologies that could facilitate sugarcane improvement. Among such technologies are: a) the use of molecular markers for marker assisted breeding and germplasm management applications, and b) new diagnostic techniques (serology, PCR) for disease/pathogen indexing. The Philippines will host the sugarcane biotechnology laboratory through which new technologies will be transferred to other participating member countries through training and research internship.

Conclusion

The ICSB has shown the way for international cooperation and collaboration in sharing resources to fully exploit the benefits of biotechnology. ICSB can serve as a model for development of molecular biology in crop plants not yet in the mainstream of biotechnology development, especially where the size of the crop and funding are limiting factors. Several institutions that have participated in conducting the research projects are now recognized as being at the leading edge of sugarcane biotechnology.

Acknowledgements

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Closing Remarks

CHANCELLOR WILFREDO DAVID

UP Los Banos

I really consider it an honor to close this conference. After all, the experts already carefully dissected the subjects and the final say is given to the one who will deliver the final remarks.

This conference provided differentiated responses from the government, industry and the academe to the growing controversy on biotechnology.

We are one in the view that biotechnology is a means of meeting our technological inadequacy in sustaining agriculture, aquaculture, health and the environment. Today, we put our minds together so there will be more who will take the road we are taking. Despite their busy schedules, our colleagues in the industry and government took the time to illuminate the road ahead and place directional signs to guide us.

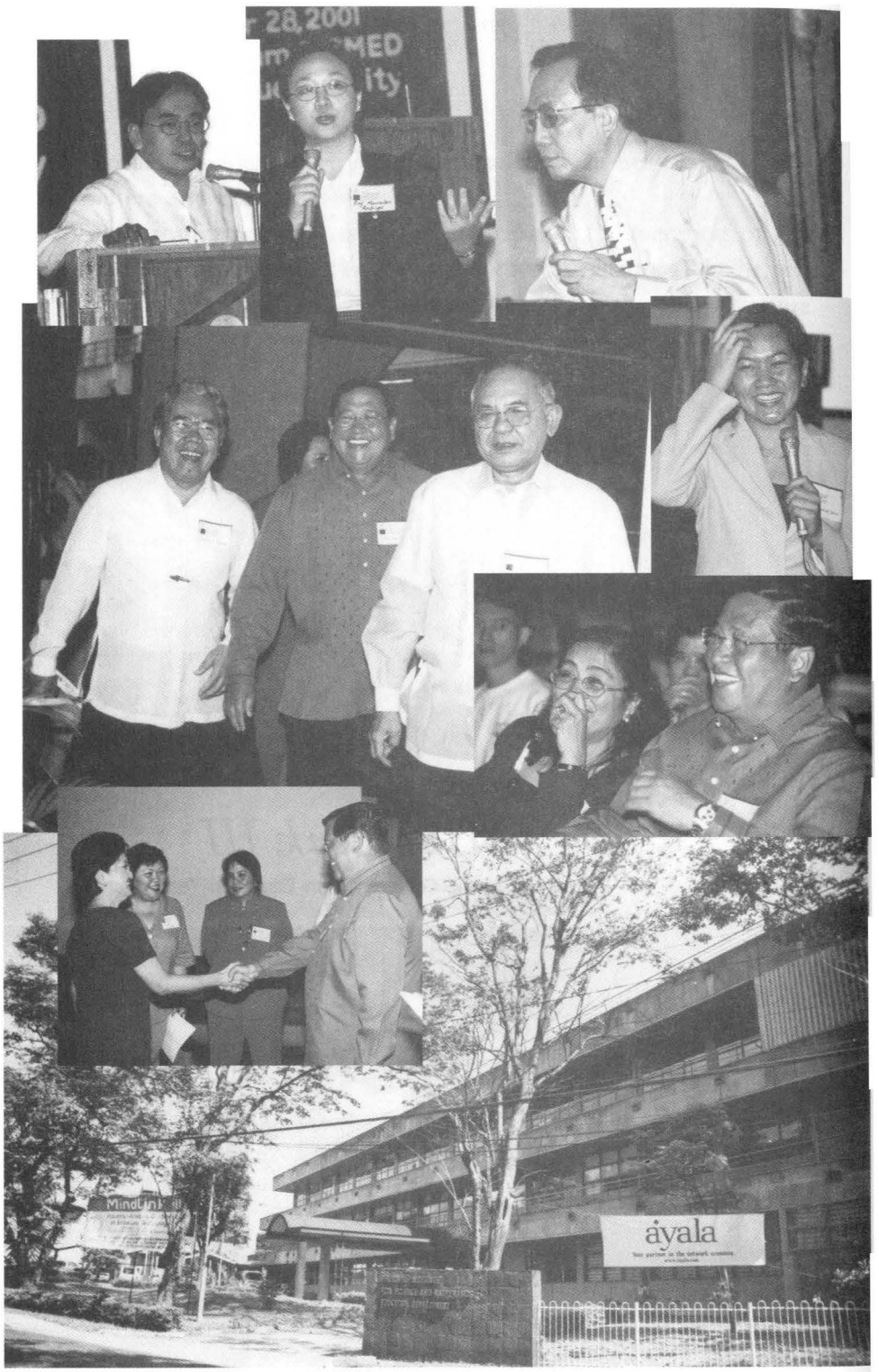
Our peers in the academic community have showcased the outputs that can fuel our national drive to progress. Industry and academe will be closer partners in the knowledge-based economy. As we shift gears, let us keep attuned to the changing realities of the global village, bearing in mind that in community, there is strength. And by being responsive

to each other's needs, industry and the academe can help usher a new historical era and change how people live.

To the resource persons and other participants, the members of the organizing committee headed by Dr. MAGPANTAY and all those who helped put this concept into action, our deepest thanks for this long overdue and enlightening meeting of minds.

MindLink III

Industry-Academe Conference on Education Technology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MINDLINK III

Industry-Academe Conference on Education Technology

September 28, 2001
STTC Auditorium, NISMED
UP Diliman, Quezon City

PROGRAMME

8 A.M.	**Registration**
8:30 .M.	**Welcome Remarks**
	Dr. Francisco Nemenzo
	President, University of the Philippines
	Opening Remarks
	Dr. Esther A. Garcia
	Chair, Commission on Higher Education
	Keynote
	Hon. Raul S. Roco
	Secretary, Department of Education
9 .AM.	**Future Educational Technologies and the Future of Education**
	Dr. Roger Posadas
	Professor, UP Technology Management Center
	Director, Research and Development and Academic Linkages
	Systems Technology Institute
9:30 A.M.	**IPR Issues Related to Education Technologies**
	Atty. Lorna Patajo-Kapunan
	President, Intellectual Property Association of the Philippines
10 A.M.	Open Forum
10:15 A.M.	Break
10:30 A.M.	**Education in the 21st Century: Taking it to the Nth!**
	Ms. Cynthia R. Mamon
	President and Managing Director
	Sun Microsystems Philippines, Inc.

10:50 A.M.	**Lifelong Learning: An Opportunity for Business-Education Collaboration** Dr. Ma. Christina D. Padolina *Commissioner, Commission on Higher Education*
11:10 A.M.	**Technologies for Student Support** Mr. Carlos Berba *Chairman, Lessons, Inc.*
11:30 A.M.	**Upgrading Competencies of Teachers/Educators in the Use of Education Technology** Dr. Vivien M. Talisayon *Director, National Institute for Science and Mathematics Education Development (NISMED)* Ms. Celia Balbin *Information Science Group* *NISMED, UP Diliman*
11:50 A.M.	**Open Forum**
12:05 P.M.	**Lunch Break**
1:15 P.M.	**Microsoft in Education** Mr. Richard Lozada *Director, e-Commerce and Developer Solutions Group* *Microsoft Philippines*
1:35 P.M.	**Intel Innovation in Education** Ms. Rosario S. Ventura *Regional Public Affairs Manager* *Intel Philippines Manufacturing Inc.*
1:55 P.M	**Information Access and Delivery: Applications in Education** Ms. Lourdes David *Director, Rizal Library* *Ateneo de Manila University*
2:15 P.M.	**Technology Enabled Learning The Hewlett Packard experience** Mr. Vicente M. Diño *Country Education Manager* *Hewlett-Packard Philippines*
2:35 P.M.	**E-Learning thru the CISCO Networking Academy** Ms. Cristina G. de Jesus *Area Academy Manager* *CISCO Networking Academy Program* *CISCO Systems Philippines*

2:55 P.M.	**Open Forum**
3:10 P.M.	**Parallel Sessions**
	Session 1 Experiences in Virtual Learning Environment
	Session 2: Upgrading Competencies of Teachers/Educators in the Use of Education Technologies
3:50 P.M.	**Break**
4:55 P.M.	**Summary**
	Dr. Maria Serena I. Diokno
	Vice-President for Academic Affairs
	University of the Philippines
5:15 P.M.	**Closing Remarks**
	Dr. Emerlinda R. Roman
	Chancellor
	University of the Philippines Diliman

Opening Remarks

ESTER A. GARCIA, PH.D.

Chairperson, Commission on Higher Education

When President Nemenzo told me about the Industry-Academe Conference on Education Technology yesterday, I was very pleased to learn that UP, together with industry, is undertaking this program. In 1987, when I was first seconded from UP to government as Deputy Executive Director for the Philippine Council for Advanced Science and Technology Research and Development (PCASTRD), I was convinced by our partners in the Department of Science and Technology (DOST) that universities should open themselves up to industry-academe collaboration. In fact, at that time, we convened many similar meetings among industry and university people. However, nothing much came out of it.

Later, when we formulated the priority programs for the different councils in the DOST, one of the criteria we put in for people to be able to get DOST funding is proof that the projects being undertaken have industry support. If possible, industry should provide funding for projects of academe where they, industry, can also benefit.

In the case of Advanced Science and Technology however, that was not a very rigid criterion because we realized at that time it would be very difficult to get partners, for example, to work in superconductors or in information technology.

Since then, things have changed. UP now has a program on technology management initiated by the DOST-Engineering and Science Education Program and UP Diliman then under Dr. ROGER POSADAS. I must confess that initially, Dr. POSADAS and I were not industry-conscious and we had a lot of discussions on this issue. Probably, the three of us, including President NEMENZO, would have been the last to adopt this kind of attitude. However, we learned and we learned fast. One of the lessons we learned is that unless the University opened itself to this kind of linkages, we could not move forward.

In the past, the work that was being done in the University was maybe a decade ahead of what was going on in industry. Now it is different. Industry is probably ahead in many cases, even in advanced science and technology. So where before we were talking of technologies that were 100 to 200 years old, we are now talking of technologies that are a year old or maybe even younger.

The time has come for academe to develop strong linkages with industry. It is time for you in the University to work very closely with industry not only in terms of products mentioned by President NEMENZO like software and so on, but also on products like people. Your graduates have to be attuned to the needs of the times; they have to know what is going on. I am not saying that the only thing you have to teach them is IT or new developments. What I am saying is that they should be scientifically and technologically literate: they should be IT literate and know how to use IT resources. They should also be able to communicate. Most importantly, we need to teach them values, which we may not necessarily teach in a course but by example. These are the things our students have to know when they go out of the University.

Scientific and IT literacy can be learned faster if we collaborate with industry. We should let industry people look at our curricula and

see where improvements can be made. We should also collaborate with them in terms of research so that our products may be more commercially viable.

The Commission is very seriously working on this through our technical and research panels, which have industry leaders as members.

One of the things industry keeps complaining about is that our graduates do not match their needs. We accept that, especially in information technology. As a way of solving this problem, two years ago we started a collaborative project where industry and academe work together to produce better graduates for industry.

Support to the project is provided by CHED in terms of funds and policy; the academe trains the students for three to six months; and industry works with academe relative to the curriculum. Our partners in the industry also select the trainees, decide on the kind of training they are given and employ them at the end of the training period.

I am pleased that UP, through MINDLINK, is doing that now—working with partners like Ayala, Microsoft and other private companies.

I know this will work for the benefit of industry, the University and our country.

Keynote

HON. RAUL S. ROCO

Secretary, Department of Education

Let me speak briefly on your theme, but on two ideas basically.

Dr. NEMENZO said: "Of course, UP can do much more, if UP gets more support." Yes, and we should give more support to the University of the Philippines. But we in the Department of Education, Culture and Sports (DECS) have stopped thinking of getting more support. We will achieve whatever we set our minds to with whatever they give us. That we pledged. Problems can be resolved by creativity and by the capacity of the human mind to transcend limits of material or physical limitations. We have shown how, and I think, will continue to show how.

Textbooks we used to buy at P60 to P120 we now get at P21 to P48 because of open bidding. Desks we used to buy at P750, we now get at P485. In the last bidding, we allowed Nitz Marketing and a cooperative in Bulacan to bid for 10,000 sets. They bided only P380 per desk and chair. At DECS, we have reversed inflation. All these are motivated by our goal for our graduate—*bayani, marangal* (hero, honorable). That is what I wanted to address as a keynote message: patriotism.

In the Philippine constitution, when you look at the section on education, it tells us we must teach patriotism. The first subject it

mentions is not technology, is not science, and is not literature. It says patriotism; we must teach our students patriotism and nationalism. I will concentrate on the first because no matter how many conferences I attend in the Philippines, I think I am the only one who mentions the word "patriotism." There is some reticence; there is a sense of embarrassment when you say "patriotism." It is almost as though we do not want to say we are patriotic. It is a sense of false modesty. Maybe, there is also a sense of embarrassment that we as Filipinos cannot be patriotic and love our country above all else. But that is what will make us grow. Industry-academe cooperation will only result in materialism. It is patriotism that ennobles. It is unabashed patriotism that ennobles.

On September 11, we saw images on TV. The best image I remember is that of the fireman who, after the collapse of the North Tower, was about to go up the South Tower. He was asked: "Aren't you afraid?" The fireman said, "I'm scared shit, but that's my job." He went up and never came back.

The dedication this person showed is admirable and it is easy to admire because it is from afar. We see it on Fox Television, but there is much more to admire in the Philippines. We do not have to keep admiring bravery and courage when it is from afar, because there are so many instances of bravery above and beyond the normal call that we have seen in the Republic of the Philippines.

There is a resolution in the Senate to declare SAJID BULIG, 11 years old, a national hero, and that his life must be taught in all schools so that our children can emulate him. SAJID BULIG saved nine of his contemporaries, swam again in the Bocaue River when the pagoda collapsed, and on the tenth attempt, died. That is equal to any act of bravery anywhere.

In New Jersey, Ateneo graduates all over the US had a reunion. RAMON CONSTANCIO, the club president, started with: "We came with $10, now I have an office in the World Trade Tower with 87 employees and 20 lawyers." He was saved, by the way. I contacted him. He was stranded in the subway because everything collapsed and they could not move.

He said this can only happen in America. So when I stood up, I said: "In the Philippines, there was a taxi driver, EMIL ADVINCULA, who saw two million pesos in his taxi. He looked for the passenger and returned it." I said, "Only in the Philippines," and they applauded. "It will not happen in New York, it will not happen in New Jersey, it will not happen in London, it will not happen in France." And they applauded.

I have carried the sense of pride for ourselves in Geneva.

We were discussing living together in peace. That was before the terrorist attack. In my intervention, I told them, "We are all studying how to teach education with peace, and how to live together. We Filipinos have been living with all of you everywhere." The chairman was from Iceland. It happened that I was just discussing with the ambassador to Iceland and I said: "We even have four fishermen in Iceland." And the chairman raised his hand. I said we had more doctors outside the Philippines than in the Philippines. I told them that anybody who has gotten sick and has been taken care of by a Filipino nurse or physical therapist, or has been cared for by health workers of other nationalities can attest to the fact that there is no substitute for the tender loving care of the Filipino health worker. And 800 of them applauded.

I said 32 percent of the sailors of the world are Filipinos, and we are now hitting supervisory level. Education must still produce more because the sailors of the world are the cross-breeders and cross-pollinators of world civilization, the way SINBAD the Sailor was the seed of the 1,000 stories of the Arabian Nights. I said the sailors come and go, and this is what I proposed to them: we are probably the first genuine citizens of the world. And they applauded.

In the Philippines, there are many weaknesses, which many commentators and writers tend to project. It is time to project our selves as strong, and as a people that can be proud of themselves.

This brings me to the second topic, because I must touch at least on technology.

At that same conference, one of the workshops was on ICT. Everybody but everybody was just selling computers. Malaysia was selling the big truck with computers that move like mobile libraries. The Europeans were selling state of the art computers. The Americans were not quite there. Americans have not been very participatory in many international conferences because they think everybody just attacks them, which is true. I do not envy them; it goes with the territory of power. But I said technology by itself, computers by themselves, are just the paper and pencil of today.

With computers, we can retrieve a book faster, we can calculate faster, we can design faster, we can multiply and subtract faster. Still, it is the human spirit, it is the striving and the seeking for ideas and knowledge that must motivate the individual surfing, or using the different programs merging different ideas.

It is human creativity that merges ideas. It is human creativity that merges words never combined before to show a revelation, not an explosion, the way we in the Senate sometimes do. It is human creativity that puts together cyber reality and makes you live in cyberspace.

That human creativity can only be brought about by literature, by songs, by dances, by our capacity to live together as human beings in Philippine culture. There is so much of Philippine culture that gives us the impetus for creativity. That is what we must preserve. Above and beyond technology, we must learn to read—read each other, hear our songs, dance our movements.

In that Geneva conference, I told them: "Fifty percent of the musicians of Asia are from the Philippines, and we can out sing any country in the world." They also applauded. It is culture and our character, built upon a long tradition of knowledge, patriotism and nationalism that will make us one.

Let me leave my keynote address then, with that idea, and with the poem *Ithaca.*

When Ulysses or Odysseus was trying to go home to Ithaca, it took him a long time because the gods were angry with him. A poem was

written, and the poem basically says this: When you commence on your journey to Ithaca, pray that the road is long, full of knowledge, full of adventure. Do not be afraid of the Laestrygonians, the Cyclops or the one-eyed giants, or Poseidon, the god of the undersea. You will be protected against them when you have fine feelings and noble thoughts. But be afraid of the Laestrygonians, the Cyclops, and the Poseidons that you carry in your soul and in your heart. That is what will defeat you.

It is much longer, but that is essentially what it says.

Wherever this conference takes you, remember: Do not be afraid of Poseidon because you will be protected by fine feelings and fine thoughts. Patriotism is one of them and it will motivate you. I hope you will remember and not forget.

Future Educational Technologies and the Future of Education

DR. ROGER POSADAS

Professor, UP Technology Management Center
Director, Research and Development and Academic Linkages
Systems Technology Institute

Education today is undergoing a revolution driven by new and emerging educational technologies, bringing about a paradigm shift in teaching and learning. My talk will cover the following: an overview of emerging educational technologies, a delineation of the paradigm shift that is starting to occur in education, and a discussion of what all these developments imply for Philippine education.

Let me start with an overview of emerging and future educational technologies.

Educational technologies consist of instructional technologies and learning technologies. Instructional technologies can be classified into global telecommunication networks, authoring and presentation software, instructional delivery systems and instructional management systems.

Learning technologies include personal access devices (sometimes called learning appliances) learning ware and computer tutors, learning materials and archives, virtual reality and simulation technologies.

The present and emerging global telecommunications network consists of the Internet as we are familiar with it today, and the emerging or transitional technology called Internet 2, which is being developed by about a hundred universities subscribing to this project to improve on Internet 1.

The future global communications network is the advanced Internet or the next-generation Internet. This will make possible ultra high capacity, ultra high speed, wireless, mobile and ubiquitous communication and computing that will embody the full convergence of voice, video and data communication.

An example of authoring software is the *Multimedia Toolbook* while presentation technologies would be exemplified by *Power Point* and electronic whiteboards.

Present instructional delivery systems are of two types. The first is synchronous delivery systems and Internet video conferencing. The state of the art would be desktop video conferencing, which could be one-to-one, or one-to-many. Some institutions, like the Ohio State University, are already using these to reach out to their branches. Synchronous delivery systems use CD ROMs, and now DVD and web-based course delivery.

Future delivery systems make use of 3D holographic face-to-face meetings in a simulated lecture, seminar or conference using speech interaction. You will feel as if you are in a lecture hall because of virtual reality.

Then you have asynchronous full multimedia delivery for learning on-demand, just-in-time, anywhere.

Instructional management systems offer tools for course development, enrolment management, student progress tracking, grade maintenance and distribution, access control, email, etc. There are several commercial organizations offering these services as Blackboard and eCollege. If a university wants to develop courses for online delivery, they can outsource the technologies and get the services of some of these organizations.

Some universities like the Massachusetts Institute of Technology (MIT) and Stanford are collaborating for developing open source software to put their courses online. If you want to access an MIT course, let us say in IT, you can look at their web pages.

Future instructional management systems are customized, personalized, fully interactive instruction where topics will be selected based on the student's need, interest, aptitude and prior learning. Course materials will be presented dynamically at a pace suited to the student's own ability and learning style. Student progress will be evaluated, tracked and recorded automatically and a personal, Socratic e-tutor will advice, guide, cajole and entertain each student.

Present personal access devices are desktop computers, laptops and notebooks, handheld PCs, mobile smart phones, PDAs and pocket PCs. What we are seeing is the convergence of PCs and cell phones. Eventually, you can have a cell phone that is also a computer.

Future personal access devices will be wearable as a wristwatch, ring or pendant. These will be voice-activated, voice-recognizing computer devices with ultra high storage, ultra high speed and no moving parts using a miniature laser attached to eyeglasses for projecting computer-generated images and miniature earphones for listening to voice transmission. These smart devices can be also be equipped with optical devices and software to enable the wearer to identify persons and materials they encounter. Prototypes of these devices already being developed and tested at the MIT media lab.

Examples of current learningware computer tutors are computer-aided learning software, search engines and intelligence software agents as Yahoo! and AI-based intelligent tutoring systems.

For the future, we forecast highly individualized, adaptive and interactive programs using natural language interaction. In other words, you speak to the computer using your own language. That will help the student search and select educational materials. It will continually assess what the student can and cannot do and help the student discover or

construct his or her own knowledge. In general, these will serve as the student's personal tutor and mentor.

Present learning materials and resources include textbooks and e-books. In fact, there are now schools, colleges and universities in the US where at the start of the semester, you go to a bookstore and download all the textbook contents you need for the entire semester. The next semester, you get another set. So the future is not too far off.

Future learning materials and resources include e-books integrated into wearable computers where you get everything you need for the entire semester in a miniature computer.

The global learning infrastructure will consist of a global network of digital libraries, knowledge webs including virtual exhibits and topic-based and peer-based learning communities. Part of your learning resources will be the virtual learning communities you will be interacting with and learning from. Then you have the advanced World Wide Web.

Present simulation technologies are gaming technologies, role-playing simulators, modeling, and virtual reality. These are important because they allow kids to learn by doing. "People don't learn when they are talked at, as in a lecture. They learn when they attempt to do something and fail. Learning happens when they try to figure out why." This is a quotation from a cognitive scientist, Dr. ROGER SHANK.

In the future, we will have 3D, full multimedia interactive holographic simulation of a real or imagined environment or culture. If you want to see how the Battle of Mactan took place, you can have a virtual reality of that.

This is a very nice quotation from CONFUCIUS: "I hear and I forget. I see and I understand. I do and I remember." By using simulation technologies—creating simulated environments you can interact with, you can learn more effectively, say cognitive scientists.

We can now go to the delineation of the paradigm shift that is starting to occur in education.

The paradigm of education for the past millennium has been the classroom-teacher paradigm where information, sometimes called

knowledge, is transferred from the teacher/professor to a class of students within a fixed place called the classroom using the educational technologies of talk and chalk and a textbook.

The present educational paradigm is teacher-centered, sage on the stage, space dependent, classroom on campus, time-bound, with fixed class schedules, fixed course duration and is standards dominated. That is why you have the Commission on Higher Education (CHED), the Department of Education, Culture and Sports (DECS), and the Technical Education and Skills Development Authority (TESDA) for standardized courses and assessment.

New technologies are now making it possible to provide access to high quality education on a drastic scale, not only to the traditional kindergarten to college students, but also to the rapidly-growing numbers of knowledge workers—the cognitariat who want access to affordable, lifelong learning, just-in-time, on demand, anytime, anywhere.

In the past five years, the Internet and other new educational technologies have enabled the rapid growth of global online education, both asynchronous and synchronous. Many traditional educational institutions and new for-profit education companies have started seizing the new technological and market opportunities to offer a plethora of online courses and degree programs not only to off-campus office students, but also to on-campus residential students.

Since asynchronous online education allows for anytime, anywhere learning that replaces an on-campus class by a virtual class and shifts the focus of the educational process to the learner, its global expansion is undermining the present classroom-teacher paradigm.

Nevertheless, the current educational system still has weaknesses. Despite the advantages of online education in terms of place, time, flexibility, and despite the hundreds of studies indicating that online learning is as effective as classroom learning, today's online education still shares several weaknesses with traditional classroom education.

First, it still uses standardized courses and curricula and fixed course duration and schedules. Two, it still uses a one-size-fits-all approach,

ignoring the different learning styles of students. Three, it still precludes personalized tutoring and mentoring of individual students.

As the future educational technologies become available in the next decade—in fact many of them are just around the corner—online education will evolve into the education of the future which will have the following major features:

1. Personalization of learning through computer-based tutoring and mentoring
2. Distance online learning, fully independent of space and time
3. Encouragement of cooperative, interdisciplinary, international learning: when you have classmates from all around the globe, you have international learning
4. Menuization and customization of educational programs: the course will be broken up into several topics which become standardized modules, and you get a menu of these modules
5. Multiple, multinational sourcing of learning modules and credentials: if you want to pursue a BS in Physics degree, you can take a course from MIT, another module from UP so your degree will be made up of all kinds of courses from all kinds of course providers
6. Lifelong learning pursued on demand, anytime, anywhere
7. Globalization of education and variegation of educational organizations: you will have a variety of educational service providers, which is already happening today. In other words, the educational processes will be unbundled. Instead of teaching, learning, research, student services all found in just one organization, some of these will be provided by specialized organizations.
8. Transformation of the teacher from a sage on the stage to guide on the side: the teacher will be a facilitator of learning.
9. Automation of certain educational process such as tracking and assessment of student progress

10. Provision of accessible and affordable quality education for all: as computers become cheap and affordable, and as computing becomes ubiquituous, we can expect this.

The educational paradigm of the future will be a restoration on a high tech plane of the Socratic-Platonic model of education or what ALFRED BORK calls the tutorial learning paradigm.

As online education and computer-based tutorial learning expand globally, the schools (as institutions where one finds classrooms, lecture theaters and libraries, and where information and knowledge are transferred from teachers to students) will become obsolete since many of their traditional functions will also be undertaken by new educational service providers. The schools of the future will become smaller and specialized, each trying to find its competitive niche in the education market as possible meeting places for face-to-face seminars and conferences, skills training centers for hands-on apprenticeships, or research centers for hands-on instrumental research.

Implications for Philippine Education

To ensure the viability and competitiveness of our country in the global knowledge economy of the twenty-first century, our educational system must be capable of continually producing vast numbers of Filipino knowledge workers or cognitarians. They must be equipped not only with the basic skills of literacy, numeracy, and what I call computeracy, but also with what I call the 5Rs of the new millennium: higher level skills of reasoning, researching (knowing how to learn), relating (social skills, interpersonal skills), reckoning and reinventing.

Philippine education has always been suffering from a chronic crisis rooted in the inadequacy of our education infrastructure and resources to meet the needs of our ever-increasing numbers of students. Unless we can find immediate solutions to the crisis, our educational system will not be able to supply our country with the large numbers of

knowledge workers who will constitute our economy's principal source of national wealth.

Our educational system must obviously meet the present challenge of providing quality education to any citizen, anytime, anywhere, at any level. This translates to the objective of ensuring that Philippine education at all levels shall be widely accessible, very affordable, and of high quality.

How can the new educational technologies help us meet the challenge?

In the case of wide accessibility, we can provide asynchronous online education using an advanced broadband national learning network. For high quality, the use of cheap and mobile learning appliances, learning ware, computer tutors and other learning technologies and resources. The biggest cost in education is of course personnel costs, the salaries of teachers. To lower costs, the solution is to increase the student-teacher ratio and the use of fewer teachers as content specialists, learning ware developers, learning researchers and learning consultants. According to Dr. VIVIEN TALISAYON'S research, only four percent of high school physics teachers have backgrounds in physics. Instead of trying to develop more physics teachers, we can get the few physicists we have to develop quality courses for delivery online.

To enable our educational system to meet the challenge of providing accessible, affordable and high quality education to anyone, anytime, anywhere, at any level, I recommend that:

1. The national government and the private sector work together to put in place an advanced broadband national network that will become the core of a national learning network that would interconnect our schools and other learning resources;
2. DECS, CHED, TESDA and local universities develop national educational programs and a national pool of experts in educational technologies and online learning;

3. The national government establish a national virtual university that would take the lead in designing, developing and delivering online learning at the post-secondary levels;
4. The national government also establish a national virtual school that would provide online learning at the K-10 levels;
5. The national government establish within selected universities research programs and laboratories for the assessment, creation and development of educational technologies;
6. CHED, DECS and TESDA relax their regulatory policies which are based on today's classroom-teacher paradigm and encourage local schools, colleges and universities to experiment with new systems of learning and teaching.

I conclude with a quotation from Sir JOHN DANIEL, Vice Chancellor of the Open University of the United Kingdom:

> "In Chinese, the ideogram for crisis is made by combining the sign for danger with the sign for opportunity. That is a profound insight. The dangers are clear, but we also face opportunities, new technology is one. What shall we do about it?"

Intellectual Property Rights Issues Related to Education Technologies

ATTY. LORNA PATAJO-KAPUNAN

President, Intellectual Property Association of the Philippines

I am told that teachers and lawyers are quite similar in one sense. Both are obsessed with starting every thing with a definition of terms. But whereas for the teachers this propensity for definition is an academic pursuit, for the lawyer, it spells the difference between winning and losing a case, between collecting fat fees or collecting from a disgruntled client, and also between producing a good document or a lousy contract.

We will start with the definition of property. There must be a clear concept of property and the difference between property and intellectual property (IP).

The most important feature of property is that the proprietor or the owner may use his property as he wishes and nobody else can lawfully use his property without his authorization. Of course there are generally recognized limits to the exercise of that right. For example, the owner of a piece of land is not always free to construct a building of whatever dimension he wishes but must respect the applicable legal requirements and administrative regulations. So, a building owner cannot build it up

to 30 floors high if it disturbs his neighbor's easement of light and view. There are certain restrictions to the rights over a property.

What are the kinds of properties? Generally speaking, there are three kinds of properties. The first is what we refer to as property consisting of movable things, examples of which are your wristwatch and a car. No one except the owner of the wristwatch or a car may use these objects. This is a legal situation which is called an "exclusive right" belonging to the owner to use the thing that is his property. Naturally, the owner may authorize a person to use his property but such authorization is necessary and the right to use is not unlimited.

The second type of property is immovable—namely land or permanently fixed things such as houses. It is easy to see that movable and immovable property are tangible property and therefore, when one deprives the real owner of these properties, it is clearly a criminal offense. When you steal a watch or a car, it is theft or carnapping; when it is land, it is land grabbing.

The third kind of property is called intellectual property. The objects of IP are the creations of the human mind, the human intellect, which is why this kind of property is called IP. In a somewhat simplified way, we state that IP relates to pieces of information which can be incorporated as intangible objects at the same time in an unlimited number of copies at different locations anywhere in the world. The property is not in the copies but in the information reflected in the copies. Similar to movable things and immovable property, IP too, is characterized by certain limitations. For example, limited duration as in the case of copyrights and patents. Intellectual property often refers to intangible property. While it is easy to appreciate that stealing or use without consent of the owner of tangible property (such as your wristwatch, your land, your car, your house) could be theft, why is it very difficult for most of us to understand that stealing or the use without the consent of the owner of intangible property or IP is simply theft?

IP, as a third group, is divided in two branches referred to as industrial property and copyright.

There is this misimpression and misunderstanding that industrial property relates to movable or immovable property used for industrial productions such as factories or equipment. That is not so. Industrial property is a kind of IP and typically this relates to inventions, utility models and industrial designs. What are inventions and industrial designs? Simply stated, inventions are new solutions to technical problems and industrial designs are aesthetic creations determining the appearance of industrial products. To be patentable, the inventions must be new or must involve an inventive step and there must be an industrial applicability. In addition, industrial property includes trademarks, service marks, commercial names and designations including indications of source and appellation of origin and the protection against unfair competition.

So what is a trademark as compared to a patent?

A trademark is any visible sign capable of distinguishing the goods of one from another. A service mark, on the other hand, which is also an industrial property, is any visible sign capable of distinguishing the service of the enterprise, and a trade name means the name or designation identifying or distinguishing an enterprise.

The operative word for patent is novelty as a requirement for registration whereas the operative word for trademark, trade names and service mark is distinctiveness. For example, Coca Cola or Coke is perhaps the number one trademark all over the world in terms of name recall. Coca Cola or Coke is a trademark. The Coca Cola company is the trade name of the company that manufactures and distributes the product. The formula or the concentrate (that makes Coke different from Pepsi, Cosmos or Sarsi) is covered by a patent. The shape of the bottle (Coca Cola shape) can be registered as a design. You have in Coca Cola all things that are registerable: the name, trademark, the name of the company which is Coca Cola, the formula or the concentrate, and the shape of the bottle. Of course needless to say, I was the company's corporate secretary for the longest time.

The second group of IP relates to copyright. By way of background, the laws relating to industrial property and to IP were previously embodied in two separate republic acts and a copyright law: there was a republic act on trademark, a republic act on patents and a separate presidential decree on copyright. Sometime a couple of years ago, the IP Code was born and became law effective January 1, 1998. I am very proud to say that the author of the IP code that codified all the separate laws was then Senator Raul Roco, who was a senior partner of my law firm at that time. And so by way of advertisement, I am happy to say that we did have a hand in the drafting of the IP Code.

So what is a copyright? A copyright simply is a legal term describing rights given to creators for their intellectual creations.

Under the IP Code, intellectual creations are either original works or derivative works. Original works in the literary and artistic domain are protected from the moment of their creation. These works are therefore protected by the sole fact of their creation irrespective of their mode or form of expression, as well as their content, quality and purpose. In the old copyright law prior to January 1998, registration was required to enable the copyright owner to sue for damages. Under the new IP Code, registration is not a condition for protection which, as I said and must emphasize, arises from the moment of creation. The copyright owner can sue for damages for copyright infringement even if the original work is not registered.

What are these original works? Under the IP Code, original works refer to literary and artistic works (and this is what you call in the academe perhaps as educational technologies): these are books, pamphlets, articles and other writing, periodicals and news papers, lectures, sermons, addresses, dissertations prepared for oral delivery whether or not reduced in writing or other material form letters, dramatical or dramatic musical composition, choreographic works or entertainment in shows, musical composition with or without words, works of drawings, paintings, architectures, sculpture, engraving, lithography or other works of art, models or designs of work of art, original ornamental designs or models

for articles of manufacture whether or not registrable as work of industrial design and other works of applied art, illustrations, maps, plans, sketches, charts and three dimensional works relative to geography, topography, architecture or science, drawings or plastic works of scientific or technical character, photographic works including works produced by a process analogous to photography, lantern slides, audio visual works, cinematographic works produced by a process analogous to cinematography or any process for making any visual recordings, pictorial illustration for advertisement, computer programs, and other literary, scholarly, scientific and artistic works.

The most often asked question is: can a computer program can be registered as patent? In the Philippines, a computer program cannot be patented because according to our law, a computer program is not novel. It does not fulfill the requirement of novelty. So how does one protect a computer program? In the Philippines, computer programs are protected by copyright because these are considered under the Philippines' IP Code as falling under literary or artistic works or original works. Aside from these original works, there are other kinds of works, called derivative works, which are also protected by copyright.

What are derivative works? These are dramatization, translation, adaptation, abridgement and other alteration of literary or artistic works, collection of literary or scholarly or artistic works and compilations of data and other material which are original by reason of the selection or coordination or arrangement of their contents. The author of speeches, lectures, sermons and dissertations shall have exclusive right of making a collection of his or her works. Sometimes we see a collection of works and sometimes, an enterprising student or professor puts the work of an author together for a collection. Is that a violation of the copyrights of the author? The answer is yes because only the author himself or herself can put together in a collection (which is referred to as a derivative work) his or her own work.

Now, how is this derivative work protected? Derivative work shall be protected as a new work: the collection itself, the dramatization etc.,

is considered a new work and protected by copyright. However, such new work shall not affect the force of any subsisting copyright upon the original work employed or any part thereof or be construed to imply any right to such use of the original works or to secure extent of copyright in such original works.

What does this mean? Let us say my best friend has produced several books but does not know how to market them. So I say, let me put these books together in a collection and we will sell it as a collection of your books. Now there are two works: the original books (the copyright of which is owned by the author of the books) and second is the collection of all of these books. The IP Code says the collection itself, which is the derivative work, can be copyrighted. Let us say my friend is the author and I am the publisher. Who owns the copyright to the collection? This will depend on our agreement. It can be a joint ownership of the copyright in which I cannot publish or reproduce without the author's permission and neither she can do that in respect of the collection without my permission as publisher because it is a joint ownership of the copyright. This is not to say that the publisher therefore acquires also the original copyright by simply having produced a collection of the books together because the author retains the copyright to that original work.

In addition to the right to publish, what about published edition of a work?

The IP Code provides that the author, his heirs or assignees—and not the publisher—own the copyright. In addition to the right to publish granted by the author, his heirs or assignees, the publisher shall have a copyright consisting merely of the right of reproduction of the typographical arrangement of the published edition of the work. This means the publisher of the work has the copyright to reproduction of that particular typographical arrangement of the published edition of the work. Thus, original works, derivative works and published edition of these works are protected by copyright.

Is there anything not protected by copyright? Yes. Under the IP Code, no protection shall extend to any idea, procedure, system or method or operation, concept, principle, discovery, or mere data as such. You cannot copyright an idea. You cannot copyright a concept: it is intangible. You cannot copyright a principle or discovery or mere data even if they are explained, expressed, illustrated or embodied in a work. You cannot copyright the news of the day and any other miscellaneous facts having the character of mere items of press information. Neither can you copyright any official text of legislative, administrative or legal nature, as well as any translation thereof.

Can works of the government be copyrighted? The answer is no. No copyright shall subsist in any work of the government of the Philippines. However, prior approval of the government agency or office wherein the work created shall be necessary for exploitation of such work for profit. Such agency or office may, among other things, impose as a condition the payment of royalty. No prior approval or condition shall be required for the use for any purpose of statutes, rules and regulations and speeches, lectures, sermon, address, and dissertations pronounced, read or rendered in a court of justice, before administrative agencies, in deliberative assembly and meetings of public character. The government however is not precluded from receiving and holding copyrights transferred to it by assignment, request, or otherwise. Nor shall publication or republication by the government in a public document of any work in which copyright is subsisting be taken to cause an abridgement or annulment of a copyright or to authorize any use or appropriation of such work without the consent of the copyright owners. Simply stated, the government cannot own a copyright and cannot obtain copyright.

Lifelong Learning: Opportunity for Business-Education Collaboration

DR. MA. CRISTINA D. PADOLINA

Commissioner
Commission on Higher Education

President ARROYO established and heads the Information Technology and e-Commerce Council which seeks to make the Philippines a world class information and communications technology (ICT) services center. The Council is exactly what this forum is about: academe and industry coming together. The Council is composed of 10 cabinet secretaries, including the Chair of the Commission on Higher Education (CHED), and eight members from the private sector. Thus we are very glad CHED is part of this forum.

Too many statements have been made about this society being a knowledge society and our world being knowledge-intensive. We will not belabor these points in this talk but accept them as givens and move on from the oft-stated conclusion that education continues to be, in fact more than ever, the moving force for human, institutional, societal and national development. The role of education may be the same, but the pressure on education has intensified. The imperative is now to do more with less. In the Philippines, we probably need to do much more

because we have not done enough in the past so that the backlog has piled on top of the present concerns.

"Doing more" for higher education institutions (HEI) arises in part from society's need, in this so-called new economy, for lifelong learning. People, if they are to remain a contributor and benefactor of the economy that provides them daily bread and occasional cake, will need retooling and retraining throughout life.

What does that tell us as educators?

First, individuals must be equipped for this lifelong activity. Being equipped, in turn, means two things: one, to have the inclination; and two, to have the skill for lifelong learning. Our students need to realize that their undergraduate degree is not a degree for life. They need to have fulfilling experiences in learning to provide them with emotional motivation for lifelong learning. Their initial experience in higher education must be strengthened to provide a good foundation to allow them to undertake further learning in the major portion of their adult life. We need people who can ask questions rather than people who only have answers. We need individuals who can explore and create and be open to new ways of thinking and of doing things—individuals with new perspectives and new practices. Undergraduate education must allow our students to realize the need for lifelong learning and build into their psyche a healthy motivation for lifelong learning while providing them with the skills to do so.

The second implication of the imperative for lifelong learning is that HEIs must provide for and be equipped to offer this opportunity.

There are three characteristics of lifelong learning provisions: diverse, flexible, and accessible. The three are intertwined. Diversity does not only have to do with the areas of study but also with variations of degree program types. We need to look into short-cycle programs which may also be designed as nested, or what we usually call ladder-type programs. These would provide students with convenient exit points that alternatively, may also serve as entry points.

Flexibility can mean freeing students from rigid classroom schedules and may incorporate asynchronicity in teacher-learner interactions. It is a reality in our country that the availability of quality programs and relevant courses is severely limited to a small number of institutions capable of offering such programs and to their concentration in urban areas. We must find ways to channel the knowledge from these oases of learning that they may irrigate the barren regions. We, who have experience in employing people, are familiar with the reality that even with a large number of graduates, and therefore applicants for the job, there are actually so few to choose from. The present number of Filipinos who can significantly contribute to our economic recovery is just too few.

This University has certainly tried to address the matter of access by establishing 10 campuses in various regions of the country and by founding the UP Open University. But even that may not be enough. We need to help upgrade other HEIs so that a greater than the present number would also produce quality graduates. This is to our advantage because the HEIs' products are the inputs to our graduate programs. They also influence the quality of the secondary schools in their area and therefore, they influence the quality of those that enter our undergraduate programs.

In providing for lifelong learning, universities must also realize that adult learners measure the quality of a program in terms of its direct use to their jobs, or of its being up-to-date, and certainly, the competencies their employees put value on. These education consumers may also be seeking knowledge and skill sets that would allow them to compete on an international level. They will look for education providers that offer not only quality but also portability of learning.

"Doing of more with less" is providing continuing and professional education for working adults. Government just does not have the budget to finance higher education at the same level of pesos per student as it did some years back. The pressure for more funds is not only for the

improvement of programs and infrastructure, but in supporting the human resource needed to carry out the program.

So, can universities still address lifelong learning?

UP has decided that this kind of education should no longer be made a burden to government but should be borne to a greater part by the students, thus its decision to increase fees at graduate levels.

I wish to propose that lifelong learning be an area where the academe and industry can work together and create a win-win situation, one where there would be a productive synergy between the two sectors. Industry will certainly profit from good programs for retooling and re-training their personnel and the university gains from the increase in student enrolment and from the enrichment of the faculty that results from close contact with the industry.

Corporations know that the key to their survival is in developing people. They compete to be the best in their industry and they know it is their employees' expertise that will get them to the top. This is the reason that many corporations have, in fact, set up their own universities—corporate universities they are called.

The first corporate university was established in 1961 by McDonald's Corporation. You might laugh at the name of the university because it is called Hamburger University. Or at the sight of Disney University's coat-of-arms that features Mickey's eponymous ears.

Corporations really take their universities seriously, spending an average, in the US, of $12.4 million for operating expenses annually. In 1998, there were 400 such universities, with the number expected to quadruple within a decade.

Universities in the US, realizing the corporations' need for a world-class workforce, have made the strategic decision to address this need and have been designing and offering programs closely resembling those in corporate universities. These universities have incorporated project-based work in their courses and use problem-based learning as strategy. In some cases, universities also provide tailored top-to-bottom educational services to corporations. These universities have decided

to have a share of what is estimated as a $40 billion annual market for corporate education.

I would like to cite some examples of such initiatives of US universities and perhaps, we could learn some lessons from the examples.

Duke University has formed a private corporation named Duke Corporate Education, Inc., to provide clients with business education designed specifically for their needs. Pensare, Inc., a leader in e-learning business networks, has been tapped to provide the distance learning technology for their courses. They expect to deliver programs at every level of personnel in the corporate ladder, not just for upper management. Their initial clients are Deutsch Bank, Ford, Siemens and Ericsson.

The College of Engineering of the University of Michigan, through its Transportation Research Institute, has contracted with Ford to provide their engineers week-long mini-courses each summer to keep them abreast with advances in computer aided design.

Columbia University has established a company called Morningside Ventures, Inc., to create an online learning center to produce and distribute high quality educational resources. They expect to develop a wide range of innovative education models to augment their traditional campus-based programs and plan to cover the entire spectrum of academic disciplines.

The president of Columbia University, GEORGE RUPP says, "Columbia will continue to offer its traditional campus-based degree programs. Indeed, applications to our undergraduate and graduate schools are at record levels. However, interactive online multimedia programs will be among the most important educational developments in the twenty-first century. We believe it is vital that Columbia, both because of its academic strengths and its research in new media technology, should be a leader in this movement. The content of education, whether on-campus or online, is best provided by outstanding colleges and universities."

Another example is Stanford University. It has spun off its first start-up company to market a high-speed virtual search engine for doctors.

The venture firm, which they named E-Skolar, has its roots in an internal service developed and used by Stanford's medical school. E-Skolar allows doctors anywhere in the world where there is Internet service to search multiple medical references, such as textbooks, medical journals, drug databases and clinical guidelines. E-Skolar also intends to provide for continuing medical education needs. This is Stanford's first direct Internet venture. The plan is to distribute stock options to its employees and to make a public offering in the stock market in the near future.

Last year, three ranking competing business schools in the US decided to collaborate. These are the business school at UC Berkeley, the University of Michigan Business School, and the Darden School of the University of Virginia. They now offer each other's students courses in e-business and technology using video conferencing and other Internet technologies like chat rooms.

The UK Open University (UKOU) formally created in 1998 a subsidiary university, the US Open University (USOU) which started their operations in 2000. The USOU has US staff and accreditation but shares the goals and values of the UKOU. It uses a blend of courses and programs sourced from UKOU and North American universities. It is registered as a non-profit corporation and licensed as an institution of higher education in Delaware. Its board of trustees is largely made up of distinguished Americans from various walks of life.

Unext.com is an online learning company that established the Cardean University, described as an online learning community for working professionals. The university derives its name from Cardea, an ancient Roman goddess who, according to Roman lore, was believed to guard over the threshold of doorways. The founders consider Cardea a fighting guardian for the learning community because of their belief that learning opens opportunities for growth and shuts out the dangers of ignorance. Cardean provides continuing professional education courses and a Master in Business Administration program. Its partners, which provide course content, are Carnegie Mellon, Columbia University, Stanford

University, University of Chicago and the London School of Economics and Political Science.

These examples illustrate several models of new ventures from both industry and academe that attempt to address and profit from the need for knowledge workers. In these examples, you see business and education, industry and academe coming together. Business needs the education sector's experience and expertise in pedagogy. On the other hand, academics need the business sector's experience and expertise in product development and marketing. From this convergence arises the education and training industry.

Many of the programs offering these new business education partnership ventures are in the area of business management. I hope that if this university decides on this venture, other course offerings will be considered, particularly those addressing the need for continuing education of faculty members in other HEIs.

Now, I will speak like somebody from CHED. Allow me to give you some facts that I hope will convince you of our country's great need for help from this premiere institution of higher learning.

There are more than 80,000 tertiary level teachers in the country. Only about a third have master's degrees and only seven percent have doctorates. Most of those with graduate degrees are in the public sector. And yet, the public sector services only one-fourth of all the students. The private sector, which enrolls three-fourths of the students, has less qualified faculty. Baccalaureate degree holders have in fact rated the quality of the teaching staff as the lowest among all factors that determine the quality of education they receive.

In 1995, the Task Force on Higher Education did a survey among embassies in Manila, asking them which schools they consider to be comparable in quality to good HEIs in other countries. Only five—one public and four private—were were rated as category A. Of course, the only public institution is UP. The four private institutions are the University of Santo Tomas, De La Salle University, Ateneo de Manila University and the Asian Institute of Management.

In the second category were only six private institutions, four of which are in the provinces. These were St. Louis University, University of San Carlos, Siliman University, Xavier University, Assumption College and Miriam College Foundation. These are only 11 institutions among more than 1,350 HEIs. I think they stopped the classification after class B and considered all the others class C.

The third data I wish to share with you is that the overall pass rates in professional board examinations are very low, averaging only 44 percent of those who take the examinations. And, take note that these is only a percentage of those who take the exams because if the total number of graduates is used as base, the pass rate would even be lower. Since many graduates do not take the board exams, it is probably correct to assume that they do not take them because they would not pass them.

Three fields with the highest enrollments have very low pass rates. These are accountancy (16%), the teaching profession (30%), and civil engineering (32%).

Why should UP care about these statistics when we remain to be tops in this country? Wouldn't this university reap, along with the rest of our country, the benefits of a more robust economy, ran by a robust human resource? And wouldn't we all suffer the perils of a fledgling economy?

I give you these facts because we have here the premiere provider of higher education in the country and the premiere recipients of the products of higher education in the country. This University does not produce enough to fuel the needed rocket booster to propel our economy.

We have in our faculty the greater percentage of this country's intellectuals. Let us ask how they can be used to serve a greater number than what we are able to serve in our space and time-bound conventional modes of teaching.

I propose that UP, the premiere university of this land, make it its primary challenge to improve higher education in our country. It is a self-serving mission because this university gets its inputs from the rest of them out there. But the beauty of it is that, it is at the same time a service-oriented mission.

Upgrading Competencies of Teachers and Educators in the Use of Education Technology

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University of the Philippines
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Introduction

Education technology in a broad sense refers to any process, approach, technique or product used for teaching and learning and other education purposes. ROBLYER and EDWARDS (2000) define educational technology as a combination of processes and tools for educational needs and problems, applying the most current tools, namely, computers and related technologies.

In this paper, education technology is limited to information communication technologies (ICT) used as teaching-learning tools for different subject areas, particularly, science and mathematics. The focus is on in-service upgrading of teachers and teacher trainers. Issues are discussed based on experiences of the University of the Philippines National Institute for Science and Mathematics Education Development (UP NISMED) as a teacher training institution for more than three decades.

Computer Use in Schools

One project involvement of UP NISMED was the Third International Mathematics and Science Study (TIMSS) 1999. The study showed the comparative use of computers by 300 Filipino teachers (in 150 randomly selected schools nationwide, with region as stratum) in teaching Grade 7 mathematics and science (TIMSS-R, 2001) in relation to the international sample of 38 countries. It appears that the Philippines is competitive in students' use of computers (Fig. 1). For students who never used computers, the Philippine percentage (75%) was comparable to that of the international sample (79%). Percentages of students who used computers almost always and pretty often were slightly higher for Filipinos than their international counterparts. The students were not interviewed on their responses; some Filipino students might have interpreted "computer" liberally to include video games and play stations.

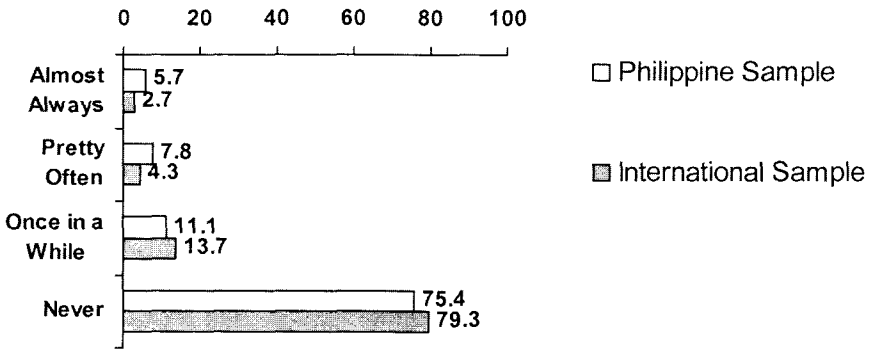

Figure 1. Students' Use of Computers (TIMSS 1999)

On the teacher's use of computers in a mathematics class (Fig. 2), 57 percent of the Philippine sample reported "never", compared to the 82 percent of the international sample. Philippine percentages for mathematics teachers using computers in class almost always and pretty often were much higher than those in the international sample.

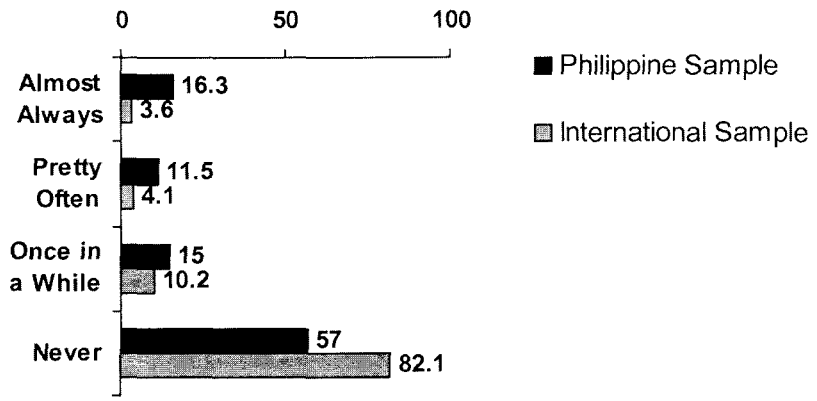

Figure 2. Teachers' Use of Computers in Mathematics Class (TIMSS 1999)

In science classes (TIMSS-R, 2000), TIMSS 1999 data show the same medium index of emphasis on information technology (Fig. 3) for the Philippines (63%) and the international sample (88%). The Philippines had a much higher percentage of students (36%) than the international sample (9%) having a low index. For a medium index, computers are available for students' use, and schools have access to Internet. High index indicates, in addition, teachers' use of Internet, and students' use of email and World Wide Web, while low level means absence of all of these.

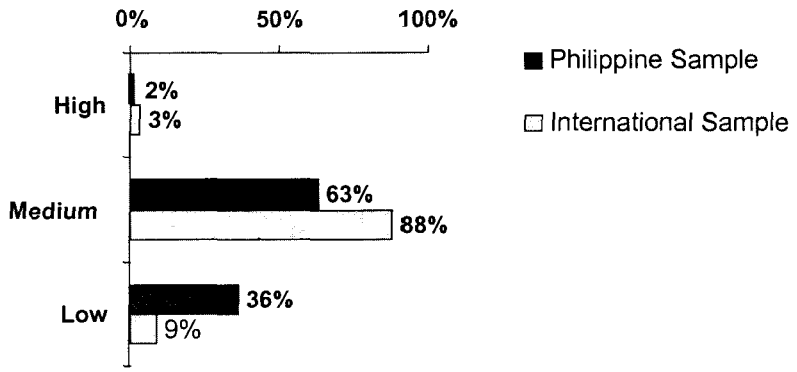

Figure 3. Index of IT Emphasis in Science Class (TIMSS 1999)

Majority of the Filipino (93%) and international (89%) students had teachers who said that computers were never or almost never available for use in their science class (Fig. 4) and even in other instructional rooms (65% and 57%, respectively, for Philippine and international samples). On teachers' Internet use for instructional or educational purposes (Fig. 5), the international sample had a much higher percentage (58%) than the Philippine sample (9%). Forty six percent of teachers in the international sample, compared to only16 percent of Filipino teachers, indicated their classes had access to Internet.

Among the reasons frequently cited by teachers for non-use of computers as teaching tools in the classroom are: lack of funds to purchase computers for teaching purposes, lack of software for teaching and learning, and lack of teacher training on use of ICT for instruction.

The government, through the Department of Education collaborating with other government agencies like the Department of Science and Technology (DOST) and Department of Trade and Industry, recognizes the need for Filipino students at all levels to be globally competitive in ICT. However, obtaining economic conditions preclude all if not majority of schools being equipped with computers (hardware and software) for instructional use. To reduce the digital divide between rich and poor schools within the country, the government explores partnerships with the private sector for ICT sponsorship of public schools.

Although commercial computer software is available for teaching and learning at basic and tertiary levels, there is a dearth of locally produced software for this purpose. In the same manner that local textbooks are written to have more relevant instructional materials for Filipino students, there is a need to produce local instructional software. UP NISMED and the Department of Science and Technology Science Education Institute are among institutions developing local software for schools. UP NISMED has developed nine DOS-based computer programs and two CD multimedia programs for teaching science and mathematics (Table 1).

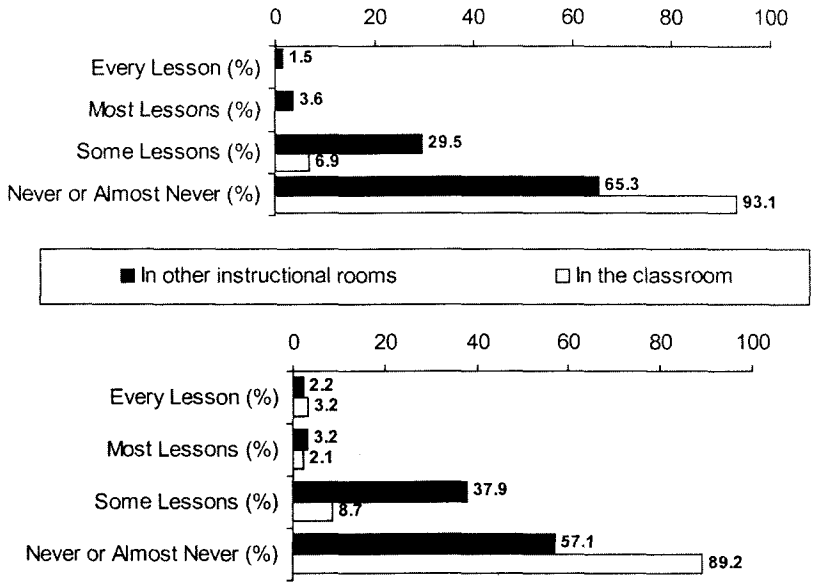

Figure 4. Availability of Computers for Use (TIMSS 1999)

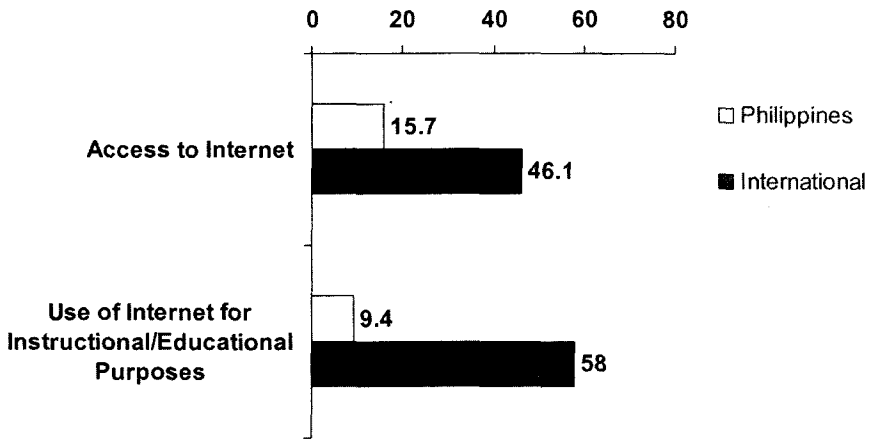

Figure 5. Teachers' Internet Access and Use (TIMSS 1999)

Table 1. Software Produced by UP NISMED

DOS Based

1. Linear Function
2. Linear Inequalities
3. Product of Two Binomials
4. Factor Game
5. Stretching and Shrinking of Butterfly
6. Tower of Hanoi
7. Strong and Weak Acids
8. Salt Water Intrusion
9. Water Pollution

Multimedia CD

1. Distance Formula
2. Who's Who in Mathematics

Production in Progress

1. The Life Cycle of a White Sine and Cosine Curves
2. Exploring the Area of a Trapezoid
3. Typhoons
4. Chemistry of the Atmosphere
5. The Water Cycle
6. Ionizing Radiation in Medicine

ICT-mediated instructional materials programs do not necessarily facilitate meaningful learning (Fig.6), nothwithstanding their ability to transmit information in color, with sound and animation, as well as present choices to the learner. They may promote rote learning if they do not engage the students in active learning, for example, provide activities to the students and develop their critical thinking skills. Current teaching approaches can be used with ICT (Jonassen 2000) for facilitating meaningful learning.

Figure 6 shows three divides: learning divide (meaningful vs. rote), economic divide (rich or poor) and digital divide (low or high ICT access). Educators and education officials need to examine interventions for all kinds of students who learn rotely. The most disadvantaged group which needs government and private sector assistance is the group of poor students having low ICT access and learning rotely. Utilizing

meaningful teaching-learning approaches, ICT can be harnessed to reach remote areas with poor students and untrained teachers. For meaningful learning, development of software and hardware educational packages needs to be a joint undertaking of the education sector and ICT industry.

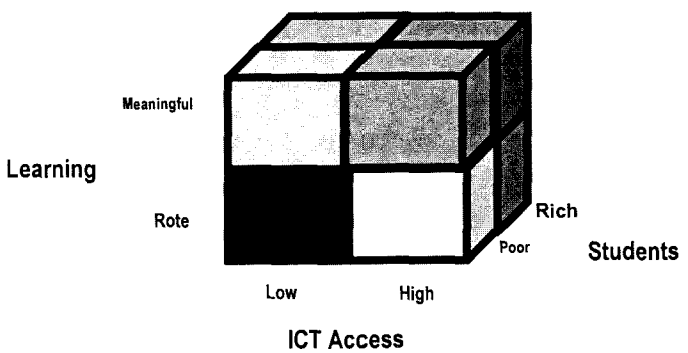

Figure 6. Learning, Economic and Digital Divide

The key to good education is still the teacher who, in an ICT world, can facilitate use of ICT in the classroom. From the TIMSS 1999 findings, Filipino teachers need to be more competitive in Internet use to utilize its vast resources for classroom use and enhancing teaching effectiveness. Availability of computers and schools' Internet access do not automatically imply that the teachers use Internet for instructional purposes. Teacher training on ICT is critical for students to use computers and Internet in the classroom.

ICT Competencies of Teachers

Computers have been in classrooms for years, but teachers continue to struggle to understand their usefulness (Gale Research, 1998). Many students are more skilled in ICT than their teachers. Teacher training has been inadequate; teachers are often trained in software and hardware but not adequately on applying this knowledge to student

tasks. In the 1995 survey results of *Electronic Learning* magazine, teachers reported that 66 percent of their recent ICT training dealt with software packages and hardware information and only 21 percent on curriculum-related matters.

In this ICT age, computer literacy is expected of teachers, that is, understanding of computer characteristics, capabilities, and applications, and ability to implement this such knowledge appropriate to one's role in society (Kim 1995). In teaching a subject area like science or mathematics, among the ICT-related competencies are:

1. To integrate computer software and hardware and other available ICT devices in the curriculum and use these in the classroom
2. To surf the Internet for subject-related resources like activities, articles, books, test items;
3. To use e-mail for sending course notes and assignments, receiving students' work, consultation with students; and
4. To use the computer to encode handouts, examinations, and grades make transparencies and class presentation of power point slides.

Further competencies include conducting e-chat or e-talk with the students, making a homepage for the course, and encouraging students to create their course-related homepages.

What are the ICT competencies of Filipino teachers? Three hundred ninety three science and mathematics teachers who received training at UP NISMED in 2000 and 2001 responded to an ICT survey that asked them (1) to rate their background in ICT and (2) rank four ICT courses/ sessions they are interested in attending. Results (Tables 2 and 3) showed that 73 percent of the teachers had no ICT background, about 24 percent considered themselves novices, and only 3 percent rated themselves as experts. Lack of ICT background was highest in database management software (91%), followed by integrating software in instruction (85%), the Internet (84%) and electronic presentations (82%).

Teachers ranked integrating software in instruction as the course they are most interested in attending, followed by computer system basics, word processing, and lastly, the Internet. The low rank of Internet is perhaps due to school's or individuals' lack of Internet access or lack of appreciation of Internet as a valuable teaching resource. This result appears consistent with the TIMSS 1999 (Fig. 5) low (9%) percentage of Filipino teachers using the Internet, compared to 58 percent of the international sample.

Table 2. Teachers' ICT Background (UP NISMED Survey, N = 393)

Topic/Skill	**None**	**Novice**	**Expert**
a. Computer systems basic (parts & functions, DOS/Windows)	44%	50%	6%
b. Word processing (e.g., MS Word)	55%	37%	8%
c. Electronic spreadsheet (e.g., Excel, Lotus)	71%	26%	3%
d. Database management (e.g., dBase, Access)	91%	9%	0%
e. Electronic presentation (e.g., Powerpoint, Hyperstudio)	82%	16%	2%
f. Integrating software in instruction (e.g., CAI, multimedia)	85%	14%	1%
g. Internet (e.g., e-mail, World-Wide Web)	83%	14%	3%
Overall	73%	24%	3%

ICT teaching competencies assume a very positive attitude towards computers on the part of the teacher. Studies (Kim 1995) indicate a

significant relationship between positive attitude towards computer use and experience with computers. Having computers available for classroom use and teacher training on use of computers in teaching different subject areas are crucial initial steps towards ICT-aided teaching and learning.

Table 3. Teachers' Preferred ICT Courses (UP NISMED Survey, N = 393)

Course Topic	Overall Rank
Integrating software in science/ mathematics instruction	1
Computer systems basics	2
Word processing	3
Internet (e.g., e-mail World-Wide Web)	4

Teacher Training Programs

The private sector experience is that productivity and profits can increase when downsizing is accompanied by increased spending for training (Gale Research, 1998).

Cost-effective teacher development activities for teachers include working meetings, research teams among teachers, and teachers assisting one another (peer teaching and mentoring). The Internet is a vast teacher training resource.

On the web is the OpenCourseWare (OCW) of the Massachusetts Institute of Technology (MIT) in the United States (Wiggins, 2001). OCW is free of charge to any user in the world (Wiggins, 2001). It contains course materials like detailed course notes, outlines/syllabi, problem sets, typical examinations. The OpenCourseWare (http://www.mit.edu/ocw) was conceived, particularly, for developing countries that need information in building infrastructure and institutions. The

MIT faculty participation is voluntary, based on freely sharing knowledge generated through research and teaching.

In the Philippines, UP NISMED is among the institutions conducting ICT curriculum-related teacher training programs. On the average, UP NISMED yearly offers three short-term courses on computers, such as *ICT Essentials for Science/Mathematics Teachers*, and trains about 50 teachers a year. In 2000, for instance, UP NISMED trained about 130 teachers on ICT in teaching with some courses conducted in cooperation with Intel and DOST. Other UP NISMED in-service courses in science and mathematics integrate ICT training.

To accelerate the design, production and adoption of ICT-based educational materials in science and mathematics and develop a nationwide pool of ICT-competent science and mathematics teachers/ curriculum developers, UP NISMED proposes a three-year project with two phases. Phase 1 (one year) focuses on setting up state-of-the-art ICT facilities at UP NISMED and training of curriculum developers/teachers on interactive multimedia and web-enhanced instructional materials. Phase 2 (two years) concentrates on development of ICT-aided instructional materials and on-the job training of additional teachers.

Planned project outputs are 14 multimedia materials and 7 trained teachers trained per subject area: Elementary Science and Mathematics, Grades 1-3, 4-6; General Science; High School Biology; High School Chemistry; High School Physics; High School Mathematics, Years 1-2, 3-4. In all, 140 multimedia materials and 70 trained teachers are expected project outputs in three years. The estimated total cost of the project is P13 million (Phase I, P3 million; Phase II, P10 million).

Cost of in-service teacher training programs are prohibitive, with the bulk (60%) of costs allotted to subsistence allowance. Typical cost of a live-in training program at UP NISMED is P1.M for 120 teachers for three weeks. Compounding the financial problems are the motivation and openness of teacher trainees. Costs for government are drastically reduced if ICT literacy is integrated in pre-service courses for future

teachers. The ICT training in this case is part of the tuition fees paid by students.

More importantly, pre-service students are relatively more open to ICT training, perhaps due to youth, confidence and trust in the university faculty, and less unlearning to be done. Thus, it is important that integration of ICT in teaching the different subject areas is established in the pre-service teacher education programs. Future in-service ICT training can focus on updating/upgrading competencies, with love for computers as teaching-learning tools earlier developed in undergraduate programs.

Follow-through of in-service programs is essential for optimum or maximum utilization of expensive teacher training. This is probably best done at the classroom level by the trainors, supervisors, and school administrators. A critical question that needs to be answered is: Did the training result in higher student achievement? Some teachers may need reinforcement and additional on-site training to fully implement ICT-aided teaching.

Conclusion

ICT mediation of teaching and learning requires pre-service and in-service training of teachers and assumes availability of computers in the classroom. Challenges in upgrading competencies of teachers and educators include motivation of trainees, implementation of training, and follow-through of trainees. For ICT access of poor schools, government intervention and private sector support are essential. To facilitate meaningful learning, ICT software and hardware educational packages need to be developed as a partnership between ICT specialists and education experts.

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Intel Innovation in Education

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Intel Philippines

Intel is a strong supporter of the use of technology in education as well as the improvement of science and math education worldwide.

Intel Corporation's mission is to be the preeminent building block supplier to the Internet economy. It had been mentioned that the center of the industry is now the Internet; thus our mission is to support to the worldwide Internet economy.

Now in our twenty-seventh year, we are the oldest American semiconductor company in the Philippines. We have two major locations in the country: Makati and Cavite. In the Philippines, we produce the latest generation of microprocessors as well as flash memory products that are used mostly in telecommunications, for example, your cell phones. Our flash memory products are also powered by microprocessors and other peripherals like chip sets to support mobile as well as desktop PCs.

Intel's view on education is best exemplified by the works of Dr. CRAIG BARRETT, who said Intel is committed to playing a positive role in preparing our youth for the demands of tomorrow. We work to make a difference by offering tools, resources and programs to achieve targeted

goals in math, science and technology. Dr. BARRETT has continuously visited the Philippines for the last 20 years in his various capacities. In his visit sometime in August this year, he again reiterated his commitment and support to improving education in the Philippines specifically through our Intel Innovation programs.

We call our major education program "Intel Innovation in Education," which we also use as part of our branding. This program is a global multimillion-dollar initiative to promote and improve math and science education in the US and in various localities worldwide. The program has several important goals: to improve science and math education; to broaden access to technology; and to improve the effective use of technology in the classroom. While the program started in the US, we adapted this to the local environment. However, the objectives and the philosophies behind the program remain the same.

The program has several components in the Philippines. The first is the Intel Philippines Science Fair, which seeks to improve science and math education in the high school level. The Fair used to be sponsored by the Department of Science and Technology (DOST), but Intel started to sponsor the program in 1997. The program is a part of the Intel International Science Fair we sponsor worldwide. The yearly contest has several rounds, starting from the district and regional levels where the winners get to participate in the Intel International Science and Engineering Fair in the US every year. This program also encourages the use of research methods in the different science projects in the high school level.

Another initiative we support is Project RISE, which stands for Rescue Initiative for Science Education. The project is implemented by the Department of Education, Culture and Sports (DECS) and DOST and aims to increase and improve content knowledge for non-math and non-science majors who are teaching in the elementary and high school levels. We are currently supporting RISE in Region IV.

Intel Teach to the Future is another project that aims to improve the use of technology in instruction. We will elaborate on this program

later. In terms of broadening access to technology, we are going to start the Intel Computer Clubhouse here. We have also made donations to two universities, one of which is the UP College of Engineering, and to three technical schools in Manila and Cavite. We have scholarships in the technical as well as the engineering areas and Intel has committed to provide the computers for a mobile IT classroom in conjunction with DECS and DOST.

Intel Teach to the Future is a worldwide project committed to teach 400,000 teachers worldwide on the use of technology in education. In the Philippines, the commitment is to train 20,000 high school teachers for two years, between this and the next year. This year, the commitment is to train 10,000 teachers on how to use computers in the classroom. Right now, I think we have trained something like 1,700 teachers and we have around 750 master trainers.

This program was started in one of the US universities and as I have mentioned, we have tried to localize it to suit the environment. We had teachers that studied the program at UP-NISMED who looked at the curricular and the teaching methods and localized it for the Philippine environment. We are also using 18 regional training agencies nationwide and 64 regional trainers to support the different regions in the country. The program does not only teach teachers how to use the computer in the classroom but teaches them to integrate the use of technology in their curriculum. In essence, it enables the teachers to integrate the use of computers in teaching the different subject matters in school.

We have latched this program to the PCs for Public Schools Program, which is spearheaded by the Department of Trade and Industry and DECS. The schools participating in this government program will definitely use this as a teacher-training component. We are also bringing this program to some other schools that have met certain computer literacy requirements. The PCs for Public Schools program and the Intel Teach to the Future program were recently launched in Malacañang by President GLORIA MACAPAGAL-ARROYO. We had a symbolic awarding of a certificate to a teacher at Bukal National High School, Ms. SANTOS, who

was one of the first Intel Teach graduates. However, Intel formally launched the program in July.

The Intel Philippine Science Fair is organized in cooperation with the DOST and DECS. The winners join the Intel International Science and Engineering Fair held in the US every year. Since 1997, we have sent local winners to compete with winners from other countries in the US. So far, around 8,000 Filipino students have participated in this contest, which we are supporting with a teaching component on research. In other words, we have another program that teaches students to do research to be able to support this program. Since we started sending contestants to the US, there have been winners from the Philippines each year and we are very proud of that. I think it was last year when all the representatives from the Philippines won a prize at the international contest which was participated in by at least 15 countries. One student I talked to said one of the things they get from the program is the ability to gauge themselves against other young people all over the world. The experience and the confidence they get from participating in this program are tremendous.

The other program we are starting this year, probably in November or December, is the Intel Computer Clubhouse. This program is for people who would like to use the computer for creative purposes. We believe this will work in the Philippines because Filipinos are generally very creative. We have a budding animation industry in the Philippines and we believe the users of the Intel Computer Clubhouse can be latched to the animation industry. We also donated a class A computer animation lab to the UP College of Mass Communication. We are hoping that some of the people who will benefit from the use of this animation laboratory can serve as mentors in the Intel Computer Clubhouse. We are doing it in cooperation with Angular Foundation, our partner organization. We are the first to have such facilities in Southeast Asia, which will be located at the Mother Dolorosa Parish in Makati, which is a middle class community. For use in the creative arts, we have made available hardware and software for animation, computer programming,

video and audio editing, electronic music and web design. Right now, our coordinators are getting ready to train in the US and we will open this sometime in November. This, by the way, is patterned after the Boston Computer Clubhouse in the US.

As mentioned, we have also donated a number of laboratories to improve research as well as the quality of the facilities in a number of universities and technical schools in Makati and Cavite. Our first computer lab is housed at the new building of the Department of Electrical and Electronics Engineering in UP. Presently, we also have 34 scholars for the undergraduate and the graduate programs in a number of universities.

To summarize, Intel Innovation in Education is a global effort to promote science and technology education. Right now, our focus is on the three major programs: the Science Fair, Intel Teach to the Future, and the Computer Clubhouse. The major program we introduced this year is Intel Teach to the Future.

If you have any questions or if you want samples of some of the work that has been done or more details on our programs, you can access us through the web through YVONNE GARCIA, who is our education manager, through her email address: yvonne.garciaflores@intel.com.

Technology Enabled Learning The Hewlett Packard Experience

MR. VICENTE DIÑO

Country Education Manager, Hewlett Packard

I had a difficult time trying to determine what I am going to say this afternoon because I am in the information technology industry and I know next to nothing about the academe. So I decided, perhaps the best way is for me to tell you how Hewlett Packard (HP) itself is making use of technology to train its employees. From there, I hope you will be able to draw your own conclusions and probably have some ideas on how you can use technology to become better educators and to better manage the learning process.

Like all businesses, HP is subject to all of the changes that are happening in both the political and the economic spheres worldwide. There are several issues that have direct impacts on how employees learn within the HP corporate environment. One is the issue of profitability.

Profitability is really a euphemism for cost-cutting, especially now that as the world economy is slowing down, the focus of most large corporations like HP is not in generating more revenues, but in trying to keep costs down. When you are trying to keep costs down, one of

the first things to go is the training and education budget for employees. The implication is that there are smaller budgets for training and managers must focus more sharply to determine the return for investments of education.

Then, there is the issue of accelerating change. Most of you must have read *Future Shock* or other books by ALVIN TOFFLER. We are undergoing a rapidly changing environment, and we, in the IT industry, are one of the first people to feel that accelerating change. You introduce a product to the market today and one week later, somebody has come up with a better product, making your product obsolete. This implies that when we bring people in for training, for education, more often than not, one or two months down the road, most of what they learned is already obsolete. And we have to bring him or her in for training again. Thus, with accelerating change, the shelf life of knowledge becomes shorter. At the same time, because there is so much change and so much need for more information, there is a need for more, and not less education.

One consequence of accelerating change is that the pace of business is likewise accelerated. The past 12 months have been the most stressful to me, as a professional. We started with the impeachment trial of then President JOSEPH ESTRADA and from there we made some plans on how to handle the economic situation. Then, all of a sudden in January, we had the EDSA III revolution. When we felt everything was going to be okay and started planning for growth, the May 1 riots brought new problems. Again, we did not know what to do, so we changed our plans. After the May elections, we started to stabilize but a couple of months later came the investigations on Senator PANFILO LACSON. Then came the World Trade Center bombings. All of a sudden, deals were off and we did not know what to do anymore. The situation was so stressful because of the changes. Our work doubled; we worked even during our free time and did a lot of re-planning. And because you have a lot more work to do, there is very little time for education. It is very ironic that

because of accelerating change, we need more education but because of the pace and pressure of business, we have less time for education.

Lastly, we have decentralization. We are living in a globally integrated economy where multinational corporations are closely linked with corporations throughout the world. HP has research facilities in China, Japan and the US. It has manufacturing facilities all over the world and the output of these manufacturing firms are integrated in some other countries. The operations of multinational companies now are very integrated and as a consequence, you have a geographically dispersed work force.

For people who manage the training of employees, there is a big problem: how to ensure that everyone in all the HP offices are trained at the very same level and are provided with the same quality of education as in the head offices. The other problem is how to ensure knowledge sharing if you have engineers scattered all over the world. How do you ensure that the best practices learned in the US are transferred to, let us say, China, and vice versa? What engineers may have learned in China maybe of some use to engineers in Europe. How do you ensure that people collaborate across time and space?

This is the HP story. There are business issues facing HP as a company in terms of corporate training.

A couple of years back, HP decided to embark on what it calls the Enterprise Workforce Development Program. It is an initiative to fully integrate technology into the training and learning experience within HP. To give you a magnitude of what we are talking about, globally, HP has 18,000 learning sessions per year. On average, we have 30,000 courses to manage. We have 160,000 employees scattered throughout the world. There are 600,000 transcripts of records and 9,000 certification programs that need to be managed. In terms of magnitude, the need to manage all these is really great.

HP embarked on that project with five objectives. The first is rapid course development and delivery to a wide audience. With employees scattered throughout the world, you have to ensure that an employee

reorientation program would be deployed equally and at the same quality at each HP office. The second is to know whether your training program is effective and if it is delivering the results you want it to be delivered. You want an easy way to deploy the Learning Management System (LMS). You do not want the technical hassles of implementing the LMS: you lose the focus on delivering education. Third, it should have the ability to manage the certification programs of the company. Fourth, it should have the ability to track the efficient use of resources because of the cost pressures on the company. Finally, it should be able to deliver both asynchronous and synchronous learning: asynchronous meaning self-paced web-based training and synchronous, the virtual classrooms.

This is the high level architecture of the learning infrastructure HP implemented. At the bottom is the learning management platform. It is a system that automates the registration, records and resource management. Records refer to the training records of the employees. Resources are things like classrooms, instructors and how to schedule these resources. The LMS also handles the assessment of employees. It has a skills database and a competency database that the system manages as well. On top of that platform is where we deliver our self-based, web-based training courses. Our collaborative learning environment is composed of the virtual classrooms as well as the traditional face-to-face instructor training. The learning management platform manages all the different delivery mechanisms for education.

To implement it, we have the learning system called Do Cen at the center. Surrounding that, you have the asynchronous training, the web-based courses. Then we have the synchronous training we call the HP virtual classrooms. We also have tracking, reporting and data management coming from the LMS.

When we implemented the step measures for ourselves, we wanted to know how successful we were in what we were doing. So, at the beginning, we decided that learning should be accessible, convenient and flexible. To business, it means it should translate to higher cost savings for the company in terms of learning delivery. Learning should

be timely, it should provide for higher quality operations, and that means employees are prepared for their jobs. And indirectly, that should result in cost savings for the company as well, since your employees are efficient. And then, the learning platform should mean that learning is consistent throughout HP offices globally. This should mean consistent level of customer service at the very end. Lastly, the learning management platform should be able to track progress and correlate that to business goals, for example, increase in quality or lower cost.

I would like to go through each of the different technologies HP implemented for the learning infrastructure. First is the LMS I mentioned earlier: it gives us the capability to plan, register, deliver, certify and manage the entire learning process. Planning provides the individual employees the ability to assess his skills by accessing a particular web site. After assessing his skills, the employee can then plan his own curriculum. The employee now knows his skills and can identify the knowledge he still needs to do his job effectively. Thus he plans his own curriculum. From that, he could also keep track of his own skills profile, which is also accessible to his manager, so the manager would be able to keep track of the progress of each and every employee through the skills profile database.

With Registration, the system allows employees to register online. They can access a particular web site to look at the courses available and then register. Of course some payment in e-commerce capability is included which is not applicable. In our case, it should support all forms of learning delivery.

Under the Resource Scheduling Systems is a database of learning resources as well as instructors and classrooms. It allows the training institution, the education center to schedule these resources according to the employees' demand.

The Delivery System manages the delivery of classroom training, web-based courses as well as synchronous learning via virtual classrooms.

The Certification System has a database to keep track of tests and assessments done on employees after attending a particular class. At

the end of a course, it should help the company manage the training, the entire learning process by providing management reports, costs, as well as the progress of all the employees in the company.

The other technology we used aside from the LMS is the virtual classroom. Most of you are familiar with the technology. A virtual classroom is a web-based environment that allows people to congregate virtually to attend a meeting, share information or hold classes. This means there is a teacher who puts up a power point presentation via a particular web site and students who want to attend that class would access the web site at a particular time. From there, the teacher can deliver his class: it is a virtual classroom where they could interact accordingly. We use the virtual classroom if there is a new product that comes out and all of our engineers want to get updated on the product immediately. That is a lot cheaper than, let's say, flying in engineers to Singapore to attend training on product updates. Of course the engineers regret not having to go to Singapore, but then you have to cut costs.

The last piece of technology we used is the HP Information Technology Resource Center. The IT resource center has three components. It has a maintenance and support capability, training and education, planning design, implementation and forums. Maintenance and support is actually a database of all the technical information needed by the engineers. Let us say if they are troubleshooting a problem they cannot solve because they lack information, they hook up to that web site and look up the technical documentation they need. All of the problem resolutions are also posted there, along with the past history of the particular technology.

The training and education component is where our new engineers and employees get their self-based courses. They can access these web sites to get their training there at their convenient time.

I will skip the Planning, Design, Implementation component. This is where knowledge sharing comes in the form of forums. In this particular module, there are forums for specific topics where discussions are ongoing, where engineers can post questions and engineers in other

countries with the answer can post a particular response. This is our mechanism for knowledge sharing.

In summary, the learning infrastructure we implemented gave the individual employee the power to manage his training by giving each the capability for self-assessment, planning his own development program and learning what he needs when and where he needs it via the self-based courses. At the same time, it gave the HP management the ability to track and monitor the learning progress of its employees, resulting in lower overall cost of delivery, principally because of the reduction in airplane fare and hotels fees for engineers who had to fly to attend a particular training. It increased collaboration and knowledge sharing among geographically dispersed employees through our IT resource center, and resulted in rapid update and roll out of learning content from one center.

E-learning through the CISCO Networking Academy

CRISTINA G. DE JESUS

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CISCO Systems Phils.

I am going to talk about the CISCO Networking Academy Program. It must be a good coincidence that Mr. DIÑO of Hewlett Packard (HP) spoke before me. HP is one of our business partners and the Learning Management System (LMS) he talked about is integrated into this program, which is specifically designed for the use of schools. Previously, the LMS was used by companies; now, schools can use the very same technology in the classrooms.

Let us talk about the Internet revolution. Previously, we had the industrial revolution that linked people and factories together, people and machines together. Now, the Internet is linking people and information at a much faster pace. What took generations, even centuries to link together had been brought about in just a few decades, say 10 to 20 years. And the people, corporations and countries that can cope with the Internet revolution are those who will be at the forefront, those who will progress either politically or economically or those who will become leaders in the knowledge industry.

The Internet is changing the way we work, learn, live and think. We get access to information not just through libraries now but through the Internet via e-mail and via databases. We communicate via e-mail, we even purchase things online. We are not just talking about books or toys; even food can now be ordered through the Internet. And of course, it is changing the way we learn, because it is delivering education, delivering content not just to the classrooms but also to our homes. We are talking about business learning, about life long learning. It does not mean that as we grow older and leave school, learning should stop, right? Since you are educators, I am sure all of you are pro-education, as well as pro-learning for life.

So, what are we at CISCO doing here aside from bringing education?

Our company and our chairman firmly believe that today's students must have access to world class technology, world class education and must acquire strong technology skills to get ahead. Businesses around the world need IT professionals. Students who have this kind of knowledge will have tremendous opportunities in the Internet economy. We are talking about the law of supply and demand. We do not have enough people knowledgeable with the Internet technology. What does that translate to? IT professionals get their choice of jobs. In fact, companies will run after them, and they could actually demand higher pay. That translates to a higher quality of life not just for themselves but for their families as well. We are talking about actually improving the Philippine economy and moving the country forward; this is part of the government's ICT strategy.

As an analogy, let us look at the recent history of technology and education.

In the 1980s, we had a few computers, but these were stand-alone devices. They were not connected and could not communicate among themselves. Towards the 1990s, computers were supplemental—local area networks were being set-up, but these were few and far between. In 2000, everything was integrated. A lot of schools were getting connected to the Internet. And among themselves, they collaborated to

produce better curriculum for instance, or better instructors. This was not just happening in the country but worldwide: schools were collaborating across continents. We are talking to schools in Singapore, Australia, US, even Africa. And it is not just the instructors or the administrators but students are now interacting among themselves.

E-learning is the latest buzz word. Essentially, e-learning encompasses the creation, development, management and the actual delivery of content. We are talking about the whole educational system being done through the various nets in the Internet: the Internet and the extra nets.

So essentially, what are we doing?

We are moving away from what used to be an instructor-centric system. You have an instructor teaching, and if the instructor misses something, that is just too bad for the students. What we are doing is actually empowering the student to be able to access all the various sources of information: everything is up-to-date, it is just-in-time, what is out there now in the market.

Internet-enabled learning provides accountability not just to the instructor but to the student as well. The student is made accountable for learning whatever he is supposed to learn, whatever he is supposed to be studying in class, whether it is a homework or a work-based project. Our best example is the CISCO Networking Academy Program.

How do we integrate technology into e-learning? The process has several components: curriculum, assessment, training and accountability. We will actually go into each of these. The process integrates everything; it makes it prescriptive, adaptable, inclusive, just-in-time and integrates assessment into the whole system.

Going into these components individually, curriculum is web-based. We have students in front of computers as if they are playing or just browsing the Internet. Actually, they are studying online. We are not just talking about text but you have videos- it actually moves- and audio. At the same time, hands on laboratories also cater to the kinesthetic kind of learners. The program really addresses the students' various learning styles. You have online assessment, so can you imagine not

having to check any more papers? The students take their exams online, and as soon as they hit the submit button, they get their grades. I am very much in favor of that because when I was a student taking an exam, I could not remember which items I did wrong in. When I get immediate feedback, it works for me. It works for the student because he can go back to his mistakes before taking the next quiz. When it is online, it makes things immediate. It also makes things easier for the instructor since he can personally address each student's needs.

Therefore, the program provides for personalized training. It frees the instructor's time since he/she does not have to create more papers. Actually, even the instructor's guide is online. He does not have to make detailed lesson plans because the whole network shares the best learning practices from all the instructors in this program around the world. Say you did some kinesthetic activity in class that the students really appreciated and it turned out to be actually very valuable and very productive. You could share that with the rest of the community through the online discussion forums, or send it via e-mail or you can do it during the annual conferences we hold for the main contacts and instructors. We are talking about sharing knowledge and being able to deliver the best kind of curriculum to the students.

At the same time, everything is managed online so students can create their accounts. Each student has an individual user ID and password. They can access the program even when they are outside the campus. They can do it via the Internet at home or at Internet cafes, so they do not actually have to play games because they can study.

News is posted on the web through the whole system for immediate feedback. You get immediate news whenever it is posted. We update our curriculum four times a year. Imagine if you are using books: it takes a year or two to publish and distribute the new versions that you end up with obsolete or outdated data or information. With an online system, as soon as we post the curriculum, the school downloads it and you could use it. The accounts remain the same. They are transitioned

into the new version. Even the grades remain there. The program is really very manageable.

The students have their own web sites so they can log into the net. They can study their curriculum, take quizzes, and even search for jobs. We are launching in the next month or two what we call the courier connection web site where students and graduates of the CISCO Networking Academy Program can get linked to the industries.

I mentioned an industry shortage of IT professionals; at the same time, students are looking for jobs to earn a living. We are linking the graduates and students of the program to companies in the industry. Students can submit their resumes and find jobs online.

The program also provides hands-on learning. You have actual CISCO equipment in the laboratories for the students to practice on. They do not have to go to the school's network infrastructure and find the IT guys saying "Hands off! Don't touch anything! If this fails, the president is going to have my neck!" Students have their own computers inside the classrooms or inside networking laboratories where they can practice, configure, patch, do cables, or do simple or even complex network set-ups within the classroom.

So what are we talking about here?

When you talk to hiring managers, more than 50 percent of the time, they prefer someone with hands-on practical experience. Aside from that, we are not just teaching them how to design, build and maintain networking systems. The very same program, the very same curriculum actually prepares the student for an industry certification.

For those of you in IT or who are familiar with IT, this is the CCNA or the CISCO Certification Network Associate. This is the first of a series of certifications from CISCO. We are talking about a student being able to take and pass an industry certification after completion of the program.

This certification is recognized worldwide. It is a standard-based open system. They can go to any company in the world, present the certificate

and their name, say DELFINO URBANO CCNA #45364. The student has his name and a CCNA number when he goes out to the industry.

The CCNA level can be integrated in all levels: high school, vocational technology and college/university. You must be wondering: high school? Yes, because this program's prerequisite is third year math, English and some sciences. We are really going down to the basics, teaching a student what a PC looks like. As long as they know how to turn it on and off or browse —the basic PC skills- a student can study this curriculum. Binary computing is even being reviewed in the curriculum and how waves move, so the basics are covered. You do not have to know anything about networking prior to taking these classes.

Let us talk about program hierarchy. To make the program more scaleable and more efficient, schools that teach to students are called Local Academies (LA). The academy's instructors are trained at the Regional Academy (RA). We have nine of these in the Philippines. The RAs are authorized to train instructors while LAs only teach to students. RA personnel are trained and monitored by the CISCO Academy Training Center (CATC) which is based in Singapore. A CATC handles 30 RAs or groups. An RA trains and monitors 10 LAs each. Of course, the CATC is trained by CISCO.

The training structure is at the same time the monitoring structure. We have a quality assurance plan to ensure that each school's teaching, curriculum and instructors are up to par with the standards CISCO has set.

The Quality Assurance Plan is a document that each academy has access to. How? Of course it is online so that information is given to the user on a prior need basis.

Let me give you a brief history of the program. It was launched in 1997 in the US in only a few schools in a few states. Then, the schools were just getting wired. You are probably experiencing this now. It is either your school has just gotten wired, or was one of the first to get wired, or is still in the process of getting wired. The US schools were then saying, "We are getting connected to the Internet, but we don't

know how to do it. Hey CISCO, can you come and teach us?" We held seminars similar to this one. But as you have experienced, you know teachers do not have enough time. So they said, "Can we have students sit in since they are actually good at doing this? They are fast learners and technology is one of the things they are very interested in." So we allowed students to sit in the class. The audience was getting bigger and bigger and the students were saying that since they were sitting in these seminars and were actually doing good in it, can we create a curriculum for them? They asked to put the curriculum in their classrooms so they get grades for it. And that is what we did. This is the program that has evolved and is now in used in some 8,000 academies in over 130 countries. It is in nine different languages, so if you want to teach a class in German, Chinese, or in Italian, you can actually do that.

On the average, there are 25,000 online exams taken daily in the 8,000 academies world wide, with almost 20,000 students and 160 instructors currently studying and teaching the program. So, you can imagine what the Internet is bringing to make things easier for you? The good thing about it being online is the feedback mechanism of the program on the students, the exams, technologies or maybe the curriculum itself. With the feedback, we update and improve the program continuously.

Majority of schools running the program are high schools. In the Philippines, the majority is tertiary educational institutions, but that is not really saying anything. It only means high school, college and vocational or technical schools can run this program.

As I said earlier, we partnered with companies like Microsoft, Sun Microsystems and HP to be able to come up with this kind of program and to bring you the best industry can offer. Of course, we have to partner with schools because education is their core competency. We cannot take that away from you, so we work with you to be able to help our youth and our nation. We call it the Education Ecosystem. In the Philippines, we are working with the Department of Social Welfare and Development to bring this program to the out of school youth. We also

work with the IYF, the World Bank, the Ayala Corporation/Foundation to be able to bring this to under privileged communities. It is the same program that could be run in your school. Over 70 million people are online on the Internet and seven out of 10 students are saying they get better grades because of this.

I firmly encourage you, if you are not into this program yet, to actually partner with us so we could bring technology to your schools and help our students.

SUMMARY

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The message of the conference is crystal clear: in today's world, education is the primary source of competitive advantage. Our problem is to persuade policy makers and legislators, but that is a separate concern altogether.

We heard various lecturers tell us about the new technologies and what we can expect in the future: webtone, Internet 2 and so on. In the industrial age, we were reminded, the student went to the classroom. In the information age, we were advised, the classroom goes to the student. We heard how the "sage on the stage" is becoming the "guide on the side"; how TCT— talk-chalk-textbook— is being replaced by PAL— personalized, adaptive, life-long learning. And of course we cannot forget that constant refrain of on time, on demand, anytime, anywhere-learning. These changes prompt us to think that is before, students learned despite their teachers, in the future, students will learn without us!

We are also seeing new players in the education sector, which could edge out schools and universities. First are the parents, who have become an even more significant stakeholder in the learning process; they are

increasingly less willing to let schools run (and ruin) the day. I think this is a challenge we teachers should face squarely. We can count on parents to at least keep us forever on our toes.

The second player is industry. As I listened to the Hewlett-Packard learning management system— plan, register, certify, deliver, manage— a similar process (albeit different in substance and wording) is what we apply in the education sector. What will happen or is happening is that the demarcations of home, school and workplace are fast disappearing and once again, the challenge to educators is to keep up and modernize, or silently fade away into oblivion. One way to keep in step is precisely the purpose of this conference: to collaborate with other sectors of our society in enhancing and advancing the learning process.

In addition to the entry of new participants in education, modern technologies have a direct impact on teaching and learning. First, they question the myth that technologies are dehumanizing. This is, of course, potentially true of any technology; the outcome will depend on how and for what the technology is used. The educational technologies aim to further develop a person, and to do so in ways we did not fully realize before and admittedly, in a manner far more exciting than chalk-speak. Consider the descriptions of learning that we heard again and again today— personalized, individualized, customized, adaptive, flexible. For the longest time, we went by the "one size fits all" formula of learning, which works best when the student population is fairly homogeneous. But in a diverse population like UP's, where students come from all over the country and different sorts of high schools, the application of technologies that would make learning more adaptive and flexible could well address the varied levels of proficiency that first time entrants possess.

Another impact of the new technologies is the meaning they give to teaching and learning. We always assumed (perhaps with more hope than conviction) that when we teach, the students learn. With the new technologies, a learning chain emerges; there are technologies that deliver knowledge (as we do when we teach) and technologies that assist learning

(such as interactive materials that focus on the student-learner rather than the teacher). Where one stands in the learning chain is essential and the teacher can opt to stand back and give the student a forward position in the chain or take over as the need arises.

Educational technologies have also successfully developed the notion of lifelong learning. Though some teachers might be threatened by this idea, what is evident from the conference presentations is that the most challenging function of the teacher will not be the need to know everything (not possible), or to simply impart knowledge (potentially boring), but to make students want to learn and keep learning the rest of their lives. We have to inspire our students so that even when they leave us, they want to learn more. And I tell you, that is the toughest thing for any teacher to do; no machine can do that yet. As we complete our syllabus, then, we have to constantly think beyond it and hone up our old skills and acquire new ones.

As for the content of the curriculum, once upon a time students could not easily verify or validate what we said. The teacher was god. Now students can check what we say without great effort. They can go to the Net, check a variety of sources, or compare our course syllabi and notes with those of universities abroad. Again for us teachers this means a lot more work than we normally put into our classes.

The question left in my mind is: Do our academic programs really allow for some personalized learning, given the character of our student population and our regular teaching load? Or, put more aptly, how can we design our programs so as to allow some flexibility and a reasonable degree of individualized learning? The good thing about the learning technologies is that they offer tremendous and immense possibilities for learning. Although not all of us will create the software or put our courses online, we cannot, must not shy away from doing two things. One is to rethink the basics: what we should teach and how best we can teach them. And the second is to keep our minds constantly open to new ideas and new modalities of learning, as the educational technology mantra goes, online, on demand, anytime, anywhere.

What Now?

The MINDLINK gatherings brought together technology practitioners from the University and the private sector. In each of the three meetings, the academics presented their capabilities and research results, while the industry representatives discussed available products and services in the market (local and global) and the problems they encounter in their business. Although some of the researches done by the academe cannot be immediately applied by local industry (for example, the high electron mobility transistor developed by the National Institute of Physics [NIP]), there are many areas where collaboration can immediately be started (e.g., software development and IT enabled services). Similarly, there are industry concerns where the academe can, even now, apply their expertise to help the private sector (e.g., agricultural biotechnology and content of learning modules in education technology).

The question we would like to address at this point is, what now? Given the present capabilities of both sectors, what should they be doing separately? At the same time, where should they collaborate so that jointly, they can help develop the country's technological capability and move activities toward the higher value chain of products and services? The answers to these questions entail policy, program, infrastructure and institutional aspects that this section addresses, each within a specific time frame. Less attention is will be given to the public sector response, which falls under the general category of S&T programs and policies, as these have been extensively discussed in papers prepared by NEDA, PIDS and DOST. There is,

however, one crucial program that needs to be discussed, and that is the problem of the lack of venture capital necessary to spur the growth of businesses in the technology areas that hold the greatest promise of collaboration. This problem is also tackled in this section.

Information and Communications Technologies

It is clear from the presentations that of the three technologies—ICT, biotechnology and education technology—the largest gap between academe and industry is in the field of Information and Communications Technologies. The reason is simple. Academe tries to work on the advanced science and engineering areas, while local industry players are either: (1) subsidiaries of multinational firms involved primarily in sales (Microsoft, Sun) or at best, in the labor-intensive part of the manufacturing process (Intel, Fujitsu); or (2) Filipino-owned companies that do contract manufacturing for MNCs (such as IMI); or (3) telecommunication service providers that are completely dependent on foreign companies for all their technology needs (PLDT, Globe, Smart). Furthermore, it is also in ICT where even the few advanced researches of academe (high electron mobility transistor, optical data storage, broadband digital microwave link, RISC microprocessor design) lag behind the state-of-the-art researches (X-ray lithography, molecular electronics, quantum computing, etc.) in advanced countries.

If the Philippines is to catch-up with the advanced countries in ICT, therefore, academe and industry must work hard separately on their respective concerns and even harder together on common areas. And since we have very little capital and few resources, we must focus on specific areas. A major problem is that government economic planners are averse to industrial policy. Rather than "choose" winners, they prefer that government "attract" winners. But in a technologically backward country where the captains of industry view technology as a cost rather than an investment and generally do not take risks, the strategy of "attracting winners" will not work. Moreover, to know which areas to enter, a comprehensive forecast of ICT is necessary. Unfortunately, this is an activity that has received scarce attention (if

at all); even the big industry players do not engage in it. Thus, their business decisions are not guided by a strategic technology plan but rather by short-term possibilities.

What Academe Must Do

On the part of the University, the biggest problem is the inadequate number of Ph.D. scientists and engineers who independently undertake state-of-the-art research. (This is obvious from their relatively few publications in international refereed science and engineering journals.) A Ph.D. degree alone does not suffice in highly competitive research universities. What counts is the intellectual work done after the PhD dissertation: the creative scientific pursuits whose results measure up to internationally accepted standards of merit. As the country's only research university in science and engineering, the University of the Philippines must address this problem as a priority program.

In the short to mid-term, it is imperative that UP send out its promising Ph.D. faculty to do postdoctoral work abroad and encourage junior faculty members to do their Ph.D. studies locally and, if necessary, in foreign universities. This must be a deliberate, aggressive project carried out for five years. After that, the University should stop its faculty development program altogether. Its long-term program should be to hire only those with Ph.D.s and postdoctoral experience, as is the practice in credible research universities. Such faculty will be given the rank of Assistant Professor, with promotion directly linked to the level of intellectual productivity.

At present, the units of the University that do ICT-related work are the Electrical and Electronics Engineering, Computer Science, and Metallurgical Engineering departments of the College of Engineering, and the NIP (Condensed Matter Physics, Photonics and Instrumentation Physics Laboratories) of the College of Science. These two colleges also jointly run the Materials Science and Engineering Program. To encourage these units to increase their publications in ISI journals, their research budget and other operating expenses must be pegged to their

publications. There is no reason why their faculty members should not be publishing given the incentives provided by the University since President FRANCISCO NEMENZO assumed office in 1999.

In the long run, the University should be ready to spin off units and laboratories and form specialized institutes consisting of highly research-oriented faculty who publish regularly in credible publications and graduate substantial numbers of students at the graduate and undergraduate levels. Examples of specialized areas are Nanotechnology, Microelectronics, Photonics, Instrumentation and Control, Wireless Communications, Software Design, and Materials Science—the fundamental areas that will prepare the University for future developments.

What Industry Must Do

The electronics industry, which is a major component of the ICT industry, is the country's biggest exporter. In 1999, electronics products amounted to $25.35 billion, or 72 percent of total exports. From 1992 to 1999, electronics exports grew from 20 to 55 percent of the total, indeed a remarkable performance by any standard. The industry employs about 300,000 engineers and technical workers and attracted investments of more than P52 billion in 2000. Most of the firms are located in Export Processing Zones where they avail of various incentives provided by the Philippine government.

On the other hand, software exports are only a small fraction of that of electronics: $225 million in 1996, or one-fiftieth of electronics exports. Compare this amount with $253.9 billion, the value of the world software business in 1996. (The country's output was one-thousandth of that of the world's total). The reason for the Philippines' low contribution is that local IT firms are primarily subcontractors of big MNCs, especially those in the US.

In terms of the value chain, the local private sector—in hardware, software and IT services—sits at the lower rung of the ICT industry. The domestic ICT industry must therefore plan to move their businesses

to the high-value adding part of the chain or the country will be marginalized by the Peoples Republic of China in ICT manufacturing, which is getting most of the foreign investments. Another competitor in IT services and software is India, which at this stage is well ahead of the Philippines as evidenced by India's huge exports to the US market and their well-organized software industry. Our biggest problem in this area is competition from the two biggest countries (in terms of population); although they only opened up their economies recently, they are doing better than the Philippines in ICT. Notably, both China and India have a stronger S&T program than the Philippines (understandable because of their deeply entrenched scientific tradition), making the competition tougher for Filipino industry.

Assuming that academe produces well-trained engineers, scientists, programmers, software designers and technicians, industry must plan the transition from (1) assembly and packaging to design and testing in semiconductor manufacturing, (2) making accounting software to designing software for embedded systems, etc., and (3) from call centers, transcription services and backroom operations of financial institutions to engineering designs, IT consulting and enabled services. Already there are signs that we can achieve these transitions. In wireless services, for example, small start-ups have been able to conceptualize and implement services beyond traditional SMS. The EEE Department at UP produces graduates with excellent training in digital circuit design, while the NIP trains students in semiconductor physics and devices.

How do we implement these transitions? In some areas, like semiconductor manufacturing, we need to work with MNCs and convince them to give us time to prove our capability in the high-value adding sectors. As for designing ASICs and embedded systems, we can do this ourselves or in a joint venture with foreign investors. But IT consulting and IT enabled services are things we can well implement on our own. As early as1986, Dr. CELSO ROQUE of the NIP and DENR had suggested that the country establish Information Processing Zones along with Export Processing Zones. This is essentially what India did in the 1990s

and today, the whole city of Bangalore is one big information processing zone. IT problems are downloaded from the US (at the end of the working day) to India and uploaded back to the US (before offices open) the following day.

Another reason why India is doing exceedingly well in IT enabled services and software development is the way their industry is organized. Software firms and IT consulting companies formed the National Association of Software and Service Companies (NASSCOM), which markets the entire industry in foreign countries, particularly the US. NASSCOM also helps the Indian government formulate policies to make India globally competitive in IT by gathering data from industry members. Firms provide reliable data to NASSCOM and cooperate with the government because India adopted the policy of exempting IT firms from paying taxes until 2010. In response, IT firms have plowed profits into R&D and the expansion of their businesses. The net effect is the phenomenal rate of increase of IT exports at about 50 percent per annum.

In the public sector, the Software Technology Parks of India (STPI), which are under the Ministry of Information Technology, also promote the export of India's software. In addition, like our Export Processing Zone Authority (EPZA), the STPI has the power to grant incentives to exporters. However, unlike EPZA, it also provides technical support to member firms and offers incubation facilities to start-ups, making the agency a real technology park. Finally, the STPI operates the satellite telecommunication facility, which is very crucial to India's software and IT consulting services. All these activities and responsibilities make STPI unique, quite unlike anything we have in the Philippines.

What Industry and Academe Must Do Together

To sustain its migration to the high-value adding end of the ICT business, industry must work closely with academe because the technology-based businesses will surely come from discoveries in the laboratories. Academe brings to the table the scientific and technical know-how and, more importantly, an informed sense of where the

technology is heading. Business brings to the table an awareness of the market, business sense and capital. The best arrangement would be for industry and academe to work on common ICT concerns through a Science and Technology Park. As discussed in the Introduction, in the context of the University of the Philippines, the S&T Park may also solve the migration of UP faculty to the private sector.

In the short to mid-term, business and academe must explore various cooperation modes. They will not be starting from scratch given previous experiences of cooperation (Manufacturing Linkage Program, Virtual Center for Technological Innovation). But to maximize the collaboration and provide a solid learning experience, the joint projects would have to involve solving concrete technical problems needed by business. Without something concrete to build on, the collaboration will die out. Moreover, in working out the solutions, the strong points of each of sector will come into play. All these can be done in the Technology Business Incubator being run by the Ayala Foundation. The firms could also enter into an agreement with the ICT-related academic units of UP for specific technical consulting. Now that the University has defined its IPR policy, issues related to IPR can be guided accordingly.

The collaborations that bear fruit may lead to other undertakings, perhaps even a joint venture between the University and the private sector that utilizes the technology developed by their partnership. It would also be ideal if some faculty members were to start their own high technology. business based on their researches. It is also hoped that the University's S&T Park will attract part of the MNCs R&D operations. The idea is for the University's S&T Park to host firms of all sizes in different areas of ICT, with technology development being the common factor—a "cathedral and bazaar" model that would suit a variety of partnerships.

Biotechnology

Of the three technologies in the MINDLINK series, biotechnology is the country's strongest. We have many practitioners in classical or traditional biotechnology (agriculture, veterinary and animal science,

food processing, medicine). Historically, too, the country has been strong in the biological sciences and agriculture as exemplified by the fact that the first ever ISI journal in the country was the Philippine Journal of Biology; today, the only ISI journal in the country is the Philippine Agriculturist. Yet in spite of this relative strength, very few of the locally developed technologies have been utilized at the commercial level. These are the plant tissue culture of orchids and bananas, while other technologies such as biofertilizers, industrial enzymes, amino acid production and vaccine production remain at the non-commercial level of utilization.

If our major problem in traditional biotechnology is how to commercialize homegrown technologies, in modern biotechnology we are still primarily at the science stage. Although we have had some research and academic programs in molecular biotechnology in the past ten years or so, our efforts have not been able to result in any significant contribution to the pool of knowledge, much less a contribution to our economy. Cuba, on the other hand, which only started doing biotechnology in the 1980s, earns hundreds of millions of dollars from recombinant DNA products. The Philippines is not that far behind Cuba and other latecomers. But before we discuss how to catch up, let us first convince ourselves why we need to catch up.

Biotechnology is a big business and a major component of any country's economy; it deals with agriculture, medicine, food processing and environmental remediation. To have a sense of its relative importance in the economy, a few statistics is in order. ERNST AND YOUNG (cited in Mendoza and Dalmacio paper presented in NAST meeting) sum up the contribution of biotechnology to the US economy in 1999 as follows: 437,000 jobs and $47 billion in revenues ($11 billion of which were plowed back into R&D and $10 billion as tax revenues). Of the 1,500 US biotechnology companies in the same year, the top 350 had a total capitalization of $350 billion.

In terms of income derived by an academic institution from intellectual property, the University of California System in 1999 earned

about $81 million on patents. The top five university earners, all in biotechnology, accounted for 68 percent of the total income. Of the top 25 patent earners in the UC System, 18 were in biotechnology. Clearly, therefore, biotechnology has high revenue potential.

Finally, many countries today are seriously taking the forecast that the 21st century will be a biology century. In their discussion of the major biotechnology activities of Japan, China, Singapore and India, Mendoza and Dalmacio described how these countries are establishing research centers and allocating big money for research, giving incentives to business and making hard and controversial decisions on such issues as GMOs. Since it is not possible for all these countries to be wrong, we must do as they do or be left behind again, ironically in an area where we were strong a few decades ago.

What Academe Must Do

Let us begin with the long-term perspective on biotechnology. Academe must establish the expertise in the following advanced areas identified by former DOST Secretary WILLIAM PADOLINA: genomics, transcriptomics, proteomics, metabolomics, structural biology and bioinformatics. These areas must be started as early as possible because it will take a minimum of 15 years to achieve a modicum level of success even with full support. Not one of these areas should be ignored because they are the key areas of modern biotechnology.

Developing programs in these areas requires the following: (1) increasing enrollment in the undergraduate molecular biology program; (2) encouragement of and support for the brilliant undergraduates to pursue graduate studies in these advanced fields; (3) the active search for faculty with postdoctoral experience in top-rate institutions abroad; (4) formation of links with institutions abroad that have active research programs; (5) establishment of properly equipped research centers/ institutes once there is a sufficient number of practitioners; and (6) provision of research funds. These must-do activities require a solid

commitment from the University with budgetary and appropriate policy support from the national leadership.

At the other end of the planning time frame, the short to midterm programs deal more with classical biotechnology. Since academic units in these areas already have ample and well-established practitioners, the main task is simply to maintaining their interest, increase their productivity and train more students. Providing the needed funds is easier to justify because their outputs have direct application to local industry. They must also be encouraged to forge closer ties with the private sector.

Academe must also work faster on their recombinant DNA researches of the past ten years. The work of the Institute of Plant Breeding and the Institute of Biotechnology of UP Los Baños require more support and their faculty, more research time so that their products can be commercialized.

Academe must also take the lead in responding to the issues raised against biotechnology such as the Bt corn controversy. Although industry people are equally qualified to answer these issues, they suffer from a credibility problem because of the conflict of interest. Biotechnology practitioners from academic institutions, on the other hand, especially those who have not received funding from industry, are more credible to the general public. Besides, academics generally have a broader perspective on the controversies, which enable them to differentiate among the political, economic, scientific, IPR, health and safety dimensions of the issues related to the use of transgenics. Once the public is well informed, policy makers can decide on the issues on the basis of science and what is good for the country and less because of pressure politics.

What Industry Must Do

It is difficult to gauge industry's performance because, as MENDOZA AND DALMACIO point out, data on the number of firms, products and

revenues are lacking (unlike the situation in ICT). The first thing industry must do, then, is to convince firms to provide data to the relevant organization (for example, BAPI or DOST) so that industry's performance can be periodically assessed and benchmarked against those in other countries. The data will also enable concerned officials to make fact-based decisions on how to move the industry forward. At present, decisions are based on limited information.

What is evident, though, is that local agribusiness and food processing firms have not made extensive use of locally developed biotechnology products, except for tissue culture of banana and orchids. The question is why. If the reason is lack of awareness, it is basically the fault of the technology developer. The solution would then be for the R&D group to make sure that firms know their new products. Conversely, firms should try to keep tabs of the progress made in academic R&D units.

But if the firms are aware of the new technologies and think that these have potential but are not sure of their scalability to large production runs, then the solution is to do a detailed business plan on the feasibility of a medium-scale prototype production. Since local firms are generally averse to risk-taking, government can help provide part of the capital for the prototype. But in the long run, aversion to risk is a symptom of lack of confidence in local science and engineering capability. Ultimately, these firms would have to improve their technical staff, establish R&D units and instill the culture of research and doing things right in the organization. Only then can local firms view technology as a resource to be managed and risk as an inevitable element of a well thought-out project.

In the long term, if academe successfully establishes world-class programs in modern biotechnology and local industry makes the cultural transformation just described, we will see local firms move toward transgenics, biotransformation, cell and gene therapy and even genomic services. Commercial modern biotechnology does have a future in the Philippines but academe and industry must do their part.

What Academe and Industry Must Do Together

The prototype facility needed to test the scalability of new technologies is best put up in Biotechnology Parks of universities for several reasons. First, it is convenient for the scientist who discovered the technology to work on the scaled-up prototype while teaching in the university; the synergy between discovering and applying science is maintained. Second, since the Park is a university undertaking, locators would have access to university facilities (library, analytical service laboratories, computing facilities, etc.) and technical experts. Third, the Park can grant incentives to locators, such as tax deductions of R&D expenditures and tax-free importation of equipment. Fourth, the Park can offer a one-stop service shop where all the paperwork required by government agencies like the city government, the Bureau of Internal Revenue, Board of Investments, Bureau of Customs, Department of Finance, DOST and DENR, can be taken care of. Fifth, the Park can facilitate the financing aspect through venture capital groups that are also located in the Park.

Unfortunately, the present Biotechnology Park of the University (in Los Baños) offers only the first service. Access of locators to university facilities and the one-stop service unit are purely the University's decision, while the grant of incentives requires official recognition of the Park by PEZA. The most problematical is the venture capital presence in the Park. This far the country's experience in venture capital has been negligible and local financial institutions generally do not have the technical expertise to evaluate advanced technology ventures. The provision of this service would take the longest to establish.

Aside from hosting traditional biotech companies that will scale up the production of new technologies, the Park is also the natural host for start-up companies dealing with modern biotechnology. Public concern for the safe handling of transgenics and genetically modified microorganisms can be allayed by management's assurance that facilities are in place and mitigation measures exist within the Park. Considering

that the University is still in the early stage of developing expertise in modern biotechnology, it will take some time before the Biotechnology Park hosts start-ups doing recombinant DNA technology.

Education Technology

The emerging paradigm shift in education discussed in the Introduction is a consequence of the developments in ICT. Since our contribution to ICT is primarily in the low-value adding segments of the business, and our public education sector, even at the tertiary level, is plagued by the problem of unqualified faculty, one cannot expect our contribution to education technology to rate significantly. We neither have the content nor the tools to be a major player at this time.

There are many issues regarding modern education technologies. One questions the role of computers and the Internet as effective learning tools or as sources of distraction (too much information, sometimes haphazardly organized), and their effect on study habits (cut-and-paste reports instead of writing own papers). At the pre-school level, issues such as the detrimental effect of early computer use on the child's social development have also been raised.

But the most important issue is the widening gap between the rich and poor because of this technology. This is rather ironic because education is supposed to be a way out of poverty. Up until the 1960's, this was true because the Philippine public school system was good and teachers were highly regarded. Public school graduates then did not have difficulty entering the University of the Philippines, a means of moving up the economic and social ladder.

Martial law changed all these. Education was neglected, the quality of public school education declined, teachers lost their standing in the community, resulting in public school graduates' poor performance in admission exams in the University. Against this backdrop new education technologies have come in. Intended to enhance teaching and learning, the technologies are expensive and available only in exclusive schools

attended by the upper middle class. The result is not hard to guess: the gaps—economic, digital, educational—between the poor and the rich are growing.

What Academe Must Do

The first recommendation has to do with the content of education and not the technology itself. Tertiary institutions that offer the best on-line education programs also have the best in-house residential programs for the simple reason that these institutions already possess excellent content, which they just put on the web by means of technology. Thus we should strengthen first the curricular offerings of various units by moving in the direction of an all PhD faculty with post-doctoral experience. This is the norm in credible tertiary institutions even in the Southeast Asian region.

By 2003, the University's General Education and Multimedia Center (GEMC) should be functional so that the excellent course offerings of the University can be put on-line. The process could start from lecture notes and other materials of the professor, which are placed on the web with the help of technical staff from the GEMC while he/she teaches the course. Done regularly and jointly with the upgrading of the faculty, the University can expect to have more and more courses on-line. Eventually it will get to the point where most University courses can be delivered in class and on the web. The web-based course will make use of the multimedia technologies to make the subject interesting and easier to understand. Students enrolled in the distance mode can then access the materials for the course anytime, anywhere and consult with the professor or join a discussion group on the course. When this happens, there will be no more need for a separate Open University.

The above recommendation is also very crucial because of the low quality of tertiary education in the country. The University must take the lead in upgrading the tertiary sector by becoming the primary graduate institution in the country. Although it is desirable to educate the faculty of the other institutions on campus, in some cases a combination of

distance (through the web) and on-campus education can be implemented.

The web-based courses of the University can also be used by other universities and colleges in the country for their undergraduate programs, with their faculty members playing the role of coaches and teacher guides. Today, the top universities abroad offer their degree programs via the web. Because of the cost, these programs are still not affordable to many Filipinos. But the cost of these programs will decrease over time. At a certain point, local students may find it more worthwhile to enroll in Harvard, for example, via the web than to enroll in UP or some or other tertiary institution in the country. For this not to seriously affect the enrollment (both on-campus and distance mode) of the University, we must be comparable to the top-rate schools in the world. And the surest way to become so is to upgrade the faculty by adopting the hiring, promotion and tenure policies of these excellent universities.

As the content of education is being improved, the University can also work on the technology aspect. There is not much we can do with the hardware component because it is the direct concern of industry. But the University can certainly compete in making learning modules, software for support activities like registration, library, scheduling of examinations, database for students, faculty and staff, etc. Although these systems (mostly imported) are available in the market, they are not that difficult to make and it is cheaper and better for the country to develop its own systems. The computerized registration system in UP Diliman, for example, the first on-line registration in the country, was devised by computer science students and faculty without outside financial support.

What Industry Must Do

Most of the industry must-do activities suggested in the area of ICT apply as well to the field of education technology. However, there is one that must be given emphasis: the hardware component of education technology. All the equipment—video projectors, electronic white board,

teleconferencing equipment, computers, laser scanners, magnetic readers, science experiments for elementary and high school—used in education are imported. The country should decide whether it is more economical for us to continue this dependence or to start developing our capability in some of these areas. Considering the size of the education market in the country alone, it would be worthwhile for local firms to develop some of the equipment.

What Academe and Industry Must Do Together

The main issue that industry and academe must address together is the widening digital and education gap. Although education, especially basic education, is primarily a concern of the public sector, academe and industry must join forces to help and maybe even force the public sector to adopt certain reforms. The first is the reform of the Department of Education (DepEd). Surveys and opinion polls show that the public perceives the Department as one of the most corrupt in the bureaucracy. Although DepEd has the highest budget, funds are barely enough; the bulk is used for salaries of teachers and support staff. Books, desks, and classrooms are perennially under financed. Clearly education deserves a bigger budget than debt servicing but for its part, the Department must clean up the corruption in the procurement of supplies and books and even in the recruitment and staffing of schools. The savings from this clean-up can be used for a host of needs: new classrooms, desks, books, computers, learning modules in mathematics, science and language, science equipment and Internet access.

At the same time, the private sector, in particular ICT firms, must participate in the "Adopt a School Program". If the private sector cannot donate new computers, they can gather the old ones and donate them to schools along with the needed operating systems and application software. Now that there is a glut of bandwidth, supporters from industry can ask the ISP providers to connect the public schools at lower rates. Since the students are more adept in using the computer than their elders, the deficient mathematics and science education they receive can be

augmented by making them work with the learning software. Here the academe, especially those in the field of education, can help. Learning software must be developed for the Filipino child. The imported ones are not only costly but also inappropriate for Filipino children because of cultural and language barriers. If these interventions are not made, the widening education and digital gaps will evolve into even wider social and economic gaps.

The other recommendation is for both sectors to form ventures in the S&T Park to develop teaching modules, training programs, learning software, and systems for support services. Today, there are two firms (Lessons Plus and Integrative Learning International) located in the UP-Ayala Technopark. But more are needed because the education market in this country is large and will remain so because of the high population growth.

Venture Capital Formation: The Role of the Public Sector

Unlike the Second Wave industries like steel, petrochemicals and cement, which are large in scale and capital-intensive, the advanced technology industries are much smaller and are knowledge- rather than capital-intensive. These attributes are advantages a developing country can exploit in developing ICT, biotechnology and education technology. The drawback, however, of the advanced technology areas is that they still have to develop a market because the general public is not aware of the applications and relevance to their lives of the new products and services that can come out of these technology areas. The same is true for the technopreneurs in these areas. Although they may have a general idea of the lifestyles and possible needs of society in the future, they are as clueless as the general public regarding specific products and services that will satisfy future needs and lifestyles.

This is the rationale for venture capital. It provides a way of funding risky, new ventures in the advanced technology areas. Although the capital requirement is generally not big, the venture capitalist makes sure that the business has a reasonable chance of

success by requiring proof of concept, a detailed business plan and an exit strategy. Venture capitalists also spread their portfolio of investments to guarantee total profitability.

Unfortunately, the Philippines is new to venture capital business. The financial institutions here do not know how to go about it primarily because of the lack of technical people to evaluate proposals. There are also very few technopreneurs yet in the country. We therefore have a chicken-and-egg problem. Should we wait to have the critical mass of technopreneurs before developing the venture capital fund or should we put up a venture capital fund first so that we will have the critical mass of technopreneurs?

In Silicon Valley, where there are many top-rate scientists and engineers and the financial market is well advanced (banks, insurance, stock market, futures market, bonds and mutual funds), the technopreneurs and venture capital fund probably developed hand-in-hand. Can we adopt the same strategy here? The answer seems to be no. In the Philippines these two will wait for each other to develop and the likely result is that neither will grow. Also, we no longer have the luxury of time; our neighbors are moving in the same areas of advanced technologies. Even though the entrepreneurial spirit seems to be vibrant in the country (note the presence of many small and medium enterprises in the country, although many of them may have been established because of the bleak job situation), the focus is not technology but commerce and trade.

Thus, establishing a venture capital fund first seems to be a step in the right direction. But before it is established, we must assess previous projects that were put up to help technology ventures. These are the DBP special window for S&T and the venture capital put up by former DOST Secretary CEFERINO FOLLOSCO. Apparently these undertakings were not able to achieve their goals because of lack of worthwhile technology projects and the funds were treated as ordinary loans and not as venture capital. We also must look at the experience of other countries. In Germany, for example, the government guarantees up to 60 percent refund of venture funds in modern biotechnology projects.

Consultation with such individuals as DIOSDADO BANATAO, the Filipino technopreneur and venture capitalist in Silicon Valley, are also in order. After all these assessments are made and once we have an idea of what the technology venture fund system should look like, then we turn to the problem of sourcing the fund. Ideally, it should all come from the private sector but realistically, the government would have to come in, at least partly, to lower the risk of the private sector.

Given the government's current budget deficit, there seems to be no source of funds for putting up the venture fund. Maybe the smart finance people can cook up another zero coupon financing. Better still, the government can run after the big-time tax delinquents with more vigor, and part of the revenue can be applied to the technology venture fund. Another way to raise venture funds is for the government to attract part of the eight to ten billion dollars of OFW remittances. This can be done by offering higher than market interest rates. One other option, of course, is to increase the sin taxes. Ironically, the larger problem might be to convince the government of the worthiness and need for venture capital.

Concluding Remarks

Immediately after the July 11, 1997 currency crisis, our leaders claimed that the Philippines would not be as badly affected as our neighbors like Korea and Malaysia. Confidently they predicted that the country would be the first to recover from the crisis. As basis, they cited the macroeconomic policies laid down by the government such as liberalization and deregulation, which will make the country attractive to foreign investors.

Today, it is clear that our leaders were wrong. Correct macroeconomic policies in a country that does not have wealth-generating capacity are not sufficient to achieve economic competitiveness. Consider also that the emergency measures adopted by some countries that recovered quickly from the crisis were not consistent with liberal economics dogma. Thus it is clear that it is

wealth-generating capacity of a country that is crucial to its recovery from currency, financial and economic crises. History supports this contention. Since the first ever financial crisis, the South Sea Bubble of 1720 in England, economies have been able to recover from currency and financial crises and reach new heights of wealth as long as their wealth-generating capacity remained intact and active.

This is the lesson we must bear in mind. Wealth-generating capacity is the basis of sustained economic growth and not macroeconomic policies per se. For a developing country that does not have this capacity, strict adherence to macroeconomic policies of liberalization and deregulation is like reciting a voodoo mantra to ward off the evils of globalization. The adherence simply does not work. Even the most advanced country, the United States, employs protectionist policies (sometimes in the guise of subsidies and other times in terms of outright tariffs) to defend its industries and agriculture from external competition. Why should we then be more Catholic than the Pope?

To develop our capacity to produce wealth, we must focus on the knowledge-intensive industries. Industries and universities need to work individually and together in applying knowledge to the production of better goods and services needed in the market. Of all the industry sectors today, ICT and biotechnology hold the most promise for generating new wealth. The new education technologies, on the other hand, will help our human resources become better educated, able to meet the challenges of the 21st century, including the demands of such technology areas as ICT, biotechnology and other advanced technologies.

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MindLink is part of our effort to develop closer ties with industry, a key item in our UP Modernization Plan. If I may state the objectives of this plan in two phrases, it is to catch up with the other universities in Asia and to place our country in a stronger competitive position in the new global order, especially in the field of Information Technology.

The *MindLink* gatherings brought together technology practitioners from the University and the private sector. In each of the three meetings, the academics presented their capabilities and research results, while the industry representatives discussed available products and services in the market (local and global) and the problems they encounter in their business.

The question we would like to address at this point is, what now? Given the present capabilities of both sectors, what should they be doing separately? At the same time, where should they collaborate so that jointly, they can help develop the country's technological capability and move activities toward the higher value chain of products and services?

Our country can only survive and prosper in the fiercely competitive world of the 21st century if we can build up this intellectual capital. We have to train scientists and engineers who can create new technologies so that the Philippines will not remain a nation of users and vendors of imported technologies. This entails a real cultural revolution, a shift from a culture of imitation to a culture of innovation.