REFLECTIONS ON OUR DIGITAL FUTURE

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INTRODUCTION

I believe that the future of Egypt, indeed of all the developing countries, will depend on a better appreciation of what can be done with the new Information and Communication Technologies (ICT), the mastery of these technologies and their proper deployment in a strategic fashion. This requires that the national infrastructure with its international links be in place. I am happy to note that Egypt has in the last few years been blessed with a Government that understands such issues and acts upon them. Providing free Internet access, and committed to increasing bandwidth, the Government has not spared any efforts in providing the broad national framework for institutions to respond to the challenge. Many have. The private sector responded. Mobile telephone and Internet subscribers exploded. However, the Arabic e-content lagged, and the systematic access to the knowledge and techniques necessary to respond to the new challenges of research and science needed organization and development.

Given the knowledge explosion, digital libraries seemed to be the strategic instruments of choice, to create knowledge hubs for access—in an organized fashion— to the enormous wealth of information provided on

the Internet, as well as becoming the nodes for virtual networks of centers of excellence.

The Bibliotheca Alexandrina, the new Library of Alexandria, was mandated from its birth to be an institution devoted to this role. One of its four explicit goals was to become a leading institution of the digital age, rising to the challenge of the digital divide. This we pursued with a clear strategy of building on a niche of comparative advantage of tools for representing Arabic Language in Digital Libraries and of generalized excellence in our mastery of the techniques of the digital future. I believe that we are well on our way to implement that mandate. In the course of the last few years, and increasingly since the Library opened its doors to the public in October 2002, I have had occasion to address, in public forums, questions of the digital future and to reflect upon different aspects of the promise and the challenge that the ICT revolution offers. This book is a sampling of these *Reflections on Our Digital Future*.

The chapters in this booklet represent speeches I gave over the past three years. While some are a full three years old—ancient by the standards set by the pace of change of ICT—they have stood up remarkably well. The key points identified and highlighted in the speeches remain

as relevant today as they were then. Perhaps more people are aware of the complexities of these issues as well as their importance today, which augurs well for the prospect of finding solutions.

The first of these chapters reflects on **The Digital Libraries of Tomorrow**. An impassioned plea delivered at CERN, the birthplace of the World Wide Web, on the occasion of the first World Summit on the Information Society (WSIS) it correctly made the case for digital libraries, and many of the issues it raises, from Intellectual Property Rights (IPR) to peer-reviewed journals, remain timely and even more compelling today.

The second chapter is devoted to the Bibliotheca Alexandrina (BA), which I have the honor of leading as its founding Director. Entitled **Born Digital: The Rebirth of the Bibliotheca Alexandrina**, it was the maiden speech I delivered at the Digital Library Federation (DLF) Meeting of October 2005 in Washington, DC. It spells out how the BA was able to achieve so much in so short a time with so little money and so few people. In less than three years, thanks to the guidance of Dr. Magdy Nagy, and the leadership of Dr. Noha Adly, we were able to assemble an excellent team of young specialists in a very

short time, and it is their work and their imagination that achieved that level of recognition.

The third chapter is an address entitled ***From Barrier to Bridge: The Promise of Machine-Based Translation***. It was a keynote speech that I gave on the occasion of a conference organized by the UN University, and hosted at the BA, dealing with machine-based translation through connecting into a hub and spoke system, where the hub would be a Universal Digital Networking Language (UNDL), and each spoke would be a different language. The BA is responsible for developing the Arabic spoke. However, I think that the reflections on how language can be both a barrier and a bridge, remain valid today.

The fourth chapter is more recent. It is based on the discussions on ICT within the Kyoto Science and Technology in Society (STS) Forum Conference in September 2005, where I had the honor to act as rapporteur for a very rich set of debates over four separate sessions. I have chosen to call that set of reflections ***Building the Loom***, a reference to a line of poetry I quote at the beginning of the essay.

The fifth chapter entitled ***Prometheus and the Internet: A Science Supercourse for the 21ˢᵗ Century***,

is co-authored with Professor Ron Laporte of Pittsburgh University, and it draws on two documents we co-authored together. The first was a detailed explanation of the intended Science Supercourse on the Internet, submitted as part of a joint funding application, while the second was an article for ***Science*** entitled *Globalization of Science Education*: *A Scientific Supercourse*. That essay refers how, Prometheus-like, we intend to empower science teachers all over the world by providing PowerPoint presentations by experts to enable them to reach out to their students in the developing world, and spark their interest in new ways.

The sixth and final chapter, entitled from ***Knowledge to Wisdom***, was initially requested as a contribution to a project on imagining the future of Europe and ICT at the midpoint of the current century. I chose to focus on digital libraries again, with an emphasis on the need to organize data into information and interpret such information to create knowledge. Libraries can achieve that, but it is the people who apply this knowledge that must achieve the wisdom necessary to guide humanity's increasingly complex affairs.

This little collection is just a sampler of the many issues we face and a brief sketch of a few of the initiatives that our institution, the BA, is engaged with. It is no more than marking a milestone on the long journey we have embarked upon. The journey towards the promised land:

> *Where the mind is without fear and the head is held high;*
>
> *Where knowledge is free;*
>
> *Where the world has not been broken into fragments by narrow domestic walls;*
>
> *Where words come from the depth of truth;*
>
> *Where tireless striving stretches its arms towards perfection;*
>
> *Where the clear stream of reason has not lost its way into the desert sand of dead habit;*
>
> *Where the mind is led … into ever-widening thought and action—*
>
> *Into that heaven of freedom … let my country awake.* *

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* Taken from the Gitanjali or "song offerings" by Rabindranath Tagore (1861–1941), Nobel Prize winner for Literature 1913. First published in 1913, this work is in the public domain according to the Berne convention since 1 January 1992.

Chapter 1

THE DIGITAL LIBRARIES OF TOMORROW

Libraries are a fundamental part of the cultural landscape of any country. They preserve the achievements of the past and provide access to that common heritage of humanity. They are fundamental components of the education and training system, and increasingly an important instrument for spreading the values of rationality, tolerance and the scientific outlook. Many libraries have important public outreach functions. However, they are also an essential part of the scientific research and development efforts that drive contemporary economic growth.

Less developed countries face problems of access to recent research—mostly in journals—and to reference material—mostly in libraries—and to databases (some of which are proprietary), all of which severely constrains their aspiring scientists or practicing researchers. The costs were too high for their national budgets, and frequently lack of foreign currency further limited their ability to purchase the needed materials, even for central institutions such as national or university libraries. This

issue has been rapidly exacerbated in the last decade by the rapidly multiplying amounts of information, journals and publications. However, libraries are currently undergoing a major transformation in the wake of the digital revolution. Indeed, the digital revolution and the enormous advances in ICT have opened up opportunities for remedying this as never before.

The current approach to have books and other published materials collected in a useable fashion in fixed locations, where interested persons can have access to the materials has long suffered from several constraints:

- The huge costs involved in compiling the materials, cataloging and maintaining them;
- The limited choice available in any one location;
- The difficulty of accessing the material in the truly large collections (e.g. Library of Congress, BNF, the British Library, etc.) where the person who manages to get there physically and requests the book, has to wait as long as one hour, sometimes only to be told that another reader is using it.

These constraints of space and time are suddenly falling away in the wake of the Information and

Communications Technology (ICT) revolution and the widespread application of new digital technology for the production and dissemination of the products of the human mind: text, data, music, image, voice … all are now unified in bits and bytes spelled in the language of ones and zeros.

The ICT breakthroughs, especially in terms of the connectivity that emanates from the Internet and the ease of use of web-based interfaces, has revolutionized the practice of science. Material is instantaneously available to researchers everywhere at all times by posting on the web. Downloading is easy, and the work is commented on by many all over the world almost instantaneously.

Within this context, many questions arose for the idea of the library and for the legal framework within which the utilization of the material takes place. The Intellectual Property Rights (IPR) regimes that we have come to know and use increasingly seemed under challenge as the libraries started moving towards hybrid systems where they continued the traditional functions of the lending or reference library of printed materials as well as the new functions of providers of on-line digital material.

The advantages of digital libraries, based on the new technologies, are manifest:

• Immediate and easy access to materials on-line 24 hours a day, 7 days a week (24/7);
• No need to physically be located at the location of the digital materials;
• Copies of the material available in any library can be made available to other libraries at almost no cost, and with the same quality as the original material;
• Searching for information is infinitely easier in the digital format;
• Keeping material up-to-date is no longer an issue especially for locations previously considered remote from the centers of publication and dissemination of knowledge;
• Thanks to the efforts led by the Carnegie-Mellon Foundation the back issues of scientific journals are presently being made available for free to the poor developing countries, a major gift, not sufficiently appreciated; and
• We now have enormous academic resources coming on-line, as has been introduced by Massachusetts Institute of Technology (MIT) posting on-line the majority of its course materials.

Several problems are emerging:

- Problems of physical obsolescence of the material;
- Problems of technical obsolescence of the material;
- Problems of the establishment of common standards for the digitization, filing, archiving, encoding and publishing, dissemination and maintenance of the material so that it can be easily accessed on a common basis; and
- The issue of IPR in the digital age.

The first three of these problems are being handled by a number of major libraries and archives that have a direct interest in establishing a proper system of managing digital resources that are growing much faster than anything we have experienced in human history. Already the amount of material produced on electronic form exceeds all that has been produced in written paper form and the volume is growing exponentially by as much as 10% per year or more. Libraries in developing countries will probably have to follow suit and adhere to the common standard, and it is possible that some institutions—such as the newly-founded Library of Alexandria—may join the leading institutions in developing that common standard.*

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*Since this speech that was delivered in 2003, the Bibliotheca Alexandrina joined the Digital Library Federation as a strategic partner and is officially a member as of 1 June 2005.

A more complex issue is the management of IPR in the digital age. That was the topic of a major study entitled "the Digital Dilemma" issued by the US National Research Council in 2000, which carefully framed the issues but did not come out with firm recommendations on the most troubling of these issues. Specifically, the choice today is between those who would try to use the new technologies to maintain the system of "copyright" which has evolved during the long era of the print medium, and those who believe that the new digital materials require a different approach that is suited to the possibilities of the new technology. Copyright was a concept evolved in a time where the making of copies was the mechanism of reproduction and was tied to the labor and quality loss of producing additional copies. Today's digital technology is such that it effortlessly produces as many copies of identical quality effortlessly. Furthermore, these copies can be accessed from anywhere in the world where the Internet reaches. Thus new approaches, that would protect the rights of the innovators while allowing the convenience and simplicity of access to all, should be developed rather than trying to harness the new technologies (such as water-marking and other techniques) to protect the business model of "copyright" that evolved in a past era.

New technologies require new business models. The achievements of Henry Ford, Bill Gates and Michael Dell are examples of how the business model was suited to the technological innovation/change and thus worked well. In their cases the adaptation of the business model to the new technology (the assembly line, the Operating System of the PC and the use of web-based sales to cut out the distributor) is what allowed them to outdistance their rivals.

In the domain of research and publishing the digital revolution is so profound that it challenges the very concept of the organization of knowledge. Today, the density of hyperlinks in the material within a coherent domain of knowledge is far more important than the sheer size of the material. The presence of powerful search engines like Google makes the research enterprise different. The question becomes that if your material does not exist in this particular organized domain it is as if you did not exist at all! This exclusionary aspect will become more serious as the size of these domains become larger and the users far more numerous.

The very presence of a digital archive for the World Wide Web (Brewster Kahle's Internet Archive in California) is already making the issue of available digital

material moot. The duplication of this material in several centers, including the Library of Alexandria in Egypt (the Bibliotheca Alexandrina or BA), will ensure its availability against physical or political disasters that could destroy that record.

The willingness of some distinguished institutions (e.g. MIT) to think of posting their course material on-line, or of creating communities of practice that would produce an enormous body of material to be accessible to researchers and teachers everywhere in the world (e.g. the health epidemiology course materials initiative and the future BA Science Supercourse) is creating enormous new opportunities for the researchers of the whole world, especially those in the developing world who until now have been enormously disadvantaged compared with their colleagues in the industrialized countries.

Today when we stand at the threshold of the new ICT revolution and can barely see the contours of the new organization of knowledge, we must be willing to re-invent ourselves and to think of radical change, not just incremental change.

Some well-established concepts have to be reviewed in the light of the new technologies:

- Publication
- Peer review
- Copyright
- Fair-use
- Inter-library loans

All of these are central to the practice of science and to the spread of the scientific enterprise throughout the world. It is therefore pertinent to review each of them in a little more detail.

Publication

The ICT revolution has blurred the distinctions between private and public printing/ publishing/ distribution. Is material posted on a personal website published? Anybody can post anything on the web, and frequently most people do.

What are the impacts of having material in both formats (digital and print) simultaneously? After all, the movies are now releasing films in traditional theaters/ screens, showing them on TV and selling video and DVD formats of the same film. The studios have simply

changed their business model in light of the changing technology.

Print-on-Demand, already available in its preliminary forms, may well be the way of the future rather than, or in addition to, the e-book. Whatever it will be, I am convinced that the traditional way of publishing and selling books will go the way of the dodo! Our interest in this panel should be that the new models for publication are carried out in such a way as to ensure maximum access to all information everywhere.

Peer Review

Is there a responsibility in the community of scientists to enforce some sort of minimum standard in electronic posting (the electronic equivalent of the peer-reviewed scholarly journals)? How would this be done?

If, on the other hand, the community of practicing scientists does not address that issue, what are the risks inherent in getting creationism alongside evolution and astrology alongside astronomy?

Is there a responsibility for the community of science to make public the distinction between science and

quackery? If so, how in an environment where anyone, literally anyone, can set-up a website with a more or less scientific name.

The scholarly journals are in a financial crisis. The specialist journals cannot be issued conventionally without enormous cost, putting their subscription rates beyond the reach of all but a few libraries, corporations and individuals. The narrowing subscriber base further pushes up the unit price. This cannot go on, at a time when precisely the new ICT revolution should be allowing plentiful avenues to disseminate specialized research to relatively small and far-flung communities of scholars and researchers.

Peer-review practices are among the frequently cited obstacles to allowing these kinds of digital journals to prosper. But surely it is possible to allow the peer review process to occur on certain postings on certain gateways and also use some other means of evaluation for the material that may be produced by communities of practice, a needed variation if we are to allow for large volume reservoirs of knowledge to be made available as it comes on-line.

Copyright and IPR

As much as possible of the scientific literature should be put in digital form on the web for access from remote areas. New approaches should be sought to replacing copyright with more suitable ways of protecting IPR and rewarding innovators while supporting the public interest in having broad access to knowledge as rapidly as possible.

I believe that many of the presently stated copyright fears are largely unfounded. Evidence shows that sales of books posted on the web increase rather than decrease. That is the experience of the National Academy of Sciences (NAS) with its reports. Last century the same fears that broadcasting songs on radio would result in people not paying for the records proved groundless. (The Napster case is primarily a business model issue, and has been overtaken by P2P technologies and Apple's i-store.)

Fair Use

The doctrine of fair use is under challenge. Between those who see it as a fundamental right once something is made public (published in the conventional sense) and those who see fair use as an exception to an absolute monopoly granted to the author/publisher of the material.

I personally stand on the more liberal definition, although many jurists disagree with any such "rights" approach to the fair use issue. Those who agree with this view base it on the concept that the copyright is granted as part of a dual objective: rewarding the innovator and ensuring public access to the innovation.

However, extensive access to the results of scientific research can and should be used widely—short of plagiarism. Copies made for education, lectures and/or discussion and debate should be encouraged within all possible bounds to the extent that there is no commercial piracy of the work or substantial loss to the author/publisher.

The digital libraries of the future should be handling the gray literature electronically. They should be willing to maintain gateways for the sharing of teaching materials. Such electronic gateways, managed by some libraries, should be used to organize the sharing of information digitally between teachers and researchers through a model based on a community of practice sharing and improving the material being made available for all in the gateway.

Inter-Library Loans

Long accepted as a means for libraries to enrich the material they can offer their readers, it is being seen as fraught with dangers when the material is electronic. Yet this should not be so. Inter-library loans should be encouraged electronically. This would be more efficient and effective, and various models of handling the excess copying fears can be studied, from using established conventions to self-limiting or time-bound software can be explored.

Recommendations

The times we live in suggest some important recommendations:

1. The efforts to provide digital copies of back issues of the scientific journals should be intensified and the full range of that material posted for free and universal access.
2. The journals that are still in publishing should be encouraged to allow the posting of selected articles concurrently with the paper publication and reduce the time between the appearance of the latest issue of the journal and its posting in electronic form, and bring it down to say six months.

3. A major international effort should be launched to ensure that a digital format basic science library is made available to libraries in the developing countries.

4. As much as possible of the scientific literature be put in digital form on the web for access from remote areas. New approaches to replacing copyright with more suitable ways of protecting IPR and rewarding innovators while supporting the public interest in having broad access to knowledge as rapidly as possible.

5. Inter-library loans should be encouraged electronically. This would be more efficient and effective, and various models of handling the excess copying fears can be studied, from applying established conventions to self-limiting or time-bound software can be explored.

6. Major hubs in the developing world can be organized whereby they share the management of large amounts of digital information with advanced research institutions in the industrialized world. The backing up of material in this fashion is eminently sensible as well as facilitating the access to some aspects of the material (video, image) that requires large bandwidth not necessarily available everywhere.

7. A significant reduction in the cost of connectivity must be pursued for institutions and individuals, and especially the cost of high bandwidth connectivity for leading institutional hubs in the developing world.

8. Electronic gateways managed by some libraries should be used to organize the sharing of information digitally between teachers and researchers through a model based on a community of practice sharing and improving the material being made available for all in the gateway.

Envoi

The new century is one that is full of promises that we can barely imagine. The ICT revolution is opening doors that were sealed to old technologies. It is important that those concerned with the less privileged in the world act now to ensure that the benefits of the new technologies allow knowledge to flow easily to all of humanity, not just the privileged citizens of the industrialized countries. We will be re-paid many times over by the flow of innovation and knowledge that will be generated by the 80% of people residing in these poorer countries, and whose talents and abilities will be allowed to flourish by the new digital libraries of tomorrow.

Chapter 2

BORN DIGITAL: THE REBIRTH OF THE BIBLIOTHECA ALEXANDRINA

1. Introducing the Bibliotheca Alexandrina

The Bibliotheca Alexandrina (BA), the new Library of Alexandria, was intended to capture the spirit of the original Ancient Library of Alexandria, the ancient world's most prestigious center of learning. That spirit which promoted rationality, encompassed universal knowledge and created a real dialogue between cultures, is badly needed in today's world. Some 1600 years after its final destruction, the Library was revived again, almost exactly on the same spot, on the shores of the Mediterranean, a stone's throw from where Pharos, the ancient Lighthouse, one of the seven marvels of the ancient world, once stood. Occupying land on which Alexander and Ptolemy once walked; where Caesar, Cleopatra and Anthony played out the destinies of the world, and which produced an explosion in scientific knowledge that still awes us to this day. The Bibliotheca Alexandrina, to use the ancient Latin name, lives again. The new Library of Alexandria was inaugurated in October 2002.

Despite its youth—it has barely celebrated its third anniversary—the BA is a large and multi-faceted complex which encompasses:

- A library that can hold millions of books;
- A center for the Internet and its archive;
- Six specialized libraries for (i) audio-visual materials, (ii) the blind and visually impaired, (iii) children, (iv) the young, (v) microforms, and (vi) rare books and special collections;
- Three museums for (i) Antiquities, (ii) Manuscript, and (iii) the History of Science;
- A Planetarium;
- An ALEXploratorium for children's exposure to science;
- Three permanent exhibitions;
- Six art galleries for temporary exhibitions;
- A Conference Center for thousands of persons;
- Seven research institutes covering (i) manuscript, (ii) documentation of heritage, (iii) calligraphy and writing, (iv) information sciences, (v) Mediterranean and Alexandrian Studies, (vi) arts, and (vii) scientific research; and
- A discussion forum.

In addition, the BA hosts a number of institutions, including the Anna Lindh Foundation for the Dialogue between Cultures, the first Euro–Med Institution established outside Europe, and most recently a new Institute for Peace Studies, as well as the HCM Medical Research Project, the Arab Society for the Ethics of Science and Technology, the Jean-Rene Dupuy Center for International Law, the Academia Bibliotheca Alexandrinae, the Arab Regional Office of the Academy of Science of the Developing World (TWAS), and the regional offices of other networks.

These institutions have about 1,300 staff members, remarkably young (27–28 years old on average) and gender-balanced (54% female excluding security and custodial staff). They have organized and welcomed at the BA, some 500 events and close to one million visitors in the past 12 months. Their collective work is beginning to be recognized nationally and internationally.

The BA's mission is easy to state: "*To be a center of excellence for the production and dissemination of knowledge and for the dialogue between peoples and cultures*". We even sharpened our implementation focus into four clear objectives, namely, to be:

- The world's window on Egypt;
- Egypt's window on the world;
- A leading institution in the digital age; and
- A space of freedom for vibrant intellectual discussion and the dialogue between peoples and cultures.

2. THE BASICS

2.1 Basic Services

In the Digital realm, the BA provides all the basic services for a truly hybrid library, with OPAC (Online Public Access Catalog) and e-resources, and the proper management of the institutions from security to an oracle-based Enterprise Resources Management System that covers all aspects of our transactions and our records, we have a large and ambitious program of Digital work that separates us from most libraries and most other cultural institutions, at least in our part of the world.

2.2 Basic Infrastructure

Although still a very young institution, the Bibliotheca Alexandrina can already point to a substantial record of achievements. The Information and Communication Technologies (ICT) infrastructure is arguably the best in Egypt: Fiber Optic backbone and Gigabit Ethernet technology throughout our buildings with 155 Mbps

Internet connectivity; with over 330 public workstations and 770 for the staff, with over 48 servers. Most of the standard functions have been computerized: Library Information System integrated digital library services, intranet, Enterprise Resource Planning and access control and ticketing systems.

An achievement which occurred in January 2005 was the Bibliotheca Alexandrina's successful upgrade of the Internet connection bandwidth from 10 Mbps to 155 Mbps (STM1) in cooperation with Telecom Egypt and generous support from the Ministry of Communications and Information Technology (MCIT). The upgrade places the Bibliotheca Alexandrina among the first few organizations—and the only cultural institution—in Egypt with STM1 connection. The new bandwidth will allow for high-speed access to the wealth of information offered through the Bibliotheca Alexandrina serving both local and international communities. The upgrade will enhance the quality of services provided by the Bibliotheca Alexandrina to its physical and online visitors. Electronic resources and digitized collections will be accessed quickly and efficiently from within the Bibliotheca Alexandrina or through the Internet. Services such as web browsing, video conferencing and video streaming will become

significantly faster. In addition, it will better support the hosting of websites developed in-house.

2.3 Digital Laboratory

Within the International School for Information Science (ISIS), one of our specialized research centers, the Bibliotheca Alexandrina has built its own digital laboratory equipped with state-of-the-art technologies offering specialized digital services. The laboratory digitizes various media including slides in multi-formats, negatives, books, manuscripts, pictures, maps, audio and video, and is equipped with the necessary tools applied for indexing, archiving and management, thus automating the entire workflow.

The building of the laboratory was an essential starting point towards digitizing the Bibliotheca Alexandrina's collections and collections of other international libraries that are interested in pursuing the goal of "Universal Access to Human Knowledge". The Digital Laboratory is regularly visited by librarians, publishers and scholars worldwide.

During the past two-and-a-half years, the Bibliotheca Alexandrina made a mark in its leadership as a digital library in Egypt and beyond, building collections of both

traditional and digital materials. ISIS has worked on a number of projects such as the Nasser Digital Library, the Dar Al-Hilal Digitization project, *Description de l'Egypte*, and supported "My Book: Digital and Printed". ISIS undertook the digitizing, encoding, publishing, indexing and archiving of those projects.

Specifically, it was at the digital lab that ISIS staff has succeeded in refining the techniques of Arabic OCR and developed new tools allowing Image-on-Text in Arabic, to the highest standards in the world.

3. The Digital Library Federation

The Bibliotheca Alexandrina intends to become an active member among the leading digital institutions in the world. Towards that goal, the BA has embarked on a whole array of ambitious projects, in partnership with world class institutions. These range from hosting a mirror site for a significant part of the Internet Archive, participating in the Million Book Project, organizing the digital archive of the Gamal Abdel Nasser collection, presenting the first ever complete digital version of the *Description de l'Egypte*, building its own Institutional Repository to participating in advanced research such as the Arabic component of the UN-sponsored Universal

Digital Language computerized multi-language translation program and offering the most advanced 3D virtual imaging techniques in a virtual immersive environment for Science and Technology (S&T) applications. Thus, despite being barely three years in existence, the BA has already a substantial record of achievements.

These achievements did not go unnoticed. The prestigious Digital Library Federation (DLF) officially invited the BA to become a strategic partner of the group. The Digital Library Federation, founded in 1995, is a partnership organization of academic libraries and related organizations that are pioneering the use of electronic information technologies to extend their collections and services (see box, **DLF partners**). Through its strategic partners, the DLF provides leadership for libraries by identifying standards and "best practices" for digital collections and network access; coordinating research and development in the libraries' application of technology; and incubating projects and services that libraries need but cannot develop individually. The BA was deemed an excellent partner with its advanced infrastructure and experience in digitizing, processing and encoding books, especially in the Arabic language. It is to be noted that

DLF Partners

- Bibliotheca Alexandrina
- British Library
- California Digital Library
- Carnegie Mellon University
- Columbia University
- Cornell University
- Council on Library and Information Resources
- Dartmouth College
- Emory University
- Harvard University
- Indiana University
- Johns Hopkins University
- Library of Congress
- Massachusetts Institute of Technology
- National Archives and Records Administration
- New York Public Library
- New York University
- North Carolina State University
- Pennsylvania State University
- Princeton University
- Rice University
- Stanford University
- University of California, Berkley
- University of Chicago
- University of Illinois at Urbana–Champaign
- University of Michigan
- University of Minnesota
- University of Pennsylvania
- University of Southern California
- University of Tennessee
- University of Texas at Austin
- University of Virginia
- University of Washington
- Yale University

the BA is only the second partner from outside the USA after the British Library that joined the DLF in 2003.

Joining the DLF is an enormous vote of confidence by the premier institutions in the world. It is all the more gratifying that the BA was barely 30 months old when the invitation came in May 2005. The membership was officially announced on 1 June 2005.

Michael A. Keller, Stanford University Librarian and President of the DLF's Board of Trustees, states: "The Bibliotheca Alexandrina's digital library initiatives extend the leading edge of digital librarianship by the creation of new professionals, by experimentation, by portal development, and by the addition of content, which includes the digitization of 15,000 Arabic books annually, the development of the Digital Library of the History of Egypt, and the scanning of numerous image collections."

The DLF is a partnership organization of academic libraries and related organizations that are pioneering the application of electronic-information technologies to extend their collections and services.

New partners are selected based on demonstrable evidence that the institution:

- is able to contribute to DLF initiatives through staff time and creative leadership;
- shows evidence of substantial digital accomplishments and of digital library initiatives that are advanced or advancing beyond start up or project-based phases;
- has acknowledged regional, national, or international leader in some part of the digital library arena; and
- has some research and development capacity that is available to the Library and is devoted to digital library developments.

Being a DLF Strategic Partner would enable the Bibliotheca Alexandrina to participate in the worldwide effort of development and promotion of strategies and standards for creating and maintaining sustainable and scalable digital collections. As a partner, the benefits for the Bibliotheca Alexandrina will include the increased interaction with the premier institutions in the field, and the increased possibility of arranging for additional collaborative programs.

For the end-users, the DLF service will provide new and dynamic research tools providing easy integrated access to digital resources. This opens new possibilities for innovative research.

4. Our Credo

Access to all information, for all people, at all times. That is the simple credo of the BA, and to that end, we are committed to:

- honor the past,
- celebrate the present, and
- embrace the future.

Under each of these three headings, we are active in a range of activities, involving a significant number of initiatives undertaken in digital form. The following is a partial listing of the various initiatives that we are undertaking.

5. Honor the Past

The BA is the leading institution in Egypt and the Arab world in systematically applying digital technology to document and present information about our heritage. Most of this work is undertaken by several of our research institutes, especially, the Center for the Documentation of Cultural and Natural Heritage (CULTNAT), and the International School for Information Science (ISIS) who are playing major roles in this field, working hand-in-

hand with our other specialized centers, especially the Alexandria and Mediterranean Research Center (Alex–Med), the Center for Calligraphy and Writing; and the Manuscript Center. The Documentation of Cultural Heritage work is highlighted in our 2006 Annual Report, while ISIS work was highlighted in our 2005 Annual Report.

Specifically, all the BA institutions that are affiliated with the past, including the Manuscript Museum and the Antiquities Museum, are actively applying advanced digital technology to make their work more accessible to the public at large.

5.1 Center for the Documentation of Cultural and Natural Heritage

The award-winning work of the Center for the Documentation of Cultural and Natural Heritage (CULTNAT), from the world's first 9 screen interactive multi-layered digital "Cultural Panorama", the CULTURAMA, to Eternalegypt.org, a unique trilingual portal, to many other activities, has been providing a new multimedia means for people worldwide to learn more about Egypt. One of Alex-Med's main contributions will be the digital reconstruction of the Pharos Lighthouse

and a digital 3D model of the Qait Bey Fort. The Manuscript Center has been actively producing digital collections of manuscripts and partnering with European institutions to catalog and digitize their collections of Arabic manuscripts.

CULTNAT has contributed towards the documentation and dissemination of information related to heritage by:

- Implementing the national plan of action's documentation program, making use of the most up-to-date information technology in collaboration with the national and international specialized organizations;
- Increasing public awareness of cultural and natural heritages using all available media; and
- Capacity-building for professionals in the fields of conservation and documentation of cultural and natural heritages.

As the world is becoming more interconnected in the digital age, new technologies are becoming the important tools, CULTNAT is working simultaneously on various

programs for documenting Egypt's cultural and natural heritage:

- The archeological map of Egypt, providing easily accessible detailed information on the archaeological treasures of Egypt, building on layered databases including maps, images, text and video simulations;
- The architectural heritage of Egypt, providing similar treatment to the listed architectural monuments in Egypt's main cities;
- The natural heritage of Egypt, covering flora and fauna and the natural preserves of Egypt;
- Documenting Egyptian folklore by text, image and sound;
- The music heritage of Egypt;
- The photographic memory of Egypt, compiling all the valuable old photographs of Egypt, from postcards to private mementoes; and
- The scientific Islamic manuscripts heritage, presented in digital collections from the treasures of Egypt's national library and archives to the public.

In addition, CULTNAT has succeeded in developing impressive ways to communicate its research findings to the public. Online, the award-winning trilingual website (*www.eternalegypt.org*) presents a treasure trove for

anyone interested in Egypt and its history. The website allows visitors to view Egypt, both as it was thousands of years ago and as it is today. It offers guided tours that go through the story of the Pharaonic, Greco–Roman, Coptic and Islamic periods of Egypt's history. *www.eternalegypt.org* was recognized internationally by several awards from Stockholm, to Vancouver, to Geneva to Tunis. Equally impressive is the award-winning "Cultural Panorama" or "CULTURAMA", the world's first nine-screen interactive projection system.

New projects have been added to the overall mission of the Center:

- The indexing and organization and pilot digitization of the National Archives of Egypt (A four-year project which started July 2005).
- Documentation of the Coptic Heritage.
- Documentation of the Old Egyptian Press.
- Documentation of Heliopolis Company Documents.
- Documentation of Bank Misr and Talaat Harb Documents.
- Documentation of the Egyptian Presidential Palaces Contents.

- Documentation of the maps and documents of the Egyptian Geographic Society.

CULTNAT (*www.cultnat.org*) has a set of exhibitions and projections where all projects are on display for public visits, and publishes material in print and CD formats. Most notable of these is the series of archeological atlases providing exhaustive maps, locations and descriptions of the archeological sites in Egypt, governorate by governorate.

5.2 Alex–Med

Alex–Med is a latecomer to a consortium of European and Mediterranean partners within the framework of the Strabon Program. The Program objective is to build a web portal which aims to raise awareness and share the cultural heritage of the countries surrounding the Mediterranean basin. The Bibliotheca Alexandrina is already in Strabon through CULTNAT, and the contribution of Alex–Med will be to present the heritage of Alexandria on the Strabon portal through the following projects:

- The digital reconstruction of the Pharos Lighthouse;
- The Ottoman mosques of Alexandria; and
- A digital 3D model of the Qait Bey Fort.

The Alex–Med Strabon team received training on the structuring of data and adapting its format for the Internet. Another element of training will be that which the Heritage Unit will receive by Modèles et simulations pour l'Architecture, l'urbanisme et le Paysage (MAP) on the high-tech heritage recording methods such as photogrammetry and 3D scanning. This training will occur during the actual documentation and production of the 3D model for the Qait Bey Fort.

The vanished Pharos, one of the seven wonders of the Ancient World, has intrigued scholars, architects and scientists who only have descriptions of the marvel but no accurate image. Alex–Med has produced a 3D digital reconstruction of the Pharos lighthouse, using these descriptions and is also using digital techniques to reconstruct how it collapsed. With the computer technology available today, it is possible to reconstruct a virtual model of the lighthouse, visualize existing hypotheses/theories regarding its initial design, and investigate certain issues. Current work by Alex–Med includes a seismic study to analyze from a structural engineering point of view the collapse of the Pharos. Fascinating investigations are underway to address questions such as: How was the lighthouse lit? and how

do the underwater archeological pieces in the site relate to the lighthouse?

The output will be in the format of a CD and it will also be loaded on the Internet on the Strabon portal as well as being accessible through the BA website. Digital reconstructions are also under preparations for the Serapeum and the Kom el Dikka area in Alexandria.

5.3 Manuscript Center

Much, if not all, of the Manuscript Center's work has to do with the digitization, preservation and management of heritage. In addition to its own work, the Center also displays manuscripts from the collection in the Manuscript Museum. There, visitors can use touch screen technology and a sophisticated virtual browser that allows the user to turn the different pages of the original manuscript with a simple touch of the finger, and gives full control options such as magnifying and minimizing the image. Other digital presentations include the virtual visit to the Museum and the detailed text information on the available manuscripts in six languages.

The Digital Manuscript Archive Project aims to produce digital copies of the Bibliotheca Alexandrina's entire manuscript collection numbering more than

6,000 titles, as well as rare books, maps and important documents. So far, over 600 manuscripts have been digitized. These are available for consultation and study in the Manuscript Reading Room.

In addition the Center publishes in digital CD-ROM collections of seven manuscripts in each collection, some of the most valuable of the manuscripts. Every set comprises seven CDs, each with an unabridged rare manuscript. These collections of which two have been released and the third is about to be released, are made available to scholars at cost price.

The Manuscript Center has produced a digital manuscript collection of the codices held by Uppsala University Library, Sweden, within the framework of a bilateral cooperation agreement concluded between the two countries.

5.4 The Calligraphy and Writing Center

The Calligraphy and Writing Center has been active in working on the digital archiving of inscriptions and writings in Alexandria. The main aim of this Project is to build an integrated digital library for Alexandria's historical writings and inscriptions. This is part of a

larger project which aims to document the inscriptions on monuments from all over Egypt.

The Project will study all the Islamic monuments from the calligraphic and epigraphic point of view. It involves recording, transcribing and translating the unpublished inscriptions of approximately 500 monuments in Alexandria (Pharaonic, Greek and Islamic). Some of the inscriptions that the Project will fully record and archive are in serious danger from water-table damage.

It should be noted that the principal focus will be to record lapidary inscriptions. These are in stone, but many have been preserved on wood and stucco. The Project is larger than that; it will embrace historical and votive inscriptions, as well as religious and administrative inscriptions.

This Project, for the first time, will provide researchers with the number of inscriptions each monument contains and where each one of them is published. Those who would benefit from this include historians, art historians, epigraphers, philologists and those working on the conservation of monuments. Therefore, it will be a major step forward in documentation of monuments. Work is ongoing and as soon as a critical mass is organized it will

be published electronically in a special portal. The Library will also publish learned monographs on each subset of inscriptions, as appropriate.

5.5 The Antiquities Museum

The BA Antiquities Museum has equally taken great strides in this field, through the introduction of a Digital Guide in the Museum. Applying digital technology, the guide will produce the Bibliotheca Alexandrina with a reference on all 1,079 pieces in the Museum. CULTNAT is providing the technical support for that program.

5.6 The International School for Information Science

In the area of honoring the past, The International School for Information Science (ISIS) is primarily responsible for the *Digital Library of the Modern History of Egypt*, an ambitious long-term project which is also to dovetail with some of the work of CULTNAT and Alex–Med.

Covering the history of Egypt for the past 200 years or so, the History of Modern Egypt has been identified by two major projects as "bookends" that mark the anchors at the beginning and the end of the period. The first is *Description de l'Egypte*, and the second is the

Gamal Abdel Nasser Collection. Additional works on the periods, persons or institutions just before or after these two bookends are being pursued as well as other major collections in-between.

5.7 *Description de l'Egypte*

Description de l'Egypte was the outcome of the collaboration of more than 150 prominent scholars and scientists who accompanied Napoleon in 1798; and some 2,000 talented artists and technicians. For over 20 years, they systematically examined almost every aspect of contemporary and ancient Egyptian civilization, producing 20 volumes of text and plates of unmatched accuracy and detail. Historically, these engravings became the most comprehensive record and inventory of Egypt and its monuments.

This valuable collection containing images related to antiquities, natural history, and the modern Egypt of those days, has been fully digitized and integrated on a virtual browser with the objective of preserving it and making it publicly accessible. The collection includes eleven volumes of plates owned by the Bibliotheca Alexandrina, as well as ten volumes of text, a contribution from *l'Institut d'Egypte*. A tool was developed to publish books in the standard

Extended Markup Language (XML) format where books may be browsed by a virtual browser or touch screen. The project is composed of two stages. The first project stage was completed in October 2004 where the application was provided on DVD in high resolution with English and French interfaces. The relation between the text and images was also established and rendered in a searchable form. In the second stage, the whole collection is to be available in an integrated searchable form on the web.

5.8 *L'Institut d'Egypte*

The revival of the organization of *l'Institut d'Egypte*, built in Cairo by Napolean Bonaparte over 200 years ago, began through the project of the digitization of its entire collection, including over 35,000 volumes of rare and ancient references, books and periodicals in five languages. The effort started with the digitization of the 10 text volumes of *Description de l'Egypte*. Digitization of other special collections followed suit, such as the complete works of Voltaire (69 volumes), Des Mille Nuits et Une Nuit (16 volumes), and Géographie Universelle (15 volumes). Eventually, the whole library of *l'Institut* will be digitized, processed, cataloged, indexed and made accessible in searchable form through the web. This will

be the first attempt to digitize and publish a collection of such rarity and value.

5.9 Nasser Digital Library

In cooperation with the Nasser Foundation, the Bibliotheca Alexandrina was successful in digitizing the collection of the late Egyptian President Gamal Abdel Nasser and publishing it through an integrated searchable web-based system. Intended for research and documentation purposes, the collection is continuously expanding with new entries and includes the following items:

- Documents published by the Public Records Office, London, United Kingdom, between the periods 1919–1995 (around 1540 topics in more than 52,000 documents);
- Documents published by the United States Department of State (16 volumes of 7965 documents in 13,939 pages) during the period 1951–1978;
- Over 1300 speeches given by the President during the period 1952–1970, in both audio and printed format;

- Over 51,000 photos and 1000 portraits of the President covering more than 6000 events during the period 1930–1980;
- More than 1230 videos (over 50 hours) taken during the period 1948–1970;
- 1431 national songs;
- A complete archive of the articles published in the newspapers about the President and the 1952 revolution;
- The decrees issued by the Revolutionary Command Council (RCC);
- The daily news of the President;
- Minutes of the Central Committee for Arab Socialist Union (ASU);
- The President's personal correspondence and other relevant documents in his own handwriting (596 documents under 145 topics);
- A complete archive of the special weekly column "Bisaraha" by the Egyptian writer and journalist Mohammed Hassanein Haikal documenting all major events during the period 1957–1994 in simple writing for the general public;
- Books written by and about Nasser;
- A number of items representing the effect of Nasser on the culture of the region. The collection includes 138

poems, 50 rare stamps, 125 caricatures, 34 plastic arts illustrations, and 38 commemorative and circulating coins.

The collection was scanned, catalogued, indexed and subjected to Optical Character Recognition (OCR). A database was constructed for each topic storing each document's text along with its metadata. The entire collection was presented in a web-based interface with full-text Arabic and English search in both metadata and content. In October 2004, the website (www.nasser. org) was launched, facilitating browsing of the collection through the display of various items as well as providing full text and morphological searching. By integrating the different media and resource, researchers can easily find any documents, pictures, videos, stamps, articles, etc., pertaining to his field of interest.

5.10 *Al-Hilal* Digital Collection

Through an agreement concluded between the Manuscript Center and Dar Al-Hilal, with the aid of ISIS, an impressive project is currently being finalized to publish an exhaustive digital copy of the issues of *Al-Hilal* magazine since its first publication in 1892. The

issues of each decade are compiled on a CD and provided with search tools.

The volumes of the first 50 years were scanned, processed and indexed (about 51,000 pages). An application was implemented for browsing through the digital copies with searching facilities. The hierarchy, for titles and subtitles, helps users select the desired issues.

Other collections such as the *Suez Canal Collection*, The *Boutros-Ghali Family* Papers, the Papers of *Mohamed Mahmoud Pasha*; are also being digitized in agreement with the respective families. CULTNAT is also undertaking a detailed documentation of the history of Egypt through such institutions as the *Heliopolis Company* Centennial, the *Misr Bank* and the *Egyptian National Geographic Society*.

6. CELEBRATE THE PRESENT

Along with other partner institutions, the Bibliotheca Alexandrina worked on additional numerous projects such as the Million Book Project led by Carnegie Mellon University, the Internet Archive, and the OACIS (Online Access to Consolidated Information on Serials) for the Middle East project. The Bibliotheca Alexandrina has

thus developed the required expertise, equipment, and experience to make it the leading institution in the world in digitizing and archiving Arabic text of all varieties and types found in print in the modern world. In addition, the BA is also working on such initiatives as the Science Supercourse and the development Gateway.

6.1 Million Book Project

The Bibliotheca Alexandrina has been participating in the Million Book Project to create a Universal Digital Library. Initiated by Carnegie Mellon University, and with partners from China, India and the USA, the project aims at digitizing one million books within three years and publishing them as a searchable collection on the Internet. ISIS scanned and digitized approximately 25,000 Arabic books from the 75,000 target for the three-year time frame and OCRed over 9,100 books which have been encoded in Image-on-Text and ready for publishing, allowing search in the metadata of the book as well as its contents. Moreover, the project has provided a test-bed supporting research on improved scanning techniques, Optical Character Recognition (OCR), intelligent indexing, machine translation, and information retrieval.

6.2 Internet Archive

The Internet Archive is a prime example of work regarding websites. The Internet Archive is a complete snapshot of all web pages on every website since 1996 till today. The purpose of the Internet Archive is to include the main part of the World Wide Web collection. Since the web changes rapidly—the average lifetime of a page on the Internet is 100 days—this snapshot is retaken every two months. In April 2002, the Internet Archive in San Francisco donated a copy of the Internet Archive to the Bibliotheca Alexandrina. The Archive at the Bibliotheca Alexandrina includes 10 billion web pages from 1996–2001; 2000 hours of Egyptian and US television broadcast and 1000 archival films. It represents 100 terabytes of data stored on 200 computers.

Entering its second phase, ISIS has just concluded an agreement for assembling the second generation machines for web archiving, the **Petabox**. The Petabox is a machine designed by Brewster Kahle, founder of the Internet Archive, to safely store and process one petabyte (a million gigabytes) of data. The machine features low power consumption, multi-operating systems, easy maintenance and software to automate mirroring. These machines will host the 2002–2005 collections. New

machines for the 2006 collections will be designed and manufactured locally.

Synchronization with the Internet Archive in San Francisco has become faster and more reliable since the 155 Mbps bandwidth upgrade.

6.3 OACIS and AMEEL

Initiated by Yale University Library, Online Access to Consolidated Information on Serials (OACIS) for the Middle East creates a publicly and freely available electronic union list of serials and journals from or about the Middle East.

The OACIS system was launched in November 2003 and currently comprises 16 partners (including 11 US universities, one German, one Jordanian, one Lebanese, one Syrian and the Bibliotheca Alexandrina), 42 languages (with the top collections in Arabic, Persian and Turkish) and over 23,000 unique title records.

In January 2005, a mirror site of the system was launched at the Bibliotheca Alexandrina. The mirror site will enhance access to the OACIS database in the Middle East region and will serve as a backup to the original.

A content retrieval web interface for the digitized serials and journals has also been designed and implemented. Implementing a system for automatic uploading of the Bibliotheca Alexandrina and other partners' records to the OACIS server has been completed. Automatic updating of the OACIS catalog is being designed and an Arabic web interface for the collection is being implemented. Scanning, processing and OCRing of 23 volumes of the Bibliotheca Alexandrina and Yale University Library copyright-free collections have been digitized for demonstration purposes. Today, OACIS has been completed and a follow-up project, called Arab Middle East Electronic Library (AMEEL), addresses content in addition to the cataloguing work of OACIS. Yale leads this effort and the BA is intimately involved with it.

6.4 Science Supercourse

To empower teachers of science all over the world, the BA is working with a team of specialists to launch the first Science Supercourse, comprising thousands of PowerPoint lectures made available for free to teachers and lecturers, who can use them as they see fit in their teaching of science. The Supercourse has been effectively implemented in the area of Public Health and Epidemiology, with

some 30,000 faculty members in about 150 countries and providing some 2,500 PowerPoint lectures. Today, we are working to try to set up a similar course in all fields of science. This initiative I described separately and in detail in the fifth chapter in this book entitled ***Prometheus and the Internet: A Science Supercourse for the 21st Century***, which is co-authored with Professor Ron Laporte of Pittsburgh University.

6.5 Development Gateway

Set up by the World Bank and other international institutions, the Development Gateway quickly became the portal of reference for many practitioners of development all over the world. Communities of practice take on particular topics or issues and share the best available experiences or new research available. The BA has agreed to Arabize the basics of this valuable reference and research tool, and will moderate the DG community on Arab Reform. The announcement was made at the World Summit on the Information Society (WSIS) in Tunis in November 2005.

7. Embrace the Future

The BA is determined to be an active player in creating a better future for Egypt and the region. Some manifestations of this determination is found in its role as a catalyst for Arab and Egyptian Reform, and its commitment to nurture children's talents. While both areas encompass many activities, only the digital and ICT-related aspects of some of the initiatives will be touched on here.

7.1 The Arab Reform Program

Since early 2004, the BA has been nurturing the Arab Civil Society in taking a more powerful role in the promotion of reform. The first major result was the *Alexandria Declaration* of March 2004, signed by 165 distinguished individuals from 18 Arab countries. Immediately thereafter the *Arab Reform Forum* was established with a trilingual website hosted by the BA. Subsequently meetings were held, books and monographs were published conventionally and on-line, and finally a special Portal, *The Arab InfoMall* was set up and launched with messages from UN Secretary-General Kofi Anan and other dignitaries on the occasion of the WSIS meetings in Tunis in November 2005. That portal has hundreds of

NGOs from 15 Arab countries listed with their reports and publications available for the first time in searchable form. In addition, it provides a calendar of events, a public bulletin board and a discussion forum. The BA is thus a real actor in the cause of reforms in the political, social, economic and cultural areas.

7.2 Nurturing Children's Talents

Three ICT-related projects are underway. *The Hole in the Wall* program aims to replicate India's successful initiative to allow disadvantaged children to acquire—without adult intervention—the skills of using a computer and searching the web. *La Main à la Pâte* is a French Portal to assist science teachers in presenting the process of scientific discovery to children. Pioneered by Nobel Laureate Georges Charpak, and supported by the French Academy of Sciences, the portal/website has had great success in France. The BA has agreed with the Academy to Arabize the website and the materials and it will be launched on the occasion of the big scientific conference BioVisionAlexandria in April 2006.

Another program made possible by the generous support of Brewster Kahle who donated the equipment and Rachid M. Rachid who donated the car, is the children's

program entitled *My Book: Digital and Printed.* Children select material from an electronic base, they then print it, cut and bind it and have their own little book that they made themselves. That brings enormous sense of pride and promotes attachment to reading. Before they leave, they are asked to scan a page from the book they just made, and they see it re-appear on the computer! That is a moment of revelation that drives home the point that electronic and printed are different receptacles or vehicles for the same information. One set of equipment is at the BA Children's Library and the other is in the small car traveling to local schools. Invariably it has been a major hit with the children.

8. Tools for Tomorrow

The BA is actively equipping itself with important tools for tomorrow's research needs. In order to maintain the digital library collections, and to develop our role and mission, the Bibliotheca Alexandrina developed the Digital Assets Repository (DAR) and the Universal Digital Book Encoder (UDBE). In addition, the BA is participating in the UN University's international effort to develop a Universal Networking language for machine-based translation, and is providing Egyptian researchers

in many fields with state-of-the-art analytical Immersive Virtual Reality IT support in what we have termed the VISTA (Virtual Immersive Science & Technology Applications).

8.1 The Digital Assets Repository (DAR)

The Digital Assets Repository (DAR) was developed at the Bibliotheca Alexandrina to create and maintain the digital library collections. The system acts as a repository for all types of digital material and provides public access to digitized collections through web-based search and browsing facilities. DAR is also concerned with the automation of the digitization workflow and its integration with the repository. The digital laboratory plays a major role in this respect. An exclusive feature of DAR is integrating the digital section workflow including scanning, processing, OCR, encoding, archiving and publishing with the digital repository through automated tools.

The management tools developed within DAR will help the BA preserve, manage and share its digital assets. The system is based on evolving standards for easy integration with web-based interoperable digital libraries.

DAR has the objectives of:

- Integrating the actual content and metadata of varieties of object types included in different library catalogs into one homogeneous repository;
- The automation of the digitization process such that human intervention is minimized and the outputs are integrated within the repository system;
- The preservation and archiving of digital media produced by the digital laboratory or acquired by the Library in digital format;
- Enhancing the interoperability and seamless access to the Library digital assets.

8.2 The Universal Digital Book Encoder (UDBE)

For the purpose of facilitating the electronic publishing of digitized material, Universal Digital Book Encoder (UDBE) was devised as a framework for the universal encoding of multilingual image-on-text documents, binding images and text in a compound format that allows retrieval systems to search the text layer and highlight hits on the original page images. The presented UDBE framework renders it possible to utilize OCR results of any engine to compile image-on-text documents in any valid target format by adopting the proposed Common

OCR Format (COF). The current implementation of the UDBE illustrates the concept by implementing an OCR Converter for Automatic Reader and Format Handlers for the DjVu and PDF target formats, making it possible to produce multilingual—namely, Arabic, Latin and Persian—image-on-text documents in an automated fashion, providing efficient image compression, multilingual text support and multi-paging.

In its performance evaluation, UDBE was shown to be comparable to other systems capable of producing Latin image-on-text, namely, Acrobat, FineReader, and LizardTech's Document Express.

8.3 Universal Networking Language (UNL) program

The mission of the Universal Networking Language (UNL) program, initiated within the United Nations and devised by the Universal Networking Digital Language (UNDL) Foundation, is to enable all people to generate information and have access to cultural knowledge in their native languages. UNL is an artificial language attempting to replicate the functions of natural language in human communication. UNL applications will vary including creating multilingual web pages, UNL encyclopedia, etc. Currently, 15 languages have been incorporated and

a number of institutions have started to work on their respective native languages. In July 2004, partnership with the UNDL was established and an agreement was signed in favor of the Bibliotheca Alexandrina to host the Ibrahim Shihata Arabic-UNL Center (ISAUC). The Center is funded by the Arab Fund for Economic and Social Development (AFESD) in honor of the memory of Dr. Ibrahim Shihata, an international jurist and expert on international developments, and a great promoter of Arabic culture. ISAUC will play the major role in designing and implementing the Arabic component in the development of this language and will act as an active language center for Arabic.

By early 2006, progress had been made in three different components. Firstly, the Arabic Dictionary has been designed and the first version has been produced with about 50,000 entries. In addition, the workflow has been established for developing the Deco rules within the Arabic de-conversion component and the Deco rules design has been completed. Finally, design of the UNL Library Information Systems (LIS) is in progress and was demonstrated at the World Summit on the Information Society (WSIS) in Tunis in November 2005.

8.4 Virtual Immersive Science & Technology Applications (VISTA)

In the world of 21st century science, the traditional categories of theoretical and experimental science are being complemented by a third: simulation. Powerful, high-speed computers are making it possible for all disciplines to test out ideas in virtual reality, trying out many combinations and permutations, before actually touching the complex, fragile or expensive real (physical) experiment. Earlier versions of such systems were used to train pilots in simulators to avoid crashing actual aircrafts. The realism of the simulations and the immersive quality of the 3D effects is needed to make the training effective. Today, these techniques have been refined and are applied in many disciplines.

The BA is proud to provide the first ever "Flex System" of immersive virtual reality with 10" × 10" screens and 64-bit technology. This should enable Egyptian researchers to work with their peers in advanced industrial countries with no compromises on the quality of the computer analysis being done. VISTA allows linking of researchers through remote access, where up to 90% of the work can be done on regular computers remotely. Final, live sessions in the virtual environment of the VISTA are to complete

the analysis. The ICT teams at the BA will provide the support for the researchers in medicine, engineering, biology or other fields who wish to use this new tool, opening up new possibilities for the young Egyptian researchers of tomorrow.

9. ENVOI

The strong corporate spirit that has infused the Bibliotheca Alexandrina encouraged synergy within the vast complex, making all staff from various departments work toward common goals through a multitude of activities. Working as one, pooling their effort and creative thoughts to enhance the goals of the Bibliotheca Alexandrina, our young staff, working across departments is committed to pursue our mission of becoming a center of excellence for the production and dissemination of knowledge, and to make the BA truly a leading institution in the digital age.

Chapter 3

FROM BARRIER TO BRIDGE

The Promise of Machine-based Translation *

"In the end, as it was in the beginning, it is the Word, not just the Noun or the Number, that illuminates every race."—Derek Walcott
[New York Review of Books,
15 June 2000, p. 61]

PHILOSOPHICAL GOALS

We are embarked on one of the most exciting adventures that humanity has ever undertaken. Already, in the last decade of the last century we celebrated "Our Creative Diversity", highlighting that the cultural diversity of humanity, like the biological diversity of the ecosystem, was a source of strength and richness, to be celebrated and valued, not to be bemoaned and regretted.

We have always also valued the possibility of common interaction and mutual understanding. Yet, for many,

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* Address delivered at the International Conference on the Convergence of Knowledge, Culture, Language and Information Technologies, Library of Alexandria, Alexandria, Egypt; 2–6 December 2003.

diversity and understanding seemed to be fundamentally at odds. Language, that quintessentially human artifact, so essential for any community of humans to articulate culture, was itself a barrier to common understanding. Over a century ago, well-meaning individuals suggested the creation of Esperanto, everyone's second language. It never took off. However, because of a number of historical factors, English has become the Esperanto of our age. The decision of China to teach English as a second language, coupled to the Indian subcontinent's prior *de facto* adoption of English and the enormous weight of the United States following the World War II have all assured English a global constituency. The enormous dominance of English in science and technology and the speed and scope of the new developments in Science and Technology (S&T) is making it difficult for cutting edge work to be done in other languages.

Unlike Esperanto, English is not culturally neutral. It is not equally owned by all the peoples of the world. It is the first language for many, and certainly the language of science and technology. The new ICT technologies that promise so much in terms of connectivity, are seen by many as the means of stifling local languages and

spreading English, even if purists (Billington) are worried that the Internet is destroying the English language.

Whatever one thinks of it, it is undeniable that many cultures are threatened and that many languages, especially spoken languages of indigenous people in many parts of the world, are disappearing rapidly. From some 6000 languages in the world at the beginning of the 20th century, we have only about 600 surviving at the beginning of the 21st century. How much was lost by the disappearance of these languages and in many cases these communities? It is not only the matter of human rights as we understand it today, whereby cultural identity is a human right to be protected and valued, or even the relative cultural enrichment that it would bring, but also the very real factual knowledge—medicinal plants, rare crop relatives—that is now lost and will have to be laboriously re-discovered, if it is not lost forever.

Some have bemoaned this supremacy of English and have argued for a massive translation effort into the local languages, such as was done for translation into Greek at the time of the Ancient Library of Alexandria and again into Arabic at the time of Al-Maamun's "House of Wisdom" in 9th century Baghdad. Pragmatists, like

myself, have argued that we are in a totally different time. Quantitatively, the production of knowledge, especially scientific knowledge, is on such a scale that it has vitiated any effort to defy English as the common language of science and technology. Qualitatively there is so much new and novel development that new words and concepts are entering our vocabulary all the time. Why should this be a problem? After all, other languages (e.g. Greek, Latin and Arabic to cite just those three) were once upon a time the common language of science and technology, at least in the Mediterranean region and somewhat beyond. Newton wrote his *Principia* in Latin, not in English.

What if we could indeed find a way for machine translation on a credible and effective scale? That would undeniably involve many more people in the fabulous knowledge explosion we are witnessing. It would certainly expand the reach of the new science and technology, as well as open avenues for enrichment of local cultures by increasing access to the literary output of other cultures. That is certainly a dream worth pursuing. Finally, the diversity of languages of cultures would be truly experienced as an enriching reality, without that diversity acting as a barrier to understanding. Tools would be in place to truly turn potential clashes of civilizations into

dialogues of cultures where dialogue is a two-way street. That is why I am so excited about the prospects for developing machine translation and why I stated at the outset that we are embarked on one of the most exciting adventures that humanity has ever undertaken.

I dream of a day when intelligent machines will help each of us to access, in our own language, the wealth of production of the human mind. True cumulative knowledge across space and time will be available to all. The enormous richness that comes from the multiplicity of outlooks imbedded in different cultural traditions, a true ability to braid together a world culture, intertwining the outlooks of so many different worlds: French/Latinity; Anglo–Saxon; Arab Muslim; African; Indian, Chinese, etc.

That day is not yet around the corner; for language has some subtle challenges for those of us who would tame it and harness it to do our bidding.

Philosophical Challenges

Language is the primary means of communicating between humans. When written it is the primary means for the transfer of culture across time and space. Yet,

language has many subtleties and complexities. *Homonyms and ambiguities* abound.

For spoken language—important when we will come to the use of voice recognition programs for dictating text—context is paramount, not just elocution, diction and pronunciation. Thus, if we say:

> "Right on, Mr. Wright! You should write only that which is right. Not what pleases the political right."

We will have used the word "right" for many different meanings, producing enormous ambiguities for those without referential context.

In written form, language also needs context. Take the statement: "Flying planes can be dangerous". The statement has inherent ambiguities that humans handle with ease drawing on the immediate context of the sentence and the background context that we have acquired as we grew up. Yet for a machine, using rule-based programming, the sentence presents difficulties. A software program, that lacks both our knowledge of the world and our experience with linguistic structures, will ask whether the more plausible interpretation is that the

pilot is at risk, or that the danger is to people on the ground. Which of the many possible meanings of "plane" is relevant? Depending on context, "plane" could refer to, among other things, an airplane, a geometric object, or a woodworking tool. How much and what sort of context needs to be brought to bear on these questions in order to adequately remove the ambiguities of the sentence?

Or take this simple statement: "Mr. A will take you to meet Mr. B. After your meeting ends, he will take you to meet Mr. C". Does the word "he" refer to Mr. A or Mr. B? Mr. A could have waited for the meeting to end (or returned at its conclusion), to take you to meet Mr. C. Conversely, it could be Mr. B who at the end of the meeting would take you to meet Mr. C.

In addition, the languages of all cultures make use of *irony, simile and metaphor*. Translation will have to be remarkably sensitive to the subtleties of language to differentiate between varying meanings (sometimes opposite meanings) associated with the use of the same words.

These are but some of the challenges confronted by those working on machine processing of language

(whether for retrieval and classification or for translation). There are many worthy and exciting efforts underway that make this one of the most exciting fields to be in at present. Among some of these efforts, we can cite the following:

Natural Language Processing (*NLP*). The goal is to design and build software that will analyze, understand, and generate languages that humans use naturally, so that eventually I will be able to address my computer as if I were addressing another person. Recently, NLP has been considered as a sub-field of Artificial Intelligence.

This goal is not easy to reach. "Understanding" language means, among other things, knowing what concepts a word or phrase stands for and knowing how to link those concepts together in a meaningful way. It is ironic that natural language, the symbol system that is easiest for humans to learn and use, is hardest for a computer to master. Long after machines have proven capable of inverting large matrices with speed and grace, they still fail to master the basics of our spoken and written languages.

NLP is usually subdivided into two main fields:

- Linguistic analysis: decomposing the text into its basic components, and
- Linguistic generation: generating text from their basic components.

Currently, NLP is limited to the sentence level, but on-going research is underway for reaching the higher level of processing narrative text. Text generation is addressed using a mix of knowledge-engineered and statistical/machine-learning techniques to disambiguate and respond to natural language input. This area of research has major implications for applications like text critiquing, information retrieval, question answering, summarization, gaming, and translation.

Formal Knowledge Representation (*FKR*) is a major field that provides engineering tools to formalize the unstructured linguistic knowledge into well-formatted data, which the computer can process. FKR applies a wide range of techniques such as logic, mathematics, semantic nets and conceptual graphs.

Textual Data Mining (*TDM*) is a relatively new research area lying between Data Mining, Knowledge Discovery in Databases (KDD), Natural Language Processing, machine learning, and information retrieval. TDM's main objective is to extract knowledge from the unstructured narrative text and represent it explicitly in a structured format that can be handled computationally.

There are those, like Umberto Eco, who doubt that machines will ever be able to master language, with all its subtleties and ambiguities. They consider language an inherent trait of humanity. They cite the apocryphal story of the first efforts at Russian/English machine translation where the English sentence "The spirit is willing but the flesh is weak" was translated by machine into Russian and then the machine was asked to translate it back into English and got: "The vodka is good but the steak is bad!" That, they claim, is the difference between human language and machine ability.

I disagree. I do not believe that it is beyond the ken of human ingenuity to devise machine-based systems that can master language and open the golden gates of machine based high-speed translation. However, I do have some suggestions that I believe may be worth considering on

how to meet the enormous technical challenges that lie ahead.

TECHNICAL CHALLENGES

Brute strength may not be enough. It is true that brute strength enabled IBM's Big Blue to beat Chess champion Kasparov; but chess is infinitely more limited than language. It is defined by a relatively small set of rules and is played on an 8×8 board. So, what are the technical challenges that must be met for our goal to be technically feasible? And how can we apply it in real life?

I believe that we will need to address several issues: the scale, size and diversity of the available data on the World Wide Web and the ambiguities of the medium of language. On the first, there is the remarkable effort of the Semantic Web, and related efforts. On the second, I believe that distributed processing and biological simulations hold enormous promise.

The Semantic Web is an initiative of the World Wide Web Consortium (W3C) designed to create a universal medium for the exchange of data, based on the representation of all the data on the World Wide Web.

This collaborative effort led by W3C with participation from a large number of researchers and industrial partners, is based on the Resource Description Framework (RDF), which integrates a variety of applications using XML for syntax and URIs for naming. It develops open specifications for those technologies that are ready for large scale deployment, and identifies, through open source advanced development, the infrastructure components that will be necessary to scale up to the whole Web collection in the future.

The principal technologies of the Semantic Web fit into a set of layered specifications. The current components of that framework are the RDF Core Model, the RDF Schema language and the Web Ontology language. These languages are all built on the foundation of URI, XML, and XML namespaces.

The vision of the Semantic Web is to make web data machine processable, and rests on the premise that to do so we need to accommodate, somehow, the semantics of these data. Many technologies and methodologies are being developed within Artificial Intelligence, Databases, Software Engineering and Information Systems that can contribute towards the realization of this vision.

Among those are languages for semantic annotation of Web documents, ontologies, technologies and methodologies for building multi-agent systems, semantic interoperation of programs that have been developed totally independently, technologies and methodologies for describing, searching and composing Web Services, and more.

To master the enormous complexity of one language is hard enough. To do so for all the languages of the world is mind-boggling. To do so for the past and present of each language is almost unimaginable. Yet, it is essential, for part of a culture/language's inheritance lies in deciphering the fragments of its literature. All this is impossible only if we think in terms of linear and sequential approaches to the problems.

Indeed, I believe that the future is bright for Distributed Processing systems, especially those who mimic biological systems.

Distributed Processing Computer programs based on multi-agent systems in given environments, distributing the load among multiple processors that remain in some form of collaborative relationship is much more

promising and potentially much more powerful than ordinary parallel processing which in turn is much more powerful than sequential processing.

If agents are designed with some memory capability, they can acquire and retain information about their environments and behave in accordance with the original rules and the added information. Many small and relatively unsophisticated agents—mimicking a colony of ants for example—where rigid programming of each member allows for little or no leeway in behavior of individual agents, but collectively they are still capable of fairly complex tasks (think of an anthill).

Evolutionary programs add the dimension that agents that acquire information in such a way that if they do not evolve into a more efficient performer, they are killed off, either by not being allowed to renew themselves in subsequent generations, or by predator organisms if the game framework of the evolutionary program allows for such a predator/prey relationship.

These biological simulations using distributed processing can produce emergent solutions that are not immediately obvious to the initial programs and systems

designers. Indeed, they may be able to sift through the enormous amounts of data in the Web Collections of the World and deploy pattern recognition software to enormous advantage.

Another variant is designing *Neural Networks*, mimicking the human brain's neurons. Work on Neural Networks is concerned with the modeling of brain and behavioral processes and the application of these models to computer and related technologies. Models aimed at the explanation and prediction of biological data and models aimed at the solution of technological problems are both addressed, as are mathematical and computational analyses of both types of models. Work on Neural Networks serves as a central, interdisciplinary forum for all researchers in a range of fields including psychology, neurobiology, mathematics, physics, computer science, and engineering.

This raises another interesting possibility. It was first broached in Alan Turing's classic 1950 essay "Can machines think?" where Turing suggested his famous "Turing test" but where he also suggested that we could mimic the evolution of a child's brain. First, a program that would mimic the child's brain ability to learn, and

then a program to integrate the external stimuli that enable children to learn languages. Recent cognitive studies have shown that there is a "window" roughly from ages 2–14 within which the ability to communicate is learned. That, in itself, is relevant. Perhaps biology will also one day explain what happens to our neural networks that close that window. However, that is in the future, as is so much of the promise of the marriage of biology and computing science, whether for DNA-based computing, nano-technologies or other interesting fusion of hitherto separate domains of research and endeavor.

Being no specialist, and addressing an audience of specialists, I dare not venture too much into the specifics of the computer side of the questions we are addressing. I leave it at this level of a statement of faith. I believe that we are on the right track, and that the technical obstacles, though formidable, are not insurmountable. I believe that we have only just begun to indistinctly glimpse the enormous power of the coming marriage of computing and biology, and that the future is incredibly bright for those who have the courage of their convictions and the will to explore the unknown.

THE PATH AHEAD

The magic of language enthralls us across space and time. The nobility of this collective enterprise moves me profoundly. The elegance of the hub and spoke architecture, with its machine-based "Esperanto" at its core is breath-taking. Your quest, to transform language from barrier to bridge between cultures, is one that all persons of goodwill must support. It will bring humanity richness beyond compare.

Yet, we must still ask ourselves if the resulting language produced by massive amounts of translated documents would destroy the beauty of the language that we have come to know and use and love. Will machine-produced bureaucratic prose destroy the evocative power of words, lose the abstraction of concepts and misplace the transcendental aspects of consciousness that language can bring? I hope not. In fact, I dare to dream of a new discourse, if not a new language, that will emerge in this coming century, where in the words of T.S. Eliot:

> *Every phrase and sentence is right*
> *When every word is at home*
> *Taking its place to support the others*

The word neither diffident nor ostentatious
An easy commerce of the old and the new
The common word exact without vulgarity
The formal word precise but not pedantic
The complete consort dancing together
Every phrase and every sentence
is an end and a beginning.

T.S. Eliot, *Four Quartets*

This enormous enterprise we are involved with is one that holds infinite promise. Promise not of worldly riches, but of cultural riches beyond compare. It can enable the disadvantaged communities of the world to have access to the enormous tidal wave of new knowledge and possibly to take charge of their destinies as they master the new science and technology of our age. It can open up the rich heritage of many countries, and just as the discoveries of Young and Champollion enabled the stone monuments of ancient Egypt to reveal their secrets and sing of a rich heritage for all of humanity, every culture will be accessible to every other, opening up new avenues for increased understanding and mutual respect between all members of the human family.

Surely we will encounter many obstacles in this quest. Surely, there will be many questions raised in this endeavor. From the nature of language to the intelligence of machines, from the essence of consciousness to the meaning of meaning … the questions will be endless and they will be profound. However, as "questors" (Boorstin's Word) we can take solace in the knowledge that it is more in the fecundity of the questions than in the finality of the answers that true value may reside.

In a sense, it is our quest, our exploration that is the ultimate expression and ultimate justification of our humanity. If we are explorers in these uncharted waters, I have no doubt that …

> *"We shall not cease from exploring*
> *And at the end of all our exploring*
> *Will be to arrive where we started*
> *And know the place for the first time."*
>
> —T.S. Eliot

Chapter 4

BUILDING THE LOOM

In the last century, a poet remarked

Upon this gifted age, in its dark hour,
Falls from the sky a meteoric shower
Of facts...they lie unquestioned, uncombined.
Wisdom enough to leech us of our ill
Is daily spun; but there exists no loom
To weave it into fabric...

—Edna St. Vincent Millay
(1892–1950)

We devoted ourselves to a better understanding of that *loom*. How to organize *data* so that it becomes *information*, how to link and interpret it so that we gain *knowledge*, which hopefully, when refined in the crucible of experience, with insight and reflection, may lead us to *wisdom*. The wisdom to create that better world to which we are all committed.

The four sessions devoted to the ICT revolution were very rich in content and animated in debate. I will try to re-group here some of the salient points around *six* main

issues, some of which recurred like a common thread throughout the meetings, others, which were the focus of a particular session.

FIRST: A TRUE REVOLUTION

ICT technology is now moving from computer-centric to communication-centric platforms (mobile phones and PDAs) which are more user–friendly. With substantial expansion of broadband wireless, the poor can move to communication-centric platforms immediately.

Massive connectivity is here: There are two billion *mobile phones* in the world, with 350 million in China alone.

The Internet, with its enormous positive impacts, floods us with too much data of variable quality.

Storage: is becoming easier and cheaper. Technology makes information more portable and more searchable and more accessible. Imagine, one iPod can store 12 million articles!

All in all, the density and accessibility of information is increasing dramatically.

Second: Equity

This information revolution will favor the rich, the powerful, the educated and the nimble. Thus, it has the potential to aggravate the digital divide and increase the gap between the rich and the poor. However, the new technologies also hold the potential to enable the poorer people in the south to "leapfrog" the development patterns experienced in the north. While it is not a silver bullet, there was a consensus that connecting all the schools was both desirable and feasible. Although it would not replace conventional schooling, it would revolutionize the possibilities available to both teachers and students. Thoughtfully deployed, the new technology can strengthen communities and empower the poor. For example, Vietnam is using digital libraries for rural development. These become hubs of villages turning them into knowledge communities, each having a multimedia computer, printers, camera and 200-digitized movie titles.

However, the costs of the hardware and of proprietary software to the south are enormous. Brazil was spending more on licensing proprietary software than it does on fighting hunger, so now it is moving to open source systems.

Third: Interoperability

The full impact of the ICT revolution will not be fully realized until inter-operability is achieved. Consider, for example, the goal of "50 by 15" to connect 50% of the world by 2015.

This kind of goal cannot be achieved without setting standards that will ensure interoperability.

Standards drive down barrier to entry, and more entrants means better products. For many participants there was a preference for open industry standards rather than proprietary solutions. However, it was recognized that even proprietary systems have seeded the landscape with competitors and innovators.

Who sets the standards? Those who have that power often abuse it for national or commercial reasons, at the expense of the consumer, the user.

The discussions were complex and would require lengthy reporting to do them justice. In general, most thought that standards should be market-driven, though governments have to provide frameworks for anti-trust

and for public goods. Standards should also avoid the stultifying effect of blocking new technologies. What if there is a new and better music compression technology than MP3?

Fourth: The Management of Our Heritage

The digital libraries of tomorrow have the potential of archiving an enormous amount of data. Not only will books be available in digital formats, but films, images, video, music and much more. We have a dual responsibility to record and protect our heritage, including the folklore and traditional customs and oral traditions, and to make it available to all.

This will not be the work of one institution. Collaboration and exchange is essential, but will it be on open source formats? How will we deal with technical and physical obsolescence of the material and the formats? Will we keep re-recording this enormous material every few years?

Information and ideas are central for the development of humanity. However, there are intermediaries between authors and readers: Libraries have a central role to play.

Large digital collections of text, images, voice, music and video, open amazing possibilities. Hypertext links, even fluid hyperwords, object repositories, and new search engines and gateways that add coherence and credibility. We can find origins, or carry out associative semantic searching, all unthinkable in the non-digital world.

Specialized collections can add enormous impact. The Brazil–Chile–Argentina initiative of digitizing their journals made available specialized literature on health and agriculture.

In short, the library of the future will not just digitize the old books and articles. It will give birth to the new, so much of which resides in the links between the old knowledge. It will give a home to materials that are born digital! The library of the future will truly be the place to find the lasting and the lost.

Fifth: Privacy and Security

After much debate, the participants opted for supporting "Privacy for citizens and transparency for governments". National security may call for the executive to access the enormous data assembled on each

individual by virtue of the way we live today. This should be subject to judicial approval based on probable cause. Commercial use of data profiling would be subjected to informed consent by the individual concerned. The Privacy issue would be best addressed in a Human Rights framework that draws on the established formulations in the Universal Declaration and other documents, extending them from "papers and correspondence" to include e-mail and other forms of electronic and digital communication.

Indeed the issue was seen to be central to democracy. In many cases, this privacy made possible by the Internet was giving voice to freedom, and advancing the cause of liberty.

Another kind of security issue was related to the protection of our enormous digital databases, transactions and other information from attacks by hackers or cyber terrorists. Hacking should be criminalized and the public educated to the potential damage of taking lightly the risks that they pose. Stealing the information about millions of credit card accounts, identity theft and other risks show a dark facet of the rapid expansion of the technology.

Finally: A Call for New Thinking

More useable real-time data than ever before is now available to the average person; and this is going to increase in both quantity and quality. For example, **Google Earth** is soon going to come to 30 cm resolution. Can we bring into the public domain information and data that can be used for public purpose, but respecting the privacy of individuals? Can we help establish baselines for understanding our enormously complex societies?

To tackle these questions we will need *new ways of thinking*, trans-disciplinary research, and a great deal of imagination. Thinking of the multiplicative effect of the new technologies and how they impact on the environment, and how the very nature of human interaction in our societies will change remains a daunting and very exciting challenge.

Chapter 5

PROMETHEUS AND THE INTERNET: A SCIENCE SUPERCOURSE FOR THE 21ˢᵗ CENTURY*

Education is the most powerful weapon which you can use to change the world.

—Nelson Mandela

1. BACKGROUND

Today, 80% of the World's populations are still living deprived of quality on line or on time access to the most relevant scientific information that could help change their lives.

Today, teachers of science in many of the developing countries do not have the tools or the means to present to their students science in an effective fashion, thus keeping them and their students distant from the science of today.

Promoting the values of science, with all what they mean for the promotion of tolerance, rationality, creativity,

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the search for truth, adherence to codes of behavior and a certain constructive subversiveness. This last, is because it is essential in science to be able to listen to the contrarian view, and accept or reject it on the basis of empirical evidence. Science and the scientific enterprise also create a forum for the exchange of ideas and the arbitration of disputes that has served humanity extremely well in the last few centuries. Promoting the values of science are the best investment in fighting obscurantism, fanaticism and xenophobia and they help promote the capacity to embrace diversity and to cooperate across different cultures, races and religions.

Beyond the ideas of teaching science and mathematics, there are at least three fields of obvious interaction between people and science, which go beyond research into application, beyond the theory to the applied, and these are: Medicine (and Public Health); Agriculture; and Engineering. In these three fields, the practitioners apply science, and frequently deal with clinically observed approaches, even if they are not yet sufficiently understood scientifically. Furthermore, the environment, is a domain where do-gooders with limited understanding, are now giving way to an impressive body of scientific knowledge

that should help inform the actions of governments, institutions and individuals.

In these four domains of Medicine and Public Health; Agriculture; Engineering; and Environment, there is enormous benefit in being able to provide a lot of up-to-date information to the rest of the world in real-time. Here is where the proposed Supercourse approach, with Just-In-Time (JIT) lectures and knowledge delivery systems can be of enormous help to:

- help build ties across nations and expand the community of science across "silos" of specific disciplines and sub-disciplines;
- help provide badly needed information to people who can use it to combat poverty, disease, hunger and malnutrition; and
- provide quality, JIT materials to assist those who are dealing with crisis situations.

2. THE MEANS ARE AT HAND

Using Internet-based approaches, and relying on the ubiquity of PowerPoint presentations all over the world, we propose to establish communities of practice in the

various areas of science, starting with the four domains mentioned above.

The concept we are discussing has been tested successfully in the domain of Epidemiology, Prevention and Public Health. Recent efforts showed also that the concept of JIT lectures materials were enormously helpful in crisis situations.

This experience is more than a "proof of concept" it is a case study of a major return on very limited investments of public funds largely through the commitment of a few learned individuals and the positive reaction and participation of thousands of individuals all over the world who were moved by the vision and enthralled by the content of the material. Ultimately hundreds of thousands participated and millions benefited. This case study, which started in epidemiology, deserves to be presented in more detail, as it shows what can be achieved, and establishes the credibility of the present proposal, and of the individuals advancing the proposal.

3. The Experience So Far: Supercourse, Global Health And Information Sharing

3.1 A New System for Our Times

Prevention education is the most powerful weapon which can improve the health of the world. However, in the world of health there are health knowledge "haves" and "have-nots". During the past few years we have been developing a new system for global training in prevention, making shared networks and knowledge available to all, especially to reach the unreached with state-of-the-art scholarly global prevention knowledge. It has been our mission to build and distribute high quality prevention knowledge to the teachers of the world, and we are succeeding. It is also our goal to establish new boundaries for global education.

3.2 Global Health Network and the Supercourse

We have used the Internet to network together 30,000 faculty from 151 countries. The network is used to collect the best possible PowerPoint lectures on prevention, and to share these lectures among this group and the world (*www.pitt.edu/~super1*). We have been very successful in obtaining 2,358 lectures. These have come from six Nobel Prize winners, and 60 members of the Institute

of Medicine. This is a powerful tool of global diplomacy as we have 1,800 members from Muslim countries, 500 from the Former Soviet Union (FSU), and 5,000 from the USA all working as scientists and scholars. It has been stated that the project is a "noble cause", with equality, and sharing on the most precious resource of scientists, our knowledge. Our plan is to empower the teachers of the world, by offering them this material and the support of this community of practice.

The program is not driven by developed countries. We have outstanding lectures from developing countries such as Avian Flu from Pakistan and the Philippines, West Nile fever from Egypt, and Iodine Supplementation from India. We share the knowledge among ourselves and with others. It is "open source" in that copyright is held by the authors. The authors agree to make their lectures available for free. The lectures have been distributed with 42 mirrored servers (copies of the lectures) in Mongolia, Russia, Sudan, Egypt, and elsewhere. The lectures are distributed on CDs. We provide these to people with the understanding that this is a gift meant to be offered. We ask them to copy the CDs for at least five people, preferably students. Over 50,000 centers worldwide have a CD of

the Supercourse. The Supercourse is now one of biggest and best known global health projects. The network of collaborators includes the Library of Alexandria, as well as over 5,000 universities worldwide.

3.3 Best Scientists, Best Lectures reaching the Most People

We are in an age where we can start to bring the best possible materials to the teachers and students of the world. We are demonstrating this with the "Cutler Lecture" which is the most important international health lecture at the Graduate School of Public Health in Pittsburgh. Eric Noji, MD, a leading expert on disasters, gave the lecture. We decided to reach a million people with the lecture worldwide. To do this we had Eric present his lecture at the University. We used a multi-channel approach with his lecture being broadcast using web casting, and web archiving. His lecture is also available applying iPod technologies. With these methods Eric himself teaches worldwide. In addition, his lecture is available using .ppt, .pdf technology and Supercourse technology for teachers to download. In addition, we used a viral marketing strategy by sending the lecture to 30,000 people and asking them to forward it to others. Our goal is to make

the lecture available to high bandwidth Silicon Valley, as well as low bandwidth Sudan. It proved to be successful, in fact too successful. For his presentation we set the limit for the hour of 500 links coming in as we figured that most of the links would be from classes of 50 faculty and students. We were enormously surprised that for that hour 2,500 links visited, representing perhaps 100,000 people. There were people in Tehran at 2:00 am, some in Beijing and people elsewhere in China as well.

This was a very important exercise as we found that there is a huge demand for good prevention information, and that we could deliver this in almost every country using web casting. Many teachers could not be reached immediately, but they could through CDs, and putting the lectures onto slides, overheads or paper. There is no question in our minds that we can reach a large percentage of teachers in the world using multiple channels. The teacher is critical to help his/her students assimilate the provided material that may come from a scientist with a different culture or frame of reference.

The work originated in Pittsburgh, but the Supercourse and the Library of Alexandria work closely together. The Library has distributed thousands of CDs containing

the Supercourse. The Supercourse also has a lecture on the Library of Alexandria. We want to build a bridge between East and West and have worked closely to build a Muslim Scientific Supercourse of 1,800 individuals closely interacting with the US and the West. A copy of the Supercourse is on the Library of Alexandria server and the Pittsburgh and Alexandria teams work closely together. We have built a unique public health diplomacy going from east to west and from west to east.

3.4 Some Facts and Figures

The Supercourse consists of:

1. *Open source*: Global faculty share their best PowerPoint lectures on Prevention. Experienced faculty members beef-up their lectures with little struggle. New instructors reduce preparation time with better lectures. Faculty in developing countries apply current scientific template lectures to build their own.
2. *"Coach" educators*: The Library of Lectures consists of interesting lectures by scholars in prevention. The classroom teacher "takes" them out for free. Faculty who contribute lectures will shortly answer questions through a global help desk.

3. *Teaching faculty*: Six Nobel Prize winners, 60 IOM members and other top people contributed lectures. Almost half are from outside the US.

4. *Mirrored servers*: We have 45 mirrored servers in China, Egypt, Mongolia, Sudan and other places.

5. *Free CDs*: We have distributed 20,000 Supercourse CDs.

6. *Multiple channels*: In addition to PowerPoint we are using multiple knowledge channels to share information including web and pod casting.

7. *Teaching a million*: The best teachers should produce the best lectures to teach thousands if not millions. We tested this with our lectures on disaster and likely will reach a million students with a single lecture.

8. *Just-In-Time lectures*: We created scholarly lectures within days after the Bam Earthquake, Kristina and Rita, and Avian Flu. We "drilled" these into the classrooms of the world, reaching 120 countries.

9. *Quality control*: There is very little scientifically-based and effectively-administered quality control in education. We have been exploring scientifically-based quality control from other disciplines.

10. *Global health society*: We are building a global health society which will include a journal and meeting.

11. *Global Health School*: We are creating some new models for Global Health Schools. These are—like the "Honda CRX"—inexpensive, small, but of high quality, nimble and sustainable.

12. *Progress*: We published over 170 papers in journals including Nature, Lancet, BMJ, Nature Medicine, PNAS, among others. Our web pages have been identified as at the top 100 by PC Magazine. We receive 75 million hits a year and likely will help teach over a million students. We are the largest suppliers of lectures of Global Health in the world.

3.5 The Future

The Supercourse uses the power of the local classroom teachers and enhances their ability to teach. The goal is to provide the best possible template lectures over the Internet using Open Source system to "beef up" the lectures worldwide. This improves teaching with less struggle. We scientists help scientists without expensive middlemen publishers. We already observe enormous success with thousands of instructors, the teaching of up to a million students with a single lecture, and the collection of the best scientific teaching materials on prevention.

We see this as an important means to bring the top experts of the world to the table, and have them work together. Scientists want to collaborate across their boundaries and we have established a means by which this can occur. The future of all our countries is our health and our children. We can train students now so that we all will live longer and more productive lives, by making accessible and sharing the prevention knowledge of the world.

4. Helping In Crisis Situations: Just-In-Time Lectures

We discovered the power of Just-In-Time (JIT) lectures during the Bam Earthquake in Islamic Republic of Iran. This also brought Ali Aralan into the Supercourse. Days after the Bam Earthquake we created a lecture by one of the most important persons in global disasters, Eric Noji, MD. Within days after this, Ardalan from Tehran created a wonderful lecture on the Bam Earthquake which was used worldwide.

We discovered that most disasters had a "prodrome". This is a period of time before which the major effects of a disaster are felt. For example, the twin hurricanes in USA

had a 4–5 day period before they struck land. During this period we reasoned that we could rapidly establish a lecture, and make it available. As soon as the Katrina was on the radar, Ali Ardalan from Islamic Republic of Iran, and Ronald LaPorte contacted 30 meteorologists worldwide. Within two days, with their help, a scholarly lecture on "What is a hurricane" was created. We did this as people of the world were obtaining their public health and meteorological information from CNN and seeing dead bodies floating, and crushed houses. Our main concern was what we call the "epidemiology of fear" whereby much of the damage to a country from a disaster likely comes from fear to those who were not directly affected. We were able to find people who could send the lectures to all the schools in Texas and Pennsylvania, and to all the epidemiologists in Texas, as well as 42 of the 50 States. Just-In-Time lectures are a very powerful method to educate students about earthquakes.

We did exactly the same thing with the earthquake in Pakistan. Ali Ardalan from Islamic Republic of Iran prepared a beautiful scholarly lecture on "what is an earthquake" (*see www.pitt.edu/~super1/*). Khawar Kazmi, MD, undertook to distribute this to the schools of

Pakistan. There are 54 million students. We think we can reach several million of them. This is more of concern as Pakistani television continually showed crushed schools, and kids being pulled from the rubble. Kids are scared of school, and they need not be. Our lecture presents the science, showing how earthquakes develop, and also showing that although deadly, one is 40 times more likely to die of a heart attack and that any one year a child has one chance in 300,000 of dying in an earthquake. This is not to downplay the importance of earthquakes, but is important for students to know their actual risk, to counter the fear driven by the images in the media with a more rational assessment of the real level of risk.

5. Towards a Global Science Supercourse

5.1 The Scope of the Proposed Effort

We have been highly successful in improving training, research and collaboration in our chosen Public Health discipline, with tens of thousands of academic faculty and the largest collection of scholarly scientific presentations on disease prevention in existence. Why cannot we expand this to all of science and have a million faculty and 300,000 lectures helping each other? Why not put into the Supercourse PowerPoint lectures of our recent

publications? If this were possible then we could start to melt our scientific silos, thus epidemiologists could teach students about the chemistry of water pollution, chemists could teach about the marketing of products, and researchers in the Gobi desert could teach their students about the formation of snowflakes. In addition we can reduce the scientific divide between the haves and have-nots. We can also reduce the speed by which scientific information comes into the classroom from 7 years to 7 hours, or even 7 minutes.

We would use exactly the same approach as with our Public Health (epidemiology) Supercourse. The first step would be to network scientists in different communities of practice, as far as we can worldwide. The second step would be to extract and share their best PowerPoint lectures. The third step would be to present them in a coherent framework.

We recognize that there are those who would have substantial fears that astrology would find its way into astronomy lectures, or that creationism would slip into evolution or biology lectures. However, two very real examples should assuage these fears. First, the experience of the epidemiology public health Supercourse is there for

us to evaluate. It has been quite successful in maintaining very high standards. The second example is even more dramatic: Wikipedia, has hundreds of thousands of articles and has succeeded in maintaining quality by mobilizing the communities of practice to review articles and maintain quality.

Socrates was right "there is only one good knowledge, and one evil ignorance". With a Scientific Supercourse we can revitalize the teaching of science in the world and empower future generations of young scientists.

Replicating the successful experience of the Health prevention Supercourse and extending it to other domains, will require slight changes in the way we can move from a single field where the initiators were international experts of the highest caliber, self-selected into creating the teams that pushed this forward. They combined scientific expertise, Internet savvy, and a remarkable ability to network. These key individuals were critical to the success of this enterprise. Other individuals with similar attributes will have to be identified and mobilized in other domains. It is not immediately obvious that those who volunteer their services will necessarily be the best suited to the tasks. We must also be able to screen and

weed out astrology from astronomy, numerology from math, creationism from evolution. Yet we do not want to lose out on the enthusiasm of young researchers around the world who may have both the time and willingness to participate in such a venture.

5.2 Organizing for Implementation

It is thus proposed that we have a general committee of experts to guide the overall growth of the enterprise, anchored in several institutions around the world. The operative word is "guide", not "administer". The activities themselves would be based on three concentric circles, starting from the broadest to the central.

The general participants' contributions. This is like the Blogosphere. It is volunteered material from many which may not be vetted and where some discernible future patterns may later emerge. It encourages activism and participation from all over the world, but may contain errors and downright lies (intentional or unintentional). Remember that a head-of-state was once pushing a view that HIV is not the cause of AIDS.

The Knowledge Sphere. This is information divided into "domains of knowledge", each governed by an identified

"community of practice", as happened in the case of the health prevention. The material in the knowledge sphere is either produced by them, or approved by them. They will also organize the overall structure so that people can find material more easily and navigate this particular "domain of knowledge". Each community of practice will have one or more individual(s) acting as anchor(s). These anchors must be eminently recognized individuals in their fields with known institutional affiliations. They may be members of the committee of experts or at least will be in touch with them. For purposes of our vision, these have to be the best possible people willing to give the best possible lectures.

The Select (Golden) Lectures. These are the best of the best, in each domain, from introduction to science to highly specialized lectures. To these we can hope to provide the same treatment given to the Eric Noji lecture in the case of health. These will be selected by the communities of practice and the anchors.

5.3 Outputs

Based on our previous experience, the outputs of this proposal are:

An International Portal for Activist Science. From science education to crisis management, an enormous amount of posted information, organized into coherent domains of knowledge, will be available and searchable and downloadable for free. The Library of Alexandria, known as the Bibliotheca Alexandrina (BA) is ready to host this portal and maintain it. The BA had just formally joined the Digital Library Federation, a group of some 30 institutions that include the Library of Congress, MIT, Caltech, Stanford, Harvard, Yale, and thus has the wherewithal to undertake this task. The BA is also collaborating with the French Academy of Sciences to Arabize the portal "*Main à la pâte*" (*Hands-on Science*, for young people) and will host that portal as well.

Communities of Practice: in every domain, in every country in the world. Networked communities of practice will be engaged in the promotion of science and education, using the tools of the 21st century to address the global problems of ignorance, poverty, disease and malnutrition. These linked thematic communities of practice will become a network of networks, a very powerful tool for the promotion of international collaboration in many fields.

Crisis teams: drawing from different communities of practice and building on experience it will be possible to create crisis teams to address the needs of different crisis situations from around the world. These will include combinations of scientific/technical expertise and ICT expertise. The presence of such teams means that we will also build on shared experience from different crisis situations to become ever more effective.

Golden Lectures. A selection of the best of the best lectures that result in millions of people being able to have the experience of attending such an event, and the storage of such videoed lectures for others, will over time create a great educational legacy. Here the goal is to create multiple channels of lectures which include web casting, video, web archiving, PowerPoint, pod casting. The more channels we have, the easier it is to cross the digital divide. Furthermore, some of these lectures that are produced by the great luminaries of our time, the very best of the best, selected by the authors themselves, should be considered a *legacy* for future generations. These lectures would be a snapshot of the state of science at the beginning of the new millennium.

Derivative materials. From the crisis situations and the communities of practice as well as the golden lectures, we will have important inputs for people who may want to make movies and documentaries for broadcast through television.

Distribution systems to schools. Our mission is to reach the teachers of the world with very high quality lectures to be used in their classrooms. We will establish an Internet-based supply chain which will be an end-to-end solution to bring the best possible global scientific materials into the classrooms of the world.

5.4 Sustainability

The international communities of practice will be the guarantors of continuity and sustainability as they evolve and grow, and new members join their ranks. The cost of collection and delivery of materials will be very small in relationship to the numbers of teachers who will use these materials. Delivery of materials to any school will probably be less than the cost of a single textbook. We envision that this system could tap into the global library systems of the world with the Library of Alexandria taking the lead. They will be renewed by new generations of members. Sponsoring institutions will help (see below).

5.5 Getting started and sustainability

The epidemiology experience showed, it is better to *start with domains where there is existing and willing expertise*, and where at least an embryonic international network exists. This will ensure that the minimum conditions for growth are there for when the initial impetus is given. Whether we start with two, three or seven or ten communities of practice would depend on these initial conditions.

These should be announced with a proper launch event, highly publicized and inviting the participation in this open collaborative effort, with minimal screening. The community of practice would gradually and gently handle the quality control issues.

Build a consortium of sponsoring institutions. Here we could follow a DLF or JSTOR type business model: one time fee to become a sponsor plus a smaller annual fee to support the program.

6. Envoi

If these be dreams, let us salute the dreamers. Were it not for dreamers, men would be still living in caves. In

the exciting world of the new century, of the Internet and of instant communications, or plentiful knowledge and willing minds and hands across the planet, is it conceivable that basic knowledge of science should remain hostage to those who control books and textbooks and those who have the means to buy them? Surely, we can do better for the 80% of humanity that is presently inadequately equipped to participate in the exciting scientific and technical revolutions of our time. As they are empowered to provide such material into every classroom, the younger generation of students will be better able to take charge of its own destiny, to harness technology to its needs and to become real producers of knowledge, not just consumers of technology. This is a future that is within our grasp. We intend to do our part to make it happen.

Chapter 6

FROM KNOWLEDGE TO WISDOM

We are bombarded with data. And every day brings more data. Can anyone imagine how much data we will have by 2050? The challenge is how to organize data so that it becomes information, how to link and interpret information so that we gain knowledge, which hopefully, when refined in the crucible of experience, with insight and reflection, may lead us to wisdom. The wisdom to create that better world to which we are all committed. It is by these tasks that the "information society" will become the knowledge-based society, with its technology-driven economy.

The Internet provides the framework of the global connectivity that earlier generations could only dream about. However, material on the internet is ephemeral. The average lifetime of a page on the internet is about 100 days. Thus, we need to list it into an organized fashion, the collective and growing body of knowledge; the best of our heritage. As our heritage is the touchstone of our memory and the wellspring of our creativity. Efforts like the Internet Archive will have enormous value to future

historians, but they are getting so large, that unless there is a way of organizing that material into collections, the growing mountains of knowledge will become troublesome to store, hard to organize, onerous to keep and difficult to access. It is here that the *digital libraries of the future* can indeed bring humanity together and enrich everyone with unlimited access to all knowledge 24/7.

The new technologies can provide knowledge to virtually everyone, everywhere. However, scientists and technologists in developing countries have limited access to recent research findings (mostly in journals), to reference materials (mostly in libraries elsewhere), and to databases (some of which are proprietary); and these problems have been exacerbated in the past decade as information streams turned into torrents. The risks of marginalizing large parts of the developing world and creating a scientific apartheid are real. We need the new digital libraries of the future to be committed to providing all knowledge to all people at all times, and help turn the 80% of humanity living in the developing world into producers of knowledge rather than just consumers of technology.

The new digital libraries can create access to coherent domains of knowledge. The enormous advances in Information and Communication Technologies (ICT) have opened up opportunities for remedying the situation as never before. Incredibly powerful search engines, and massive connectivity, ubiquitous instantaneous contact from all parts of the planet, not to mention the possibilities of the semantic web, and federated search, all combine to show glimpses of how unbelievably powerful new technologies can transform our ability to interact with knowledge, organize it, render it accessible, and expand the domain of reason, learning and dialogue. Europe, with its strong commitment to public goods and the support of culture and cultural diversity could play a central role in this new era.

However, such a vision of the future will require enormous changes in the whole gamut of regulations and laws that govern Intellectual Property Rights (IPR), These legal frameworks, need to both recognize the public interest in access to information as well as find ways of rewarding the innovators. In the US, the copyright acts have successively extended the monopoly granted to the publisher to unreasonable limits in response to lobbying

by corporate interests. Europe has recognized the idea of authors' rights as the fundamental source of legitimacy of copyright. That is why I have hope that Europe will take the lead in crafting that future framework.

Why not imagine a new system, where authors would enter into agreements with publishers only for, say, 2000 copies or two years, whichever comes first, and allow them to renegotiate the contract and keep receiving rewards for their creative work. This would last for the life of the author and say 10 or 15 years after his/her death. Such a system would ensure rewards to the creative genius but not necessarily to their heirs and assigns. Likewise, artists should keep receiving a percentage every time their painting is sold. After all, the increasing value of the work is intrinsic to the work, so why should the sales agent (Sotheby's or Christie's) get a commission and the original artists, if they are alive, get nothing? Such thoughts need to be considered by all who want to embrace the future rather than try to hang on to the past.

As Europe discusses the establishment of a new European Digital Library, and possible collaboration on a Mediterranean Digital Library, it is a propitious time

to discuss some of these new models of both business and regulation. These new digital libraries would present our cultures to ourselves and others in ways that only the digital technology of the 21st century could make possible. Digital Rights Management (DRM) is a crucial issue here. The choices are to apply the new technologies to perpetuate old business models or go back to the drawing boards taking into account the full possibilities of the new technologies for the benefit of the authors and creators on the one hand, and the public at large on the other hand.

The importance of these concerns comes from the enormous explosion of the information base now available. It is estimated that there are at least 100 billion pages on the Web. Some say five times as much. Whatever the actual number, it is an enormous amount of information, highly variable in quality, which is growing exponentially, or at least at a very fast pace. Yet, about 90% of that material is not accessible to the public, controlled by various public agencies and private organizations. Thus, Google now indexes only about 9 billion pages out of the total pages on the web.

In addition, the information that is now becoming available in enormous data sets can be visualized in 3D and virtual reality, and the possibilities of seamless search linking pages to images to objects, all open up vistas of unusual richness and unlimited possibilities.

Will these enormous possibilities be realized? Can Europe first create the new European Digital Library, and assist in the creation of the Mediterranean Digital Library? Can Europe indeed take the lead in creating a new IPR framework that truly compensates the authors and creators and provides access for all? So many questions that will transcend anyone's ability to imagine. After all, who can look 50 years into the future, when the past shows how poorly we would have guessed where the future will lay? Indeed, who would have predicted in 1980 that in two decades something called the Internet would transform the world, and that the wealth of the world's richest person would come from computer software? Very few. Yet, we should not despair. Recall that other predictions based on principle and political will that can bend technology to serve a social purpose can be brought about. After the disaster of the World War II, there were some who dreamed of Europe without borders, where

young Germans and young Frenchmen would never even imagine that they could go to war against each other. They were right. Their dreams are now largely a reality, and progress on the construction of Europe is still ongoing. So let us dare to be bold, dare to dream of a new future, where knowledge is accessible to all at all times, in a framework that rewards the talents of the authors and the creators and that recognizes the public good. Let us dream, for were it not for dreamers, people would be still living in caves.