The Role of Science in the Information Society Conference

Part I — Plenary Sessions

Monday, 8 December 2003, 2.00 p.m. to 7.00 p.m.
Moderator: Frank Rose

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1 Welcome to the RSIS Conference

Welcoming Address by Professor Luciano Maiani, Director-General of CERN

« Your Royal Highness, Mr Secretary-General of the International Telecommunication Union, Mr President of the Summit's Preparatory Committee, Mr Special Adviser to the Secretary-General of the United Nations, Mr Special Adviser to the Swiss Federal Council, Excellencies, Colleagues, Ladies and Gentlemen,

It is a pleasure to welcome you to CERN for the Conference on the Role of Science in the Information Society.

CERN's purpose is basic research, the quest for the ultimate constituents of matter.

CERN, today, is engaged in the construction of what will be the largest particle accelerator in the world, for at least a couple of decades to come.

We will be proud to show you the great pieces of hi-tech work related to the machine and to its detectors that are filling all empty spaces in the Laboratory, while waiting to be installed in their underground infrastructures.

Research in elementary particle physics has also led to major contributions to society.

CERN is basically a particle accelerator laboratory, one of the major centres for the progress of this technology. Fifty years ago, there were just a few particle accelerators in the world, used as tools of fundamental research.

Today, over half the world's particle accelerators are used in medicine. About 20 million people each year undergo diagnosis using radiopharmaceuticals which are produced by a particle accelerator.

The prime example of how important the role of science may be in the Information Society is undoubtedly the World-Wide Web. We are very glad that Tim Berners-Lee, the inventor of the Web, has agreed to come back to CERN on this occasion as a testimony of the importance of science for civil society.

A distinguished colleague of mine, Lev Okun from Moscow's Institute of Theoretical and Experimental Physics, wrote to me recently that, "the honey of knowledge is the product of science beehives", going on to add that "it is not an accident that the most advanced and the most international of such hives — CERN — became the cradle of the Web."

Invented at CERN in 1990 in response to the communications needs of the world's particle physics community, the Web has gone on to revolutionize the way we share information and do business. Its value to the world's economy would have paid for all the fundamental science done last century, many times over.

The Web has influenced the way in which science is done. A good example is the electronic arXiv repository in physics which is open to any user of the Web. You can post your hot new article on the arXiv.org site and the next day anybody on the globe who has access to the Web can print it out and respond to it (all free of charge!). This has drastically enhanced the pace of research and involved in it scientists from countries and institutions where ordinary scientific journals are unavailable.

The existence of electronic archives is especially important at a time when the price of journals (both paper and electronic versions) is soaring. A ray of light in this situation is the international electronic *Journal of High-Energy Physics*; access to it on the Web is free of charge.

Freedom of expression and freedom of opinion, the right to exchange information and ideas regardless of frontiers (as enshrined in the Universal Declaration of Human Rights) are the necessary premise of the information society. In building such a society, the ability for all to access and contribute their information, ideas, and knowledge is essential. The Web was built and developed along these principles, which are the basis of fundamental research and the basis of the Web's success. In a recent discussion at UNESCO, by the Ministers of Telecommunication, free access to the resources of the information society has been strongly advocated.

Particle physicists, at CERN and elsewhere, are committed to developing new tools, such as the Grid, with potential benefits for all countries on both sides of the digital divide, in the areas of science, education, medicine, technology, and economic development.

In line with the UNESCO Ministerial statement, we are fully convinced that benefits from these revolutionary developments can be obtained by all countries only on condition that:

– fundamental scientific information is made freely available;
– the software tools for disseminating this information are also made freely available;
– networking infrastructure for distributing this information is established world-wide;
– training of people and equipment to use this information is provided in the host nations.

To realize these conditions is a formidable challenge which will require close collaboration of science, industry and governments. We urge that these four topics be given suitable prominence in the discussions which will take place here, to serve as input to the World Summit, later this week.

On 7 March 2003, the UN Secretary-General, Kofi Annan, issued a challenge to the world's scientists to address the clear inequalities in scientific activities between advanced and developing countries. And here, I turn to another theoretical physicist. The late Pakistani Nobel Laureate, Abdus Salam, believed that the gap between rich and poor nations was one of science and technology, and much of his life was devoted to closing that gap. In 1988, he wrote that "in the final analysis, creation, mastery and utilisation of modern science and technology is basically what distinguishes the South from the North. On science and technology depend the standards of living of a nation."

Our conference, organized jointly by CERN, the International Council for Science (ICSU), the Third World Academy of Sciences (TWAS), and UNESCO, responds to Kofi Annan's challenge and continues Professor Salam's mission.

Before handing over to Adolf Ogi, I would like to thank our partners, ICSU, TWAS and UNESCO, and our sponsors the Oracle Corporation, the Republic and Canton of Geneva, the Swiss Agency for Development and Cooperation, the Santa Fe Institute, the UK's Engineering and Physical Sciences Research Council and Particle Physics and Astronomy Research Council, the Spanish Ministry of Science and Technology, the Swedish Research Council and the African Virtual University. I have every confidence that we scientists can answer the challenge set to us by Kofi Annan, and I wish you a successful conference. »

2 Welcome from the Host Country

H E Mr Adolf Ogi, Special Adviser to the Swiss Federal Council on the World Summit on the Information Society, Under-Secretary-General and Special Adviser to the Secretary-General of the United Nations on Sport for Development and Peace

« When Thomas Edison invented the light bulb, his dream was to allow each household to have one. When Tim Berners-Lee invented the World-Wide Web, his dream was to connect every human being. And their dream was a great dream, because technology should benefit all human beings.

We are privileged to live in times of great technological advances. Thanks to scientific discoveries, and thanks to rapid access to information, doctors, for example, can now save lives they could not save before. Thanks to modern means of communication, they can even directly intervene on a patient across the oceans. This is just one example of what technology can achieve today. This implies great challenges for tomorrow.

We all know that the infrastructure of technology is just one part of the question. We all know that at the core of the debate is the human being. The real questions are: To whom do we choose to give access to the new technologies, at what price and for what purpose? Are we ready to take the necessary measures, so that each one, without discrimination, can have access to information, to scientific and technological progress? Are we truly determined to invest money, time, and energy into making universal access a reality? The international community is asked to provide answers to these questions.

Ladies and Gentlemen, I have no doubt that this summit will bring light to the debate.

Switzerland, the host country for the first phase of this Summit, is committed to making it a significant event, significant in terms of its outcome, significant in terms of its appeal, significant in terms of its innovative inclusiveness. For the first time, governments, the private sector and civil society all participate in the negotiating process. As in all democratic processes, the various parties do not always agree. It really is a superb democratic achievement that the disagreements can be voiced aloud, in public. I am proud of this democratic debate.

As a Swiss, I am proud that Switzerland is the home of CERN. When CERN was established fifty years ago, its founding idea was 'science sans frontières', science without borders. This vision was strengthened by UNESCO's role at the foundation of CERN, by an aim to foster international, collaborative research without boundaries.

CERN is also where the World-Wide Web began. This World-Wide Web, that allows unprecedented access to information, information that governments, the private sector and civil society will have to help place at the disposal of development worldwide, for the benefit of us all, for the benefit of our children and coming generations.

On behalf of the Swiss Federal Council, I welcome you all to Geneva, and I wish you fascinating, constructive and fruitful debates. »

3 RSIS at the World Summit on the Information Society

H E Mr Adama Samassékou, President of the WSIS Preparatory Committee, President of the African Academy of Languages, Former Minister of Education of Mali

Towards a Genuine Knowledge and Shared Know-How Society

« Your Royal Highness, your Excellencies, Secretary-General of the ITU, Director-General of CERN, Ladies and Gentlemen,

I would like to begin by thanking the Director-General of CERN for having invited me to participate in the opening of the CERN Conference on the Role of Science in the Information Society, on the occasion of the first phase of the World Summit on the Information Society beginning the day after tomorrow.

It is both an honour and a pleasure for me, as President of the Preparatory Committee for the Summit, to be able to exchange views with you on an event that is important not only for the international community, but especially for you, as representatives of the world scientific community, who have a unique role in the information society that is now taking shape.

That unique role is one that you are already assuming by organizing this event. However, I am well aware that it is also fully consistent with the time-honoured tradition of the scientific community in general and that of CERN in particular.

Indeed, I am convinced that the scientific community has an exemplary record in many respects. Science is a collective and global enterprise. It knows no frontiers and relies on constant cooperation among all concerned. From the first exchanges of scientific correspondence in the seventeenth century to the wealth of exchanges that underpinned the fascinating progress made by the physical sciences in the 1920s and 1930s, and ultimately to the great multinational institutions like your own, scientists have always engaged in cross-border cooperation.

Another characteristic of science that is less well known to the general public, but no doubt familiar to you, is the spirit of competition. In your particular field of fundamental physics, as well as in nearly all scientific disciplines, the desire for discovery is a key source of motivation. At the individual or group level, making a discovery and thus being ahead of everyone else is a factor of major importance and opens the way to fame and, in some cases, many and various rewards. However, this competitive dimension has a paradoxical side to it, in that competing scientists must continue to collaborate, if only in order to validate their findings.

Even Einstein's articles on relativity had to be validated by his peers! What I consider important, therefore, is that the competitive aspect of scientific research should in no way detract from the tradition of cooperation and solidarity among researchers. This essential lesson is imparted to us by the scientific community in general and by CERN itself — a truly collective and multinational institution if ever there was one.

A third characteristic of science also deserves thoughtful consideration: science operates in networks. Researchers throughout the world are in constant communication with one another, it being essential that they remain in contact in order to test ideas, check facts, establish experimental protocols, validate results, and compare opinions.

As you are well aware, it was the very idea of a network to facilitate cooperation between researchers in the field of information technology that gave rise to the Internet, and indeed the World-Wide Web came into being right here, thanks to the brilliant intuition of Tim Berners-Lee in the service of an environment, that of CERN, which undoubtedly contributed to wide-ranging discussions on collaboration between networks. From this standpoint also, the world of science prefigures the information society and deserves our careful attention. A famous sociologist, Manuel Castells, has clearly shown that the information society will be a society of networks. We must therefore heed any lessons that the scientific community can impart to us in this respect.

But rather than continue with what for you is an entirely familiar line of thinking, let me invite you to consider some concerns that are perhaps not adequately taken into account in the world of science, or at least in some scientific communities. I refer to the glaring inequalities that are to be found in the realm of scientific development. UNESCO has published a series of world science reports which eloquently address this theme: in all areas of scientific research, where public and private investment and the number of graduates, researchers, patents and publications are concerned, the disparities are enormous and continue to grow, resulting in an alarmingly massive loss of intellectual — particularly scientific — resources.

In short, the brain-drain is assuming disastrous proportions. I know that many institutions, including your own, are making every effort to take in researchers from developing countries in order to train them and give them an opportunity to work in a suitable environment, and for this I would like here and now to thank them. However, the situation as a whole remains fraught with serious dangers for the future.

The Declaration of the World Summit on the Information Society makes it very clear that the future of that society lies in the capacity to create, invent and innovate, particularly in the fields of science and technology. The fact that many developing countries are at a disadvantage in this regard is a very bad omen. The already very substantial digital divide could well become a knowledge divide that is even more difficult to overcome.

Indeed, the disparity is no longer merely a matter of the technological tools, which are lifeless instruments, but of entire nations. The capacity to train engineers and researchers, make high-level scientific institutions operational, and file patents and licences requires considerable resources and a great deal of time. As you know better than I, research in the realm of physics has readily found applications in information technologies, for example flat screens or mass memory devices.

I therefore appeal to the entire scientific community to mobilize, on the occasion of the World Summit on the Information Society, on behalf of those countries that find themselves at a disadvantage in the great adventure of scientific research and the production of technological know-how.

I would like now to share with you another subject of concern, one perhaps even further removed from your specific area of interest, namely the question of traditional knowledge. While science has today come to assume collective dimensions at both the national and international levels, it is equally the case that indigenous knowledge has served human communities since time immemorial.

However, such traditional knowledge is now under threat. First of all, the arrival of ‘western science’, validated by complex methods, could end up sidelining, and subsequently obliterating from memory, traditional forms of knowledge that are just as valid. Secondly,

some western companies do not hesitate to appropriate such knowledge and reap commercial profit from it by having it patented. Both these phenomena are today clearly recognized.

The World Summit has not hesitated to draw the attention of the international community to this alarming trend, and I welcome that fact. I should like to take this opportunity to suggest that you examine this topic in detail. A symposium on the inter-linkages between traditional knowledge and contemporary scientific knowledge might perhaps serve to lay the groundwork for more far-reaching cooperation and more effective action in this field.

It remains for me to raise one last concern, which has to do with the ethical dimension of science. This is perhaps a less momentous issue in physics than in the biological, medical or environmental sciences, but its importance should not be underestimated. Scientific know-how is neutral to the extent that it explores reality and seeks to establish the laws governing its operation. However, science is not immune from dangerous aberrations for the present and future generations.

It is not without significance that the Summit's preparatory process has sought to address the ethical dimensions of the information society and use of information and communication technologies. This initiative is entirely consistent with that approach. From the most abstract science to everyday applications, we must be careful to comply with ethical standards that are geared to preserving the human dimension of our collective efforts.

On a broader scale, I welcome the fact that the preparatory process has brought to light a large number of difficult issues that are merely technical in origin but which are giving rise to political discussions and negotiations in which the stakes, on a global scale, are vital for the societies of the present and future. The implications of the information society are as much societal as they are technological.

This is a considerable achievement on the part of the preparatory process. Internet governance and network security are indeed burning issues, but the dawn of the information society causes us to look towards the very future of humankind. Yes, the preparation of the World Summit on the Information Society raises real difficulties and conflicts in respect of ideological and political values: what is the nature of the society that we wish to build for ourselves and for future generations?

The issues being addressed by the Summit are vital because they touch on the fundamental values of our societies — values which underpin our vision of the world and our political choices, and which frequently — as in the case of science — involve us in ethical choices. There cannot be many of us who ever imagined that this Summit would end up raising such issues. And even fewer had any inkling of the scope of the human dimensions — political, ethical and societal — of the Summit's themes.

The World Summit on the Information Society is not just another summit. It has long since ceased to be the summit on information and communication technologies. Its aim is to define nothing less than the future of humankind, by seeking to build a genuine momentum for partnership between the main stakeholders, namely governments, the business sector, civil society and intergovernmental organizations, at the national, regional and international levels. The support required from each individual is therefore essential.

It is necessary, as a matter of urgency, to define the contribution of science and of information and communication technologies to the development of our countries. They should accelerate the development process and contribute to the fight against poverty, disease and ignorance by ensuring access to information and education. They should

facilitate action to combat natural disasters and help protect the environment. They should contribute to the fight against unemployment, create jobs and open up markets. They should improve productivity and make our countries competitive on a global scale.

To my mind, the challenge of the World Summit on the Information Society is twofold, being both technological and human. It is necessary to narrow both the digital divide and the knowledge divide. The information society therefore has to be about sharing in the broadest sense of the term; sharing through communication and information exchanges, as well as enhancing the ability of human beings to participate in the creation of knowledge, access information and use that information productively by transforming it into new know-how.

I have sought to share with you today my vision of the information society — a society of communication between individuals, a society of knowledge and of shared know-how, and, above all, a society characterized by solidarity between all the inhabitants of our planet, following the example set by the world of science and scientific communities. Information and knowledge can already be exchanged, shared and communicated over global networks.

All the citizens of the world will tomorrow, if we secure the necessary resources, be able to dialogue freely, share their knowledge and know-how and enrich their life experience through cultural exchanges. They will be able to build knowledge societies based on the wealth of their past and present linguistic and cultural heritage, thereby establishing a new solidarity founded on enhanced mutual understanding. They will perhaps be able, at last, to select common objectives that respect the freedom and dignity of all.

Thus it is that this Summit, which could on the model of the Earth Summit, be called the World Summit on Solidarity, will lay the cornerstone for a new abode for humankind — the abode of universal solidarity and peace.

May God help us in this great task! »

Mr Yoshio Utsumi, Secretary-General of the International Telecommunication Union

« Your Royal Highness, Excellencies, Ladies and Gentlemen. It is an honour to be invited to address the opening session of this Conference on the Role of Science in the Information Society. It is only right to highlight science's special role in driving access to information and communication technologies and it is appropriate to host this meeting at CERN, the birthplace of the World-Wide Web.

As close neighbours, the ITU and CERN have always shared an effective and fruitful working relationship on telecommunications and networking issues. Aristotle once said: "All men by nature desire knowledge." We can all agree with this. It is vital that we build an inclusive knowledge society that can satisfy the yearning of those billions of people who are still today excluded from extraordinary scientific and technological advances that humankind has achieved.

This is one of the reasons that the ITU proposed the United Nations to hold the World Summit on the Information Society. The ITU's responsibility for organizing the Summit places it at the centre of one of the great challenges of this millennium, making information and communication technologies or ICTs accessible to all citizens of the world.

Ladies and gentlemen, scientists are for the most part poorly funded. We are poor. Many promising experiments and projects fail for lack of funds. Governments feel they have to justify expenditure to their citizens and they are inevitably reluctant to back long-term projects. At the same time they are aware that the scientific and technological advances are key drivers to the growth of nations and societies.

So how should governments best support scientific research? About 30 years ago the British government attempted to answer this question. They asked a distinguished academic scientist, Sir Frederick Dainton, to write a report on the role of government-funded science. Sir Frederick's final report concentrated principally on funding pure science, on which the government of the day — and this is true of many governments even today — had difficulty in knowing how to act. So they asked for a second opinion.

The second opinion they sought was from Lord Victor Rothschild, a distinguished scientist who worked in industry. Rothschild was a no-nonsense, hard-headed type who argued for the virtues of funding focused applied sciences. The British government was perplexed at the two contradictory but worthy reports and they could not make up their minds which report to adopt. So it published both reports in a single volume called 'Green Paper' and put it out for discussion and consultation. As you can imagine the floodgates then opened. The letter columns of *The Times* and scientific journals had the most distinguished scientists giving their views, while later editions had equally distinguished scientists giving opposing views. The academic world threw itself into the debate. Eventually the British government came up with a science policy, which — not surprisingly — did not satisfy everyone. It represented a balance of many divergent views.

There are many parallels to this story within the process that has brought us to this first phase of the World Summit on the Information Society. Our world is full of divergent opinions and different, even conflicting world visions. Like the British government's experience, the bringing together of a shared vision of a global information society and an action plan has not been an easy task.

I would like to emphasize that we see this Summit as the beginning of a process, not an end. In some areas there has not been agreement. But, at least we are defining a process to reconcile diverging points of views before the next phase of the Summit in Tunis in 2005.

A couple of months ago, the ITU brought to Geneva 255 young students from developing countries, selected as likely future leaders in the telecommunications and ICT sectors. As their contribution to the Summit, these young people made a joint declaration of their hopes for the Summit. The opening passage of the declaration was a challenge to the eloquence of the most seasoned politicians:

"The world we live in is not fair at this moment. Some of us benefit daily from the empowering force of ICTs, while others, to whom simple communication could mean the difference between life and death, hope and downheartedness, a sparkling future and stagnation, do not have access to any form of ICTs. This is not our destiny."

I submit to you that constructing a world where everyone has access to scientific discoveries is not an act of generosity but principally a demonstration of good common sense. »

4 Keynote Presentations

Nitin Desai, Special Adviser to Kofi Annan on WSIS

« Your Royal Highness, Director-General, my friends, Mr Ogi, Mr Samassékou, Mr Utsumi, all of those who have been working very hard for this Summit,

It is a pleasure for me to be here. I have organized many summits, so my status in this summit is a bit like an uncle at the wedding. As I said to Mr Samassékou, Mr Utsumi and Mr Ogi when they observed that the conference would be difficult: "Well, it is worth doing because it is difficult. If it had been easy it would not have been worth while." I am very happy that things are all in place and we look like getting an interesting programme and declaration of principles ready in time for the Summit.

The Moderator asked me what my worst nightmare was about the information society. Perhaps one of my worst nightmares about the information society is that the net result may be that we will lose our capacity to converse with one another, to talk to one another. We will be too busy reading our e-mails.

The first telegraph message sent was "What hath God wrought?" The first telephone message was sent by Alexander Graham Bell who managed to spill some acid while he was making his phone call and the first phone message was a barked message: "Mr Watson, come here I want to see you." And the first Internet message was two letters, LO, after which the computer crashed. And maybe this is what the future holds for us, that we will all end up talking in staccato English.

The Moderator also asked me: "What is it that excites you most about the possibilities of information technology?" And that is what I am going to focus on, that is what this Summit is about. And I am particularly happy to do it here at CERN, the place where the World-Wide Web was born: for many of us lay people, the Internet is the World-Wide Web and e-mail. This was a technology that was basically developed by scientists for the purposes of communicating with one another, for disseminating content and for collaboration.

This was later combined with a dramatic reduction in the cost of connectivity of computers during the 1990s. The development of faster communication, content dissemination and collaboration has had a tremendous impact in every area of life, whether in business, in government, education, health, or culture.

But the area that I am, of course, much more familiar with is governance. Much of the profound impact on governance was, of course, focused in terms of governments working better and in different parts of governments being able to connect with one another. Some of it was reflected in terms of governments interacting better with citizens.

But I want to stress and focus on a third dimension, namely on the impact that this technology has had on democratization and that it can have in terms of democratization in the future. We have looked a lot at the impact of this technology on the economy and productivity gains and of the way in which geographical barriers have been eliminated so that production can be organized in a completely different way. That is profoundly important. A lot of people have looked at the impact in terms of how large organizations like governments work more efficiently and more transparently. Let me give you a few examples.

In the Philippines there was an attempted *coup d'état* and do you know how the *coup d'état* was stopped? Quite simply with SMS messages on the telephone. People just mobilized quickly using SMS messages and stopped the *coup d'état*. What was the principal source of

information for people in Milosevic's Yugoslavia? It was the Internet. What has been our most important source of information out of Baghdad before, during, and after the war? A blogger called Salam Pax. What lies behind the Landmines Treaty? The use of the Internet by citizens groups in about 60 different countries who joined together through the Internet and created so much pressure that governments had to respond. And this capacity of the medium to provide better connection between people is, I think, the contribution that it is going to make, and this is basically what it really started as. That is exactly what the old scientific ARPANet was trying to do, to connect scientists working with one another on an equal footing in a collaborative way, and that I believe is the future of this technology and this sector.

But what are the problems? In some ways a Summit like this always talks about problems. The one big problem, which Mr Samassékou referred to, which many people have talked about, is the digital divide, that is the great disparity in computers, connectivity and the capacity to use both of these, in different parts of the world and within the same country. The digital divide is a relative term. We can speak of a digital divide within rich countries. In the United States, where I work a lot of the time, the measure of the digital divide is: do you have a home computer or not? If your only access to the computer is the one at your local library, you are considered a digital have-not. I promise you, a person who has access to a public service computer in a poor country is considered to be a digital have. Similarly, in the United States only 31 per cent of African Americans have an Internet-enabled computer whereas only one per cent of Africans have it. So in many ways what we call the digital divide is to some extent society-specific.

My second difficulty with the concept is: it tends to focus attention on the digital side, as if the solution were a digital one, but in many cases the solution is not a digital one but an organizational one. In many cases the gap is not simply that somebody does not have a computer or a telephone line, it is also the incapacity to use it or a lack of content that the person needs, whether in terms of land records, agricultural prices, or whatever. So the digital divide is not something that necessarily requires only a digital solution.

Thirdly, I want to stress that in many ways this Summit is not about a problem, it is about an opportunity. The opposite of division is multiplication, so in some ways instead of talking about the digital divide we should probably be talking about digital multiples. Your telephone becomes more valuable if I acquire a telephone. That is true in any network society. We should increasingly focus on the need for people to connect better with one another, both for the purposes of articulating their views, which is the democratization concept, but also for the purposes of their productivity and for their income-earning capacity and knowledge base.

Clearly, once we see this as essentially something that allows people to connect with one another and access knowledge, issues of access to knowledge become important. This is a prominent issue. For instance, we speak of access to information, namely to scientific information. Clearly, the days of the expensive published journal should be behind us. No scientist makes any money by publishing an article in a very expensive journal. Very few people can afford it. There is no reason why we cannot have a system of dissemination of scientific information with a full refereeing procedure available faster and more cheaply to people all over the world.

These are some of the issues that we also need to address if we are serious about improving access to information. At the same time, there are serious concerns about copyright, for instance by musicians and others, which will also have to be addressed. You as the scientific community can address one dimension of this concern, namely the issue of Internet governance. This has been a major area of controversy at the conference. They have found a

way through by requesting the Secretary-General of the UN to set up a working group to address the issue. Much of what we call management of the Internet is done by the scientific community, although industry is involved to some extent. Perhaps one of the issues that needs to be addressed is: how do we involve more people, particularly people who are now entering this field in other parts of the world? This is something else for you to address.

I believe these are all issues of digital opportunity and they provide great hope for many people in many parts of the world. But there is also a great risk that if you don't address it, people will get left behind because things are moving so fast. If a country gets two, three or four years behind, it is way behind. It is not like the old industrial revolution. When we held the Rio Conference in 1992 there was no World-Wide Web. By the time we held the 10th anniversary of Rio last year the Internet and the Web had revolutionized communications. The pace of change over this decade should tell us something about what we can expect in the next.

So, for all of these reasons, I believe that the scientific community has a crucial role to play. You are the people who basically got this technology going and I believe you are also the people who have the capacity to address some of the problems that people sense in the use of this technology. Even more important are the huge opportunities for many more people to have access to it. So I look forward to your work and I look forward to your continued help as we pursue the task from Geneva to Tunis. Thank you very much. »

H R H Maha Chakri Sirindhorn, Princess of Thailand

Keynote Address on 'The Needs for ICTs in Developing Countries'

« Mr Adolf Ogi, Special Adviser to the Swiss Federal Council on WSIS, Mr Luciano Maiani, Director-General of CERN, H E Adama Samassékou, President of WSIS PrepCom, Mr Yoshio Utsumi, Secretary-General of the International Telecommunication Union, Mr Nitin Desai, Special Adviser to Kofi Annan on WSIS, Mr Walter Erdelen, Assistant Director-General for Natural Sciences, UNESCO, Distinguished Delegates, Honourable Guests, Ladies and Gentlemen,

I am very honoured to deliver a keynote address to this important gathering. First of all, allow me to express my deep appreciation to the Director-General of CERN and the Government of the Swiss Confederation for the excellent arrangements and warm hospitality.

In the information society, there are highly-developed Information and Communication Technology (ICT) networks. The access to information is equitable and ubiquitous. Appropriate content in accessible formats and effective communication can help people to achieve their potential, promote sustainable economic and social development, improve the quality of life for all, alleviate poverty and hunger, and facilitate participatory decision-making processes. The topic we will be discussing during this two-day conference is of the utmost importance because, I believe, without strong participation from the scientific community and continued scientific discovery, it would be very difficult for the majority of people of the world to realize our vision of the information society.

We are living in an increasingly globalized world where ICTs have played an important role in the development of our societies. Yet, I am sure we all agree that the benefits of globalization and technological advancement are, unfortunately, unequally shared. We have witnessed that, in many parts of the world, in particular those living in remote and rural areas, as well as those belonging to disadvantaged or under-privileged groups, are still

excluded from access to necessary technology, especially the Internet, or do not have the skills to use it in an effective and profitable way. The gap exists not only among countries but also within a country. In this respect, Thailand is no exception. The barriers to equitable access result from differences in education and literacy levels, age, income, and connectivity.

To overcome unequal access, we must take into account local conditions and specific needs and must proceed according to the sustainable principle. I wish to share with the distinguished delegates here, my experiences in science-driven ICTs and their applications in the education of the under-privileged and in social development in Thailand.

I have had the opportunity to follow His Majesty the King to almost every corner of the country, no matter how remote, since I was young. Through this experience, I have accumulated first-hand knowledge about people's way of life and living conditions. His Majesty has based his development work on scientific research and first-hand knowledge of the landscape and culture, and I have used the same approach in my work, including those related to IT, for the Thai people, especially those that are in need.

It is apparent that development must start with the empowerment of people. When I learned about IT and what it could do, I saw that it could be a potential solution for the purpose. This led me to set up, in 1996, a fund to be used in IT-related programmes. My greatest goal was to enable the under-privileged Thais such as rural school children and people with physical disabilities, to benefit from an increased use of IT so that they can have full participation in shaping political, economic, and social development.

Furthermore, my programme has focused on providing opportunities for the people to receive good education. The belief is that at the very least, they should be literate and be able to read official documents to gain knowledge about new technologies, because this would later help them to earn their living after completing compulsory education. In other words, it is important to equip young people with knowledge and skills to prepare them for full participation in the information society.

Presently, there are four groups of the under-privileged that I have focused my work on. Those are: rural school students, persons with disabilities, sick children in hospital, and prison inmates. In helping them to be IT literate and able to use IT as a tool in their education and learning of new knowledge, we provide computer facilities at various corresponding institutions, such as rural schools, schools for disabled persons, hospitals, and prisons, etc. Since teachers act as a gateway to the information society, their skills development and curriculum resources need support. Therefore, we help to train teachers and provide appropriate educational materials as needed.

To ensure that development is achieved, I started the programme on a small or pilot scale, and worked closely with each setting, frequently in a trial–errors–improvement mode, before further scaling up. And more important, I placed emphasis on monitoring and evaluation throughout the course of the programme to make sure that the programme as well as the evaluation teams worked in a cost-effective way. This also included procurement and maintenance of the equipment. When I am sure that the process is feasible I then give these tried and tested solutions to the administration in charge so they can scale them up to cover the entire population who can benefit from such undertakings.

Allow me to quickly highlight some of the achievements we have made over the course of our long endeavour, as follows:

– Students in more than 70 rural (and very remote) schools have the opportunity to learn and benefit from IT; many of them have won prizes in various national competitions; many have passed the examination to study engineering or computer sciences in universities of good standing; many have helped other young ones in their school and community to develop IT skills.
– Students in schools for the disabled have had the opportunity to learn and benefit from IT despite their "less-than-perfect" physical conditions, with the help of assistive technologies as appropriate, and some of them got IT-related jobs after graduation, some continued their studies in IT field at university level.
– More than 300 prison inmates have been trained in IT skills and have been able to take some typing or graphic design jobs which have generated income of over US$4,000 during the past three years. This income was partly reimbursed to prison inmates who did the jobs as bonuses which can be used to cover their living expenses while in prison.
– Female prison inmates who were trained specifically for this purpose have made more than 30 book titles into multimedia books in the DAISY format. These multimedia books will then be given to the library of the blind to add to their collection.

We also work with talented students, for example in science school, to encourage them to exercise their creativity. They can share knowledge with the public and enable them to succeed in their future studies.

Herewith, may I summarize and give my perspectives, which I have developed through the course of implementing such programmes. The main principle is to set the foundation for empowering those who are less advantaged by providing sufficient access to ICTs, by facilitating talented and enthusiastic people whose nature is the thirst for knowledge, and by encouraging them to participate fully in such endeavours. Being less advantaged can be caused either by their socio-economic status, geographic location, or physical condition. In the long run, it is hoped that these individuals will become more proactive in forging their own development and the development of their communities.

The challenge in all these undertakings is that there is no ready-made and no single formula for development that will suit the needs of everyone, everywhere. I do believe, developing a country must be done step by step. First, we have to build the fundamentals. Only when people have enough to eat and can meet their basic needs will they have a healthy and creative mind to accept other things or take on other challenges that are introduced to them, ICTs in this case. Throughout the course of development, a scientific approach and method as well as strong commitments are needed in order to achieve a successful and workable solution for development under each circumstance.

Lastly, let me conclude by emphasizing once again how important this conference is for the future of our global community. I am certain that Thailand is ready to work with you all to realize our common vision, that is, to free people from poverty and to achieve sustainable development of the information society for all. »

Walter Erdelen, Assistant Director-General for Natural Sciences, UNESCO

« Your Royal Highness, Excellencies, Ladies and Gentlemen, colleagues and friends,

It is a great honour and pleasure for me on behalf of the Director-General of UNESCO to take part in the opening ceremony of this important conference on the role of science in the information society. I wish to thank CERN for organizing and hosting this meeting, which is to discuss a number of issues that I see as crucial to the ways in which the knowledge society develops. I shall refer to the contribution of science to development and what it can do in particular to ensure that the benefits of that development are made available to all, notably by virtue of the tools of new technology.

UNESCO is indeed emphasizing the importance of equity, access and content in its overall contribution to the World Summit on the Information Society, which of course goes beyond scientific matters alone. This specific vision stems from the Organization's constitutional responsibilities and from its three current main strategic thrusts: developing universal principles and norms to protect and strengthen the common good; promoting pluralism and ensuring equitable access; capacity building and sharing of scientific knowledge.

It is undeniable that the world is in the throes of profound changes that are creating enormous new opportunities while posing equally daunting challenges. On the one side, advances in science combined with a digital revolution have the power to transform many aspects of our individual and collective lives. However, the digital divide is depriving countries and peoples in the developing world of the benefits, including the potential economic benefits, of these advances. The limited availability of information and communication technologies is thus a direct and major obstacle to knowledge-building and -sharing and consequently a denial of this very basic human right to enlightenment, learning, and empowerment.

The scope and effectiveness of UNESCO's action is of course limited and it seeks to make a difference in certain specific areas working in partnership with others where at all possible. In the scientific domain I can mention, for example, concrete initiatives aimed at improving science education and training and at disseminating scientific knowledge, including through the creation of multimedia courseware, virtual laboratories and virtual universities. I would also refer to the development of open-source technologies.

I would like to take this opportunity to inform you that UNESCO is launching a new programme in basic sciences known as the International Basic Sciences Programme (IBSP). This programme will be oriented towards two principal goals: building national capacities for basic research and promotion of science education. It aims at facilitating the transfer and sharing of scientific information, promoting excellence in national science, fostering awareness of science by society at large and providing the necessary international scientific expertise to Member States. IBSP will be based on the networking of existing centres of excellence or benchmark institutions in the basic sciences and science education. ICTs will play a decisive role in making such networking a reality and in fostering international scientific co-operation.

This new programme, like many other activities carried out by UNESCO, stems from our conviction that the flow of knowledge should not be a one-way process but that local and traditional knowledge and other expertise available in the South should be exchanged.

It is these and other issues of content that we hope will be at the centre of the first stage of this Summit here in Geneva and perhaps more so in Tunis in two years' time. I look forward to the Declaration and the Plan of Action that this Conference will produce and wish your meeting every success. »

5 Visionary Presentation

Esther Dyson, Chair of EDventure Holdings and founding Chair of ICANN, the Internet Corporation for Assigned Names and Numbers

« Your Royal Highness, your Excellencies, Ladies and Gentlemen,

Talk of Internet governance is in the air. The recent United Nations-sponsored World Summit on the Information Society, held in Geneva, issued a statement saying that "authority for Internet-related public policy issues is the sovereign right of States". It concludes by calling for a study that will make recommendations — at the end of 2005. For some of us, that's a rather long time. And government authority is the wrong conclusion. Taking place at the same time as the WSIS was a smaller and more productive meeting of the Internet-policy working group at the Aspen Institute, a non-profit leadership organization. Through the miracles of modern transportation (and despite a couple of snowstorms), I managed to take part in both.

A Civil Solution

In Aspen, our small group of government, business and nonprofit folks started with a more practical and urgent approach, considering three big Internet problems (eschewing domain names, for once): spam, privacy, and overall security against viruses and other intrusions. The approach we came up with is 'the accountable Net' — an Internet of people, companies and services that are accountable to one another rather than to some omniscient central authority. Many of the states contemplated by the WSIS document are not completely democratic. And even if governments were all as benign as we could wish, they cannot provide the kind of flexible, responsive feedback to foster good behaviour that we can provide for ourselves.

The idea is simple: people on the Internet should be accountable to one another, and they are free to decide whom to interact with. The goal is not a free-for-all, anarchic Net, but one where good behaviour is fostered effectively — and locally.

In the real world, good behaviour is fostered by a combination of government regulations and society standards. But the Internet is no longer the community it once was. It has become too large for people to really know one another. The solution is not necessarily more government, but rather more visibility of the kind we used to have: People need to know one another, and they need to be able to decide whom they want to know. (The new social networking tools are one manifestation of this desire, but we also need to be able to communicate safely with people we may not consider friends or business partners, but whom we wouldn't shy away from on the street.)

The default anonymity of the Internet makes it easy for individuals to do bad things — send spam, invade people's privacy and send data around the Net, launch viruses and other attacks. And that same anonymity makes it hard to enforce laws against those actions, even as it preserves our freedom.

But the Internet's technology also makes it easier for individuals to protect themselves: they can take their safety and privacy into their own hands with tools such as firewalls and spam blockers. And, of course, on the Internet, it's easier for people to get up and move to a virtual neighbourhood that they like better.

Let the People Rule

Sounds great, but how does it really work? What I'm proposing is not a rule-free society, but one in which rules come from the bottom up: generally enforced by peers, with governments in the background. Nor is this a world of individuals only. There are other players: Internet service providers, for example, who collect money from their customers, then vouch for their behaviour and deal with the more technical aspects of Internet security and spam deterrence. Vendors of software also play a role. They need to make their products more secure from such threats as viruses and spam.

The basic rule is transparency: you need to know whom you are dealing with, or be able to take proper measures to protect yourself. The accountable Net is a complex system of interacting parts, where users answer not just to some central authority, but to the people and organizations whom they affect.

That keeps each person's Internet small enough to allow for individual choice, but at the same time part of a whole large enough to sustain regimes for various tastes. To the extent that one community's actions affect another, each community can decide whether to interact. To make this work, we need government at the back end, ready to prosecute extreme cases of fraud and misrepresentation (as well as crimes such as identity theft, antitrust violations and other traditionally offline crimes). We also need a robust technical architecture, with effective means for authentication of users where necessary, strong security for keeping data and communications safe, and effective systems for keeping track of what's going on.

Note that the right to anonymity and freedom of speech can and must be preserved, along with other people's freedom to ignore those speakers (and the government's obligation to go after criminals). The default is to keep out anyone or anything that might not be worthy of your trust — but to accept parties rated positively by the people you do trust. As in real life, that amounts to a pretty broad circle.

We live in a complicated world, and there are no simple solutions. But there is a simple approach: keep control local to the extent possible, so that people can take care of themselves. Give them powerful tools. Understand the roles of government (central authority) and of the market (individual choice), and that the strongest force lies between the two: society, where people interact with one another.

Most people, given the choice, do want to interact constructively with other people they trust. Let's create a world of accountability on a human level. Online or offline, that's a worthy goal. »

During the question and answer session, in response to questions on the role of ICANN, Esther Dyson replied:

« ICANN's role is limited and should stay limited. It should remain independent and should not attempt to deal with broader questions of governance and social policy that it is not equipped to handle. On the other hand, ICANN should be (and is becoming) open to input from individuals. As scientists, you can play a role as individuals (rather than through your governments) in helping ICANN to come up with appropriate policies in its limited technical domain. Help it stay focused!

There are obviously political, linguistic and cultural implications in the domain-name system. Mr Ogi referred to 'science sans frontières'. What ICANN is trying to do is create a domain-name system 'sans frontières' open to all people. I don't think governments are necessarily the best representatives of all the individuals who use the Internet without borders, trying to reach across countries. The domain-name system is organized in part by country, the country codes, and in part according to the other domains. One of ICANN's tasks has been to open up the domain-name system to new names. It has not done that very well but it has done it to some extent. It would probably do so faster if it remains small and lightweight. It should do so in response to what the users are asking for. Again ICANN is a mechanism whereby users, individuals, NGOs, businesses, governments in their capacity as users can address a body directly and try to reach some consensus on this one issue. Democracy does not mean that everybody gets his way. It means that everybody has a voice and feels that they have played some part in reaching a compromise. That is the kind of institution that ICANN is trying to be. »

6 How the Information Society Fosters Research and Learning

Dr Ismail Serageldin, Director-General of the Library of Alexandria

« Your Royal Highness, Excellencies, Ladies and Gentlemen,

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 practising researchers. The costs are too high for their national budget, and frequently lack of foreign currency further limits 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 written materials collected in a usable fashion in fixed locations, where interested persons can have access to the materials has long suffered from several constraints:

– the huge costs involved in collecting the materials, cataloguing 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 sometimes has to wait as long as one hour, only to be told that it is being used by another reader.

These constraints of space and time are suddenly falling away in the wake of the Information and Communications Technology (ICT) revolution and the widespread use 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 comes from the Internet and the ease of use of Web-based interfaces, have 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 a 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 seem under challenge as the libraries start moving towards hybrid systems where they continue the traditional functions of the lending or reference library of printed materials as well as the new functions of providers of online 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;
– no need to be physically located at the location of the digital materials;
– copies of the material available in any library can be made available to the 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 centres of publication and dissemination of knowledge; and
– 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 that is not sufficiently appreciated.

But 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 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 in electronic form exceeds all that has been produced in written paper form and the volume is growing by as much as 10% per year. 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.

A more complex issue is the management of IPR in the digital age. That was the topic of a major study in 2000, which carefully framed the issues but did not come up with firm recommendations on the most troubling of these issues. Specifically, the choice today is between those who seek 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.

New technologies require new business models. The achievements of Henry Ford, Bill Gates, Michael Dell are examples of how the business model was suited to the technological innovation/change and thus worked well. In their cases (the assembly line, the Operating System of the PC, and the use of Web-based sales to cut out the distributor), the adaptation of the business model to the new technology 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 that the sheer size of the material. The presence of powerful search engines like Google makes the search enterprise different. 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) is already making use of available digital material moot. The duplication of this material in several centres, including the Library of Alexandria, 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 putting their course material on-line, or creating communities of practice that would produce an enormous body of material to be used by researchers and teachers everywhere in the world (e.g. the health epidemiology course materials initiative and the future BA Science Supercourse) is opening enormous new opportunities for researchers around 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-invest 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 loan.

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/distributing. 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) at the same time? After all, the movie companies are now releasing films in traditional theatres/screens that are subsequently shown on TV and sold in video and DVD formats. The studios have simply changed their business model in the 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. But 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 implemented 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 practising 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 financial crisis. The specialist journals cannot be issued conventionally without enormous cost, putting their subscription rates beyond the scope of all but a few libraries 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 researches.

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 a large volume of 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 on the Web in digital form 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 should be developed 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 are increasing rather than decreasing. That is the experience of the NAS with its report. 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 idea 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 grey 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 on the gateway.

Inter-Library Loan

Long accepted as a means for libraries to enrich the material they can offer their readers, it is being seen as fraught with danger 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 access copying fears, ranging 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 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 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 should be put on the Web in digital form for access from remote areas. New approaches must be found to replace copyright with more suitable ways of protecting IPR and reward 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, ranging from using 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 and facilitates the access to certain types of material (video, image) that require 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 on the gateway.

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7 Bridging the Digital Divide

Santiago Borrero, Secretary-General, Pan American Institute of Geography and History (PAIGH)

Spatial Data Infrastructures (SDIs): Bridging the Digital Divide

« Your Royal Highness, your Excellencies, Ladies and Gentlemen,

I would like to start by expressing my sincere appreciation to the organizers of this event: CERN, especially to its Director-General and conference leader, Mr Luciano Maiani, ICSU, TWAS and UNESCO. It is my desire that the conclusions of these two days of work will shape the role science must play at WSIS deliberations and, more importantly, the role of science during the implementation phase that follows the Summit.

In the context of today's knowledge society, I come from a very distant place, the developing nations.

Nonetheless, the reflections and recommendations I am about to share with you are based upon the empirical knowledge gained from years of exposure in Colombia as the senior executive in charge of mapping, land information, geography and from working in the area of information and development with non-governmental organizations in the region and across the international community.

Allow me now to begin by taking advantage of a situation that some of you could judge as merely anecdotal. The day I started to prepare this intervention, the initial thing I did was to check the 'Guidelines for Speakers' provided by the organizers. The first instruction reads as follows:

"Click here for information on how to get to CERN."

By clicking here, I was immediately connected to a basic map of Geneva, with a zoom capacity that allows the user to easily identify the location of CERN and the facilities where this plenary session is taking place. The information even indicates exactly where the CERN Fire Brigade is located!

This is geographically referenced information and it is an important kind of information. In fact, this type of information is available for the majority of developed regions and is relevant to many — endless — applications. The term spatial is often used interchangeably with the word geographic.

But, then I thought, what if this event would have taken place on the other side of the digital divide, for instance, in Mogadishu (Somalia), Ho Chi Min City (Vietnam) or La Paz (Bolivia)? Most probably there would be a significant difference in terms of the geo-referenced information available.

There is a completely contrasting situation if we look for more detailed and complex data. There are many developed cities, for instance, Hamilton, Canada or Melbourne, Australia, just to mention a couple, in which the user can have relatively easy access to high-quality property ownership and topographic information that allows one to review and apply data about a specific neighbourhood, square by square, parcel by parcel, even to link each lot to property rights.

The opposite situation is found in many urban areas where such digital location-based information is not existent or not available to the community, not to mention the many cases in which this situation is also the consequence of not having secure property titles or not having recognized property rights at all. Property ownership and rights have been a major factor responsible for the political instability of many developing countries.

Some of you may not agree with these examples or, as I have heard from colleagues working on international development, are of the opinion that having such databases and the corresponding information infrastructure is a luxury that costs too much for the poorest societies, at a time in which they must attend to other priorities and fulfil basic needs.

However, the facts are:

Developing a nation's information and communication infrastructure is significant, but equally important within a nation's development strategy and its opportunities for progress, is the need to carefully pay attention to geo-information content, including geographic data that better describes each nation's territory and its resources. This is important for governments, as there is a direct relationship between economic options and improved geographic information and for each citizen in terms of education, participation and democracy, by empowering ordinary people to participate in decision-making.

Today it is a truism that no matter whether there are many or few digital datasets available, developed and developing nations understand that their geographic data must be accessible, documented, structured, and reliable. Otherwise, such information in practice is non-existent because it is unavailable.

This is especially true for developing nations as they need to expand their knowledge base not only locally, but need to access the information accumulated by the leading economies, either via international cooperation, technology licensing, or foreign investment. Often, this includes information on the developing country itself.

To avoid even more isolation and a wider technological gap, every developing nation must design, advance and, more importantly, sustain actions encompassing the policies, organizational remits, data, technologies, standards, delivery mechanisms and financial and human resources required to ensure that all those working with data are not impeded in meeting their objectives.

It is my belief that spatial data infrastructures at the local, national, regional and global levels provide the integrating synergy required to bridge the digital divide.

In terms of geographic information, this is commonly referred to as the *'Spatial Data Infrastructure — SDI',* a concept advanced by the Global Spatial Data Infrastructure (GSDI) since 1996, that promotes complementary policies, common standards for the development of interoperable digital geographic data and technologies to support decision-making and global access to geographic information. Of course, the prerequisite is that the relevant basic geographic information must be readily available.

As a consequence, the concepts and the processes by which Spatial Data Infrastructures are built today are an essential part of geography all around the world. From local to global levels and vice versa, SDI is changing the way geographic data is being produced, organized and analysed, and has greatly facilitated the broad and dynamic exchange of ideas, leading to a better understanding of natural and cultural diversity, impacting on decision-making, territorial planning and sustainable development. This development is being promoted by the Global Spatial Data Infrastructure (GSDI), the International Steering Committee on Global Mapping (ISCGM), the International Organization for Standardization (ISO) Technical

Committee 211, the Geographic information/Geomatics, International Federation of Surveyors (FIG), the Pan-American Institute for Geography and History (PAIGH), the International Cartographic Association (ICA) and other international organizations.

After six years of work, there are today more than 20 global SDI initiatives, 15 at the regional level, with over 65 nations with documented infrastructures and many more at the state, city, local and corporate levels.

If this is the case, what are the barriers to the development of Spatial Data Infrastructures in developing economies?

First, there is a need to realize that to establish and, more importantly, to sustain Spatial Data Infrastructures is not an easy task in developed or developing nations.

Technology itself does not ensure the successful use and application of digital data. For instance, case studies clearly indicate the existence of a significant gap between the technology tools available and poor levels of geographic data use due to low availability of specialized human resources and, to some extent, the quality of technical assistance.

The crucial reasons are institutional, political, organizational, cultural, and economic.

In India, organizer of the forthcoming 7th Global Spatial Data Conference, Hungary, Mexico, or Chile, the national organization responsible for geographic information is already internationally oriented, well immersed in ICT technology and stands out as a key organization for institutional development and innovation, corresponding to societies in which the use of geographic information is expanding as there is a growing consciousness that information is only important if it is accessible to users.

The vast majority of other countries are still characterized by high and inefficient production costs, lack of standards, data-quality problems, poor documentation, problems affecting data maintenance and hardware and software updates, increasing data obsolescence, and frequent basic data production slopes.

A substantial amount of new thematic data sets is available but the data are often unstructured, distracting the government from the production of basic information with national coverage. There is even a deceptive way in which low-quality data is frequently used to formulate relevant policy. Very frequently, policy-making scenarios appear to be determined more by the quality of the presentation rather than that of the underlying data.

Culturally speaking, there is a particular problem of attitude: a history of isolation, ill-defined ideas, language barriers, and financial challenges.

The political component is quite influential. Policy-makers everywhere make relevant decisions without complete information. Yet in emerging regions, due to the chronic absence of core geographic information, the risks taken are even higher. Geographic information is not playing a better role in the decision-making process, and specialized entities have been marginalized because of reduced budget allocations. Most nations have not formally adopted a national policy concerning use of geo-information, including the ways in which it should be used to promote wealth and development according to local needs.

What, then, should be done?

In conclusion, what are the lessons I have learned from SDIs that can be widely applied in order to narrow the digital divide?

A Revised Approach to Capacity-Building

In developing countries, there is always an initial need for capacity-building. The programmes funded by many of the multilateral bank loans include substantial funding for education and quality training, thereby providing vast opportunities for facilitating technology transfer and ultimate self-reliance for the developing communities. Yet, in many ways capacity-building is a much-abused term in need of rehabilitation. The term 'capacity-building' is so often mentioned in the implementation document from the World Summit for Sustainable Development (WSSD) that it can imply everything and nothing at the same time.

In SDI development, there is a need to adjust the concept and the methodology for capacity-building, as often there is a total absence of sustained financial, organizational and human resources efforts.

International Technical Co-operation:
A Demand for Improved Co-operation, Co-ordination and Integration of Initiatives

Advances in information and communication technologies are accessible to everyone. However, within this realm, there is a proliferation of similar organizations, initiatives and projects that are making the whole process inefficient and, evidently, not at all well articulated. There is a lack of sufficient co-operation, co-ordination and integration action to achieve individual goals, avoid duplication of investment and increment the benefits. The principal goals of co-operation are to take advantage of proven practices and exchange of experiences.

Need for National Information Policy

Policy-makers still need to be coached as to why the linking of geographic data infrastructures across local, national, regional and global levels is fundamental to maximizing economic, social, and environmental benefits from geographic information. Many of the current difficulties will only be resolved if, at the highest level in governments, there is sustained interest and deliberate intervention in developing sound policy to organize the information sector as such.

Need to Strengthen the Institutions Addressing Information Problems

Although multilateral organizations may decide to promote data-sharing, ultimately, in terms of 'how to share' data to reach everyone in society, there is a direct responsibility of the recipient nation, and this aspect requires or will be optimized if SDI conditions are available.

Be Practical

Promote low-cost technology, enabling computing with geographic data, donated, public domain, or open-source geographic information systems (GIS) software for general use; develop 'easy to see and understand' decision support aids for politicians — in local languages; and pay attention to the needs of the disadvantaged communities.

We all know that geography has historically been a common language. In this age, however, the successful integration of information systems, technology, and infrastructure within nations and regions requires the introduction of standards and interoperability to facilitate this way of sharing the Earth and connecting us all.

While more information technology and infrastructure may become available, users do not have the availability of and access to better geographic information about their local area, their own country or region. Moreover, information technology, infrastructure and connectivity do not necessarily equate to information access and a real bridging of the digital divide.

I trust that those representing the interests of geographic information will take the lead in the developments and outcomes of the World Summit on the Information Society (WSIS), as the future of developing nations is in many ways linked to its ability to collect and share geographic information that is accurate, consistent and reliable in the long term. »

8 The Return to Society

Nico Stehr, Center for Advanced Cultural Studies, Essen, Germany

« Ladies and Gentlemen,

New social realities require a new perspective: among these new realities is that the ability of large social institutions that have significantly shaped the nature of the twentieth century to get things done has diminished in the last couple of decades. Moreover, in advanced societies, and not only here, the capacity of the individual to say no has increased considerably. We are witnessing a change from social realities in which 'things' at least from the point of view of most individuals simply 'happened' to a social world in which more and more things are 'made' to happen. In this contribution, these new realities are described as representing the emergence of knowledge-based societies. I will also stress that the changes are not so much technology-induced as driven by societal transformations, especially by what may be described as the greater 'knowledgeability' of many actors.

First, I will refer to the concept of knowledge societies and examine the notion of knowledge societies. I propose to define knowledge as a capacity to act. I will refer to the reasons for the importance of scientific knowledge before turning to those consequences of the advancing 'knowledgeability' of actors in modern society that give rise to the growing fragility of modern societies.

Objections

The term 'knowledge society' is a broad historical concept. Aside from the claim that there are much more appropriate conceptual labels to describe modern society, there are at least two not entirely unrelated and apparently powerful objections to the term 'knowledge society'. The most frequently heard criticism is that of historical repetition. Power and authority, for example, even in historical societies, was never merely a process based on physical superiority alone. The second objection, as a rule, refers to the concept of knowledge, which is seen as too problematic, perhaps as too ambivalent and contradictory to allow the construction of a theory of society.

The first objection is fair but hardly decisive. Knowledge has indeed always played an important role in human relations. This, therefore, is not at issue. What needs to be asked is why the role of knowledge has recently emerged as constitutive and increasingly displaced those factors that have until now been basic to social existence. The material foundations of social action are being displaced by symbolic foundations. Capital largely deposed land

during the industrial revolution; today knowledge diminishes the significance of both factors. Knowledge is constitutive for social integration as well for the creation of new economic value.

Despite the fact that there have also been societies in the past based on knowledge-intensive action, the idea that modern society is increasingly a knowledge society is meaningful and has practical relevance. It is as meaningful to refer to modern society as a knowledge society as it was to refer to 'industrial societies', even though previous social systems had been based on the work of 'machines'.

Loss of Political Power Through Knowledge

In the 1950s the German sociologist Helmut Schelsky sketched out his version of a nightmare: the use of electronic calculating machines raises the spectre of the totalitarian state, he claimed. Half a century later, the American entrepreneur and futurologist Bill Joy is warning us of a development that possesses similarly nightmarish characteristics: his greatest fear is that nanotechnology might start to evolve independently of its human creators.

The assessments of Schelsky, Joy and many others are the result of a symptomatic overestimation of the power of modern knowledge and technology. Paradoxically it is precisely knowledge and technology that are perhaps the most significant sources of the open, indeterminate society that is growing up around us today. Despite all pessimistic predictions we now find ourselves witnessing the end of the hegemony of such monolithic institutions as the state, the church and the military. Controlling, planning and predicting social conditions are becoming increasingly more difficult. Society has become more 'fragile'. Yet it is neither globalization nor the economization of social relations that is responsible for this state of affairs but the loss of political power through knowledge.

Knowledge About Knowledge

One can define knowledge as 'the capacity to act', as the potential to 'start something going'. Knowledge is a model for, not of, reality. The privileged status of scientific and technical knowledge in modern society is derived not from the fact that scientific discoveries are generally considered to be credible, objective, in conformity with reality, or even indisputable, but from the fact that this form of knowledge, more than any other, incessantly creates new opportunities for action. These opportunities may be appropriated either by private individuals, or corporations, or the state — although frequently such appropriation is only temporary.

Living in Knowledge Societies

This trend towards the development of fragile social systems is clearly the result of an (uneven) extension of individuals' capacity for action in modern societies. The power of large institutions is being increasingly undermined and replaced by small groups with a growing capacity for action. Using the term 'fragility' to designate this state of affairs is intended to underline the fact that not only has the capacity of supposedly powerful institutions to 'control' society declined but so has their capacity to predict social developments. But what has caused society's centre of gravity to shift in this way? What forms is this development taking, and what consequences will it have? I believe that these social changes are coming about because knowledge is no longer simply a means of accessing, of unlocking, the world's secrets but itself represents a world in the process of coming into being. In other words, we now organize our reality based on the knowledge we possess.

Knowledge societies arise not as the result of simple, one-dimensional processes of social change. Their creation does not follow any single, easily recognizable pattern of development. Although modern developments in communication and transportation technology have brought people closer together, regions, cities and villages are still by and large isolated from each other. The world may be opening up, and the circulation of fashions, goods and people becoming more intense, but differing convictions as to what is 'sacred' still create insurmountable barriers to communication. The meanings of such concepts as 'time' and 'place' are undergoing transformation, but borders separating people continue to be objects of intense respect and even celebration. Modern societies are characterized above all by 'self-generated' structures and the capacity to determine their futures themselves.

The Fragility of Society

One peculiarity of the many and varied debates on the roles of knowledge, information, and technological know-how in modern society is, as we have seen, their one-sidedness. They mostly emphasize the problems caused by the individual's being cut off from specialist knowledge and technical competence — resulting in the individual's allegedly being forced into the role of 'victim': exploited consumer, alienated tourist, incapacitated patient, bored school kid, or manipulated voter.

Yet dire prophecies that large social institutions would establish themselves in unassailable positions of power and authority have not been fulfilled. An objective evaluation of the social role of knowledge must come to the conclusion that the spread of knowledge has not only brought with it 'enormous' risks and uncertainty but also a 'liberating capacity for action'.

Uncertainty Through Knowledge

But all this does not mean that from now on every consumer, patient and school kid will immediately be able to recognize, understand and control opportunities for action that come their way on an everyday basis. An increase in opportunities for social action should not be misconstrued as bringing with it the elimination of all risk, accident, and arbitrariness — in general of all circumstances over which the individual has little control.

The flip side of emancipation through knowledge is the risk posed by the emancipatory potential of knowledge. The increasing spread of knowledge in society and the concomitant growth in opportunities for action also generate social uncertainty. For science cannot provide us with 'truths', only with more or less well-founded hypotheses and probabilities. Thus, far from being a source of secure knowledge, of certainty, science is a source of uncertainty and thus of social and political problems. Knowledge societies of the future will be characterized by a wide range of imponderabilia, unexpected reversals and surprises. The increasing fragility of knowledge societies will generate new kinds of moral questions, as well as questions as to who or what is responsible for our society's oft-cited political stagnation?

If knowledge is the main constitutive characteristic of modern society, then the production, reproduction, distribution and realization of knowledge cannot avoid becoming politicized. Thus one of the most important questions facing us in the next decade will be how to monitor and control knowledge. This will entail the development of a new branch of political science: knowledge policy. Knowledge policy as a new political field will attempt to regulate the rapidly growing volume of new knowledge in our society and attempt to influence its development. »

Onno Purbo, Indonesia, on Sabbatical leave at International Development Research Center (IDRC) (Email: onno@indo.net.id)

Information Society in High Places[1]

« Coming from Indonesia, a developing country, it is an honour and it is a piece of good fortune to be able to attend a large Information Society gathering at WSIS. It has been made possible by full support from friends at the International Development Research Center (IDRC), Ottawa, and CERN, Geneva. Thank you IDRC and CERN.

My ten (10+) years' background as a practical grass-roots ICT activist have really shaped my reflection on WSIS 2003.

I normally deal with people in real ICT need on the ground, with those needing low-cost Internet connection, knowledge of how to set up wireless ISP, knowledge of VoIP infrastructure, etc. Disseminating practical know-how, such as, http://sandbox.bellanet.org/~onno/the-guide/ or via mailing list, such as, wifi4d@dgroups.org, would be a simple solution for most of their needs.

It is not surprising to see the ICT4D pavilion fit quite nicely into my profile.

Until the WSIS, I did not realize that there is quite a big crowd of people sitting in high places in the world of the information society. They are neatly dressed and quite formal in presenting themselves.

They spoke mainly of dreams, visions, objectives, goals and targets. I am very envious to see that they are even more highly paid to talk on such subjects.

Sure, it is nice to have these people in high places shaping the mind-set of the regulators in developing countries. Well, to be honest, the Indonesian regulator is shaken by the world's objectives, such as, to connect at least half of the population to the Internet by 2015.

For WSIS 2003, being a stubborn ICT maverick, I brought all my main ICT equipment, such as Wireless Access Point, four (4) ports Internet Telephony Gateway (ITG), Kodak DC4800 digital camera, Cheez Webcam, and telephone handset, in my knapsack and am running a real-life demonstration to show people that by using such equipment we can build our own community-based ICT infrastructure. With only a few slides used during the demonstration, all real-life activities, I can run WiFi and VoIP simultaneously on the demo infrastructure. I find that a demo is a much more convincing approach than words on slides.

Unfortunately, I have had to pay dearly for my stubbornness, as I didn't realize that there is knapsack thief around during WSIS. I lost my equipment including my wallet and cell phone in the knapsack a few hours after running the demo. Well, that's life I guess. I hope for the best in the coming years.

On 9 January 2004, the Indonesian Ministry of Information and Communication organized a seminar to report the results of WSIS 2003 to Indonesian societies. Not much strategic and tactical plan was presented. In the seminar, considering current Indonesian conditions, I argued that my practical experiences indicated that we can easily achieve the WSIS's objectives if we relax the regulatory framework and enable Indonesians to build their own ICT infrastructure, using their own money. No World Bank, no IMF funding is necessary. All the silly, stumbling regulatory framework, such as taxing US$270/year to run a US$200 Access Point, has to be removed.

1. Talk submitted in February 2004.

The key strategic policies are people's education and relaxing the telecommunication act to enable community-based ICT infrastructures.

I really do place my hopes in the upcoming 2005 Summit and look forward to seeing more real examples and exchange of knowledge among ICT4D activists. I also hope to hear fewer dreams and complaints, as real people need simpler solutions and real examples. »

9 The Next Steps

Juan Rada, Senior Vice-President of the Oracle Corporation for Europe, the Middle East and Africa

The Implications of Science-Driven Technologies for the Creation and Diffusion of Knowledge

« Ladies and Gentlemen,

It is a pleasure to be here and I thank the organisers and CERN for the invitation to address this distinguished audience.

Today I would like to consider how technology, rooted in science, is having a very significant impact — not only on the way we create and access knowledge — but also on the way in which knowledge is structured and represented. I will conclude with observations on how this impacts the priorities for the modernization of education, which is one of the key consequences of this process.

Knowledge has been the cornerstone of all societies. Until recently all of these sources of knowledge and the access to them were bound to a locality by geographic, temporal and economic factors.

This has changed with the digitization of knowledge. The ability to catalogue vast arrays of knowledge through powerful new technologies, to efficiently store, categorize and search through plain language queries, has created access to a knowledge base unparallelled by all the libraries of the modern world. Increasingly powerful search engines and technology are making this not only hyper-linked but hyper-easy as well.

Although this technology has lowered the barrier to access, this barrier is still not low enough — as witnessed by current levels of Internet penetration (not to speak of broadband) and the lack of even basic connectivity infrastructure in much of the world. This happens at the time when economic welfare is becoming increasingly rooted in knowledge.

Much of this, however, is closely related to non-technological factors such as regulatory frameworks, and to open and competitive markets, a factor which also needs to be addressed.

The technological developments of the 20th century have essentially been based on scientific developments in physics and chemistry. Not the least example of this is the understanding of semiconductivity and crystallography that underpins information technology. This will, of course, continue in many new directions including photonics and nanotechnology. Both are areas where our host institution — CERN — will no doubt make seminal contributions.

For this century we can expect much technological development based on the breakthroughs that have already taken place, and continue to take place, in biology. In all these cases, science is generating volumes of information beyond anything we have seen before. This is just the beginning as this area is in many respects still at an embryonic stage.

The management and interpretation of these terabytes and petabytes of data is made possible today by the development of Grid Computing. The Grid architecture effectively pools large numbers of servers and storage into a flexible, on-demand resource. Oracle has worked with CERN on the development of Grid computing technologies and has now recently brought onto the market the first commercially available Grid-ready product. This is an example of how a pioneering technical development has rapidly become mainstream.

Grid computing is not only essential to harness the necessary processing power to undertake such data-intensive analysis, it also makes such processing power available to more institutions by dramatically reducing the cost of computing.

In the commercial arena, Grid computing will have applications in the analysis and manipulation of data that will underpin the next waves of computing and internet technologies. One can go on and describe the many, many areas of industry and commerce that this will affect. I would like to focus on one key area by posing a question seldom asked, and this is — whether and how are technologies changing the way we represent knowledge and what effect this will have? In my view, this is a critical question to understand the priorities for change in information technology for education and research.

The use of powerful processing and transmission technology allows us to envisage the 'mass commoditization' of multimedia in daily life, at least for the time being in a small part of the world. This has significant consequences.

Multimedia, by using images, sound, text and graphics, convey knowledge in a highly synthetic and powerful manner, collapsing into one medium the book, the museum, the gallery, the film, the photograph, the spoken word, the sense of place and sound. Suddenly, learning and perceiving become much closer to the daily experience of living, and by doing so have a much higher pedagogical and retention impact. One form of it, the use of 'virtual' environments, is a popular expression of this.

The cost of production of material based on rich multimedia is decreasing rapidly. The digital camera on mobile phones is an anecdotal example of this, although it is only in its first generation at the moment. The future is here if you care to look. We already know that the technology will leap forward in the next few years with the combination of the Grid, broadband, and the developments taking place for PCs as well as other devices, such as phones. This is not the occasion to enumerate the many areas of education affected by this but, in higher education, for example, it goes from medicine to statistics and from engineering to the arts.

Put simply, a new concept of literacy is emerging, encompassing a much broader set of skills than our traditional reading and writing. A new classification of knowledge is emerging, with a much higher degree of complexity and abstraction, including a multimedia view of previously separated subject matters. The current taxonomy of knowledge and the use of indexes corresponds to the sequential technology rooted in the nature of the book. This is changing as we create new 'indexes' for a world that does not distinguish between the vehicles that convey knowledge, but draws on many technological infrastructures from words in books to three-dimensional objects in museums. We are entering the world of hyper-linked knowledge and hyper-threaded thought. This is a fundamental transition in that it is currently fully engaged and that it implies a change in our way of thinking.

We had similar transitions in the past. For example, scholars of the classics have illuminated us regarding the enormous consequences on our history of the Greeks' technological and intellectual transition from a pre-literate to a literate culture, showing the impact of the introduction of the alphabet as the written word replaced the oral in the literature of Greece,

and later Europe as a whole. This transition had consequences that scholars, as usual, still and will continue to debate, but it is safe to say that in it lies the very root of our current mindset.

Professor Eric Havelock, a specialist in this domain, calls it the 'alphabetic mind'.

The alphabet converted the spoken tongue into an artefact, separating it from the speaker and making it into a 'language', into an object available for inspection, reflection and analysis. This language meant that things could be preserved without recourse to memory and that the bits and pieces of these memories could be re-arranged, cut, added and re-stated. This new world was conceptual. Philosophy was possible and with it logic and thus a key element of what we will call today, the epistemology of science and our view of modernity.

It is hard to recount here in a brief manner the enormous impact that these historical processes have had on our way of being and thinking.

While the alphabet created the basis for the 'alphabetic' mind, the invention of printing by Gutenberg, and most importantly the development of the portable book by Aldus Manutius (1450–1515) of Venice, created the personal library and revolutionized forever the control of knowledge. A new technological and intellectual transition started.

The difference in the current transition is that the power of multimedia makes the process one that is sensorial in nature; the language is one of the subjective, the perceptive, of the senses, and thus not simply conceptual or reflective in the meaning of the world of the literate.

Moreover, and with increasing complexity, the creation and diffusion of knowledge today is a collaborative activity. Current information management technology allows us to do this in a seamless way and create a world where knowledge can be built collaboratively. Collaboration is becoming intrinsic to the creation of knowledge and key to current and future developments. This is already being facilitated by collaboration platforms.

The combination of developments in Grid computing, broadband, decreasing cost of all forms of multimedia, and the availability in the next few years of equipment and systems to take advantage of the dramatic reduction in cost that these changes permit will mark the end of what will be regarded as the first phase of the transition to the information society. These new capabilities will allow not only the ability to perform functions better than in the past but entirely new forms of combining functions.

What does this mean for education in general and in developing countries in particular?

The first aspect is to realize that the changes are more profound than simply a change of medium. These in turn imply the need for a much better understanding of the pedagogical effect of how information and knowledge is represented.

For developing countries and their educational systems the challenge becomes even greater. Connectivity, a yet-to-be-achieved objective for the majority, is essential and urgent. It is possible to achieve this, with much more creativity on the part of the regulatory system, and by opening up the connectivity opportunities to all types of infrastructure.

The need for urgency is because, as is probably clear by now, the changes are not only that what we do today will be faster and cheaper, but that the capacity exists to create and convey information and knowledge in different ways and with high impact. This difference will increase day by day, and according to the rhythm of technical change. This is a dramatic change in the way people are educated.

From a priority point of view this reflection means that higher education must be the area of focus, particularly in developing countries. Modernizing the universities is essential to ensure that the new generations of professionals are as close as possible to what is state-of-the-art, and that the institutions are capable of creating a critical mass by using collaborative platforms and all forms of e-learning to lower the cost of distributing education and training.

Oracle has successfully used such technology on a worldwide basis for our own educational and training infrastructure. These professionals will also be the ones who in the future will help to shape the rest of the educational system.

In my experience we still see too many of the higher education institutions behaving like medieval castles and isolated citadels, when it is evident that in order to achieve their objective of obtaining the best IT infrastructure and connectivity, they need to move into shared services systems. This is not a technological issue but a necessary change in mindset. Interestingly the universities in some of the richest developed countries have understood that this is the only way forward to be able to achieve a level of excellence in their technological infrastructure and to confront the challenges outlined above. Behind this comes secondary education and then primary. Ideally one should do all of them. This is not always possible.

As a company we have been involved in all these areas, from universities across the world to primary and secondary education. Oracle has set up several initiatives throughout the world. One such initiative is ThinkQuest, a five-year-old competition that has engaged students in 23 countries in authoring over 6,000 educational websites for a free online public library. These websites offer a rich online resource used worldwide by teachers to inspire learning.

Another example is Oracle Think.com, a free, online learning community where students and teachers share ideas, create websites, and interact in a protected environment. The ability of children to mould how they use their Think environment also enables educators to better understand how children use the Internet to learn. Think.com to date has been launched in the UK, South Africa, Chile, Paraguay, Australia, New Zealand, India, China and Thailand.

In closing, I would like to re-iterate that today, science-driven technologies are altering the shape and nature of knowledge, and managing the wealth of information that now resides online for global access. These technologies are here today, *available* to everyone. What is not available is the *access*. Throughout this week the issues of access to bridge the 'digital divide' are being explored and debated. We must ensure that the richness, diversity and potential of our knowledge does not remain limited to small pockets of the world population. »

H E Lidia M. R. A. Brito, Minister of Higher Education, Science and Technology, Mozambique

The Needs of the Developing Countries

« Distinguished members of the panel, distinguished participants,

It is a great honour to be with you today and I would like to thank CERN and the other organizers for inviting me to address you on an important and difficult topic: How do developing countries see the ICTs working for them? I shall try to answer that question from a Mozambique perspective.

But let me start by reminding ourselves what our major challenges and problems are. Developing countries have high incidences of poverty, which in turn brings a high incidence of diseases, such as HIV/AIDS that is robbing our babies of their parents, our schools of their teachers and our health centres of their nurses and doctors, of child malnutrition and of

death of women in childbirth. Poverty is also in many ways the result of the high illiteracy rates and the low scientific and technological capacity that we see in the developing countries. Nico Stehr defined knowledge as the capacity to act. I would add that knowledge is to have many options. In many cases we have only one option and it is not necessarily the best one. Sometimes we have many options but we cannot recognize them and cannot therefore choose the best one for us.

We also need to have a governance that is more inclusive, democratic and efficient, for which we need more informed, better educated assistance, people with knowledge and people able to act.

Knowledge must be relevant to the resolution of poverty in its many shapes, appearance and impacts. We all recognize the staggering knowledge gap but we still have to recognize that developing countries contain untapped human talents and cognitive and natural resources that need to be mobilized against poverty. We need to use our local knowledge systems. We need to make sure that the knowledge that exists in our countries is systematized and shared with the rest of the world.

Identifying solutions that work in our countries is not only important for us *per se,* it is also a matter of pride in knowing that we can contribute to constantly growing global knowledge. If we do not seek to identify such solutions, we will keep lagging ever further and further behind.

We also know that knowledge is not enough. Knowledge can only be viable if it is accompanied by skills. We need to have skills to acquire knowledge, we need skills to apply knowledge and to develop knowledge, sometimes even to recognize knowledge. We need to cover a range of skills, from the very basic to the very complex such as computer programming, biotechnology and nanotechnology.

So, what can ICTs do in this framework? What worries me a lot but what also reassures me is that ICTs imply two extremes, one good, one bad, with many intermediate stages. Thus ICTs can inform but they also can misinform. ICTs can save time but can also make you waste time. ICTs can stimulate thinking but can also induce intellectual laziness. ICTs can promote global citizenship but can also enable worldwide terrorism.

Today populations in the developing countries have low rates of access to any level of education and thus smaller numbers of scientists and educators. Although developing countries account for some 80 per cent of the world's population, they have only 27 per cent of the world's researchers. We have limited resources available for research and technological developments. We are dependent on external providers of knowledge and investment, and local resources are either under-valued or under-exploited. What then can we do?

One scenario is that we get the bad extreme in terms of ICTs, that we will never develop an internal knowledge capacity and never be able to reduce poverty because our dependency on external services of knowledge and investment will grow with our people living in ever poorer conditions.

We in Mozambique believe that there is another much better scenario, namely, making sure that we increase participation in education by developing domestic research and technological capacity in the country and the region and throughout the continent. If we can invest in human resources and make sure that our universities and higher education and research institutions have the capacity, we will certainly create the conditions necessary to

increase our gross domestic product and ensure that we become less dependent on external sources. Our people will then be living in much better conditions and our societies will be much more democratic than they are today.

We in Mozambique are using ICTs to strengthen our rural extension services so that we can provide farmers and small- and medium-sized enterprises with technological, market and other essential information. We are also making sure that people communicate with each other, not only for social reasons but also as business partners.

We are also starting to use ICTs in order to improve the quality and range of medical services. The three major cities of Mozambique are already linked by a telemedicine network which allows surgeons to work with each other over great distances. We hope that this network will be extended to our rural health centres.

We are also using ICTs to help us to expand education at all levels. We have a distance learning strategy, which is a very important component of ICTs. I agree with Juan Rada when he says that this technology will change the way we educate the people but it will above all change the way we learn. This is, I think, a wonderful characteristic of ICT technologies because they can ensure not only education for all but access to high-quality education for all because learning becomes much more interactive, allowing us, individually and collectively, to learn at our own pace, according to our needs and wishes.

We are also starting to develop virtual libraries as an important tool for researchers, educators and students alike, as well as a science and technology network to allow us to define a national science policy based on the 'bottom up' principle that takes account of the specificities of each region of our very diverse country.

We have also been using ICTs for education and education for ICTs. Thus the aims of the school net programme, which is a very important part of the e-school programme in Mozambique, are to develop young people's ICT skills as well as ensuring that ICTs create a better quality environment for learning.

We are constantly examining how ICT technologies can be used to best advantage in the conditions of our countries. Thus, as fixed lines are very expensive and it takes a long time to install them throughout the country, we have introduced mobile phone coverage even in rural areas where there is no fixed line network and we have seen an amazing expansion in the use of mobile phones. When Mozambique experienced the terrible floods of 2000, all the fixed lines were down before people had time to call. It was the cell phone network that allowed us to save a lot of people and avoid a high loss of life.

E-commerce is another aspect of our ICT policy and e-strategy, principally in the field of tourism development. Similarly, e-government is being used to improve public services. The resulting inclusion of our citizens in the decision-making processes and also in monitoring government actions is making our citizens much more proactive and government much more responsive to the needs of the country and the people.

However, perhaps the biggest challenge is how to make ICTs work for us. We know that there are many things that we cannot do yet because of the constraints. Thus, Juan Rada talked about how the universities in the developed nations have forged ahead by realizing that they can save money by sharing networks. But, we have a saying in Mozambique: "In order for you to save money, you first have to have the money to spend." In many cases, this is sadly true for developing countries. We cannot save because we do not have the money to spend and usually, even if there is money to be invested, it is not our money and we cannot therefore invest any savings on something else.

So, affordability of the technology and the equipment and connectivity are important issues: if we do not achieve them, we will not have access and if we do not have access, the first future scenario will be realized: namely the one where we are misinformed and waste our time and become increasingly poor and ever more dependent.

We also need human resources and skills to acquire, use and improve. An Indian colleague told me: "In order to have 1,000 good ICT people, you need to train a critical mass of 20,000." At present, we in Mozambique train 10–15 ICT people a year. When are we going to have the 1,000? If we do not invest and obtain support to obtain the critical mass of human resources, we will continue to lag far behind. Thus it is not only ICTs that we need: we also need to be critical about the information that we obtain from these new technologies in order to make the right choices. For that, we need human resources.

We must also make sure that our policies are integrated. Thus, our ICT policy and e-strategy must be integrated with our science policy, with our education policy, with our industrial development policy and so on. We must also work on developing more and more relevant content.

The educator, Paulo Freire, wrote: "poor are those among us who lose their capacity to dream, to create their courage to denounce and announce." So let me finish, Mr Chair, by denouncing and announcing.

The first thing I would like to denounce is worldwide monopolies and in that respect I am very happy to see that companies like Oracle and Microsoft are becoming more and more socially responsible.

Secondly, we need to invest heavily in human resources, hardware, software and connectivity in developing countries and ensure fair trade, including in access to knowledge.

Finally, I would like to announce the political will that exists at all levels. We in Mozambique know that we are very far away from attaining our dreams. We are willing to proceed but we cannot do it alone. So please proceed with us. Thank you. »

Robert Kahn, President of the Corporation for National Research Initiatives

Reflections on the Role of Science in the Information Society

« Ladies and gentlemen, I am delighted to be here. Although I am a scientist by background, I am going to comment on a very related topic, namely the role of technology in the information society because science basically makes its predominant appearance in society through technology and its applications as well as through education.

Historically, science has been very closely connected with the creation of knowledge, although the linkage of science and technology has always been very strong. Over the years scientific knowledge has progressed primarily through the willingness and ability of governments to provide the funding, while technology has benefited largely from private sector investment. It is some of the most advanced technological developments — and I think the Internet is an example, certainly in its early days — for which the return on investments seems too far in the future, that have also been the result of government funding.

There are really four technological pillars of this information society that we are talking about today:

– the computing technology (and I include both hardware and software here) that we all use;
– the digital communication technology with both tethered and untethered connections, namely fibre wires and radio links by which information can now be sent not only around the world but also into outer space and back;
– the networks that have been created in recent years and the network-based applications that link all the computers and individuals together and make them useful;
– the devices of all kinds that basically support our users, namely the printers, the routers, the displays and mobile radios.

In this context the Internet plays a very prominent role along with the applications such as the World-Wide Web, electronic mail and the increasing commitment to the management of information in the form of digital objects and other media. And supporting all four of these pillars of technology are the scientific theories that enable advanced component technologies to be developed and used, such as semiconductors, all optical devices, micromechanical devices and even nanotechnologies.

But far from being the whole story or even the last word, this is merely the latest word. Science is continually unfolding, revealing the secrets of the Universe to generations of inquisitive minds. It seems clear — to me at least — that scientific researchers all over the world cannot stand still and will not rest on the laurels of their predecessors. This is the creative genius of mankind which will determine what all our future technical options are.

So I would like to focus here on two ways in which the creative potential of these technologies may be unlocked. The first way is by exploring new options for using existing forms of information such as we typically access on paper or on radio or television and for collaboration, either through meetings, teleconferencing and so forth. The second way is to investigate new units of creativity and new forms of expression that have no real-world counterparts today.

I might point out that something like the World-Wide Web has created a forum that really did not exist before and there are many others that are waiting in the wings to be uncovered as well.

In the first context we might typically identify a machine to interact with today on the Internet, even if our real goal is to interact with an individual or a specific file on a given machine. For example, consider the possibility of sending an e-mail to a book and asking it a question and then expecting that it might give you a response to that question. This is a new way of dealing with existing media in a network context. If one can identify the book itself, there is a data structure on the Net independent of its location. One ought to be able to put the identity of the data structure, namely the book, in the two fields of an e-mail message and expect to receive an answer from the book directly with no human intervention in between.

I hesitate to speculate on whether this is a good business opportunity or whether it is a capability best offered by digital libraries. Either way, this is not something that a typical user of the Internet is able to do today. Limited forms of collaboration and information sharing can be organized across the Internet but we are still a long way from the type of meeting or event where literally everything that transpires at the meeting can be captured and recorded in real time, and accessed in real time, with or without deferred access at a later time.

We may certainly wish to limit access to such information for, say, administrative purposes. It may be a private meeting, for example, but we are still a long way from this being a commonplace capability.

In the second context we were talking about things that have no counterpart in the real world. All that we can really do is speculate about the nature of future inventions and innovations that may have the ability to change the very way we interact with the outside world or even think about it. The Internet is now about 30 years old. As a technology it is about 20 years old and has been regularly used for about 20 years as a global information system. The very existence of a conference like this or the follow-on from this conference is really testimony to the way in which one scientific achievement can change critical aspects of the world in which we live.

The information society that we are all helping to develop is increasingly the product of co-operation between individuals and organizations in the public and private sector all over the world. For this environment to grow and to evolve, it needs to be nurtured by all of those in a position to co-operate in this way. The Internet really is the foundation of today's information society. This may change in the future, but with what we have already we have the potential to really improve the ways in which we live and to bring us all closer together.

Increasingly the primary financial investments in the infrastructure, the technology and the applications required to support and develop the information society are likely to come from the private sector, but I believe there will continue to be important roles for governments all around the world in encouraging people take advantage of the Internet and thereby promoting, enhancing and stimulating both our economic and social systems.

As to what is coming next, let me in closing encourage all of you to consider these issues and especially the possibilities where there are both potential technological and social dimensions and for which there is no equivalent in today's world. I believe that their development will depend critically on the insights and the contributions of the world's most talented individuals.

So, in closing, I would like to say that I very much appreciate the opportunity to have a chance to address this plenary and to share these thoughts with you. I wish you all the best. »

Dr Juergen Renn, Director of the Max Planck Institute for the History of Science and General Co-ordinator of European Cultural Heritage On-line (ECHO)

Towards a Web of Culture and Science

« Excellencies, Ladies and Gentlemen, distinguished participants,

It is a great honour to address you and I would like to thank the organizers for providing me with the opportunity to present to you an open-access initiative by the German Max Planck Society, the French CNRS and other major international science and education organizations.

I will describe the crisis which culture and science are facing in what is still the beginning of the Internet Age. I will also present to you a vision of how to overcome this crisis, and I will indicate steps towards the implementation of this vision, in particular the Berlin Declaration on open access to science and culture, signed by many international organizations.

Crisis

Let me begin by describing the crisis and first turn to the crisis of culture on the Web. It has two dimensions. The medium of today and tomorrow, the Internet, might leave behind a culture which is the heritage of our past but urgently needs to meet the challenges of the future. This cultural heritage is presently in danger of being left behind, of missing the boat of the rapid technological developments carrying us into a new information age. The bulk of information which forms the core of cultural heritage is largely excluded from the information system that constitutes the backbone of an increasingly knowledge-based world.

The great works of art and literature, the multitude of languages of this world, traditions reaching back sometimes over millennia, the treasures of scientific, scholarly and philosophical writings going back to the dawn of our civilization are not being as substantially transferred to the new medium as is necessary for their preservation in view of wars and dwindling public funds that threaten them with rapid degradation.

Cultural Techniques

The deficit in the extent to which cultural information is available on the Web is accompanied by the underdevelopment of cultural techniques adequate to the new technologies. Reading, writing and calculation, the traditional cultural techniques, have to be complemented by new cultural techniques allowing every single individual to optimally exploit the Internet as a representation of collective human knowledge. The question is, of course, how to overcome this crisis that threatens the link between our past and our future. Before coming to the answers, let me turn to the second major crisis of this transitional period, the crisis of science.

Gutenberg

The crisis is most visible in the rising journal prices which effectively make science increasingly inaccessible, particularly to developing countries but more generally to all those who have produced scientific knowledge, mostly with public funds. Scientific organizations are in fact forced to repurchase the information they produced in the first place. Effectively, the 'journals crisis' amounts to a complete breakdown of the traditional distribution of labour in the traditional information circuit. According to this traditional model, research results are produced by scientists. This is and will remain the most cost-intensive element of the information circuit. The results of research are disseminated by publishers and archived by libraries. Information is filtered by a process of evaluation performed by scientists (peers) and organized by publishers. Only that which survives this filtering process is disseminated. This well-established traditional system is now endangered by technological changes with radical consequences.

Even within the system of printed information, these technological changes are reflected in the rising prices charged by publishers for dissemination, which scientific organizations are no longer able to cover and which dramatically increase the divide between industrialized and developing countries with regard to the availability of scientific information.

Unexploited Potential

The information revolution has radically changed the technical and economic basis for maintaining the scientific information flow. This radical change is evident from the as yet unexploited potential of the Web for scientific communication. Dissemination is no longer a cost-intensive component. It can, in principle, be handled by scientists without the services of the publishers. In the electronic medium, evaluation follows, and does not precede, dissemination. It no longer has to amount to a simple in/out decision about publication.

There is no longer any reason to preclude access to the information hinterland, to observational and experimental data, software tools, or to historical sources, which currently only serve as a logistic background for published research results. Making such additional information available will help to ensure the reliability of scientific information, to broaden the scope of available resources, and to avoid duplication of effort. Moreover, the Web offers completely new forms of scholarly publication, from digital libraries of cuneiform tablets to entries in biological databases. The new medium could facilitate and improve the quality of the selection process. The immediacy, and in principle unrestricted, scope of electronic dissemination increases the likelihood of rapid responses, distinguishing valuable from non-valuable contributions.

The Present Dissemination Crisis

Against the background of this impressive potential of the Web for scientific communication, it becomes particularly evident that what is wrong in the present system of scientific dissemination is that it is dominated by publishers with a quasi-monopolistic status. First, there is the increasing cost of scholarly journals, eating up capital urgently needed to build up a more adequate and efficient infrastructure for scientific dissemination. This increased cost represents a waste of public money. Then there are the commercial barriers to the connectivity of knowledge, enforcing a fragmented landscape of information islands rather than fostering the development of a global representation of human knowledge, consisting of interoperable contributions by all players.

It is also important not to forget that publishers do not offer a guarantee for the long-term archiving of information. Again this is a challenge with which public institutions are left to grapple. We also lack adequate access and retrieval infrastructures corresponding to the needs of scientists and educators.

Finally, mapping the traditional commercial publication system into the new medium perpetuates the digital divide in science. In fact, simply creating a mirror image on the Web of the traditional system amounts to erecting an artificial boundary cutting off developing countries from the flow of scientific information.

The Insufficiency of Existing Solutions

Let us now turn to approaches towards resolving the double crisis of culture and science on the Web. The two standard solutions are the big player solution and the scout solution. Both have failed to create an adequate infrastructure fostering the dynamics that are imperative for the transfer of scientific and cultural content from the old medium to the new.

The Big Player Solution

The big player solution is most familiar from the present debates on electronic journals where a few publishers use their near monopoly to erect new barriers of accessibility. But for the digital availability of cultural heritage, the situation is perhaps even more problematic, resembling a gold rush where everybody is trying to stake out claims. The big players have in fact long since begun to secure exclusive rights on the reproduction of cultural artefacts, be they manuscripts of Leonardo da Vinci or representations of traditional cultures. But in spite of their eagerness to control large domains of cultural heritage, the big players have so far failed to create an infrastructure that guarantees a steady and reliable flow of content from the old media into the new, an infrastructure offering equitable access to all nations and peoples, often deprived of their heritage by the pitfalls of history.

The Scout Solution

The scout solution, on the other hand, is based on the assumption that the transfer of cultural and scientific content to the new medium can essentially be achieved by pilot ventures. It amounts to the realization that bringing culture and science to the Internet means settling a new continent, rather than just exploiting its resources in a gold rush. But it also amounts to the problematic assumption that this can be done by merely sending out a few scouts to survey the new territory. As a matter of fact, the scout solution has also largely failed to launch self-sustaining dynamics of culture and science on the Web.

Vision

The right solution to the double crisis can be found only if we have a vision. The vision I would like to sketch here is that of a Web of Culture and Science.

Agora, Semantic Web

This is a vision concerning both the enrichment of the Web with content and its future technological development, hopefully turning it into a global and accessible representation of human knowledge. In order to create self-sustaining dynamics that enrich the Web with meaningful content represented in adequate structures, we need a support programme for open access aimed at building up a technical and social infrastructure. Such a support programme is the core of what we have called the Agora solution, by analogy with an institution of Ancient Greece where the common good emerged from the contributions of all citizens. In order to create the tools that make it possible to adequately exploit this content for science and education, we need to develop the Semantic Web, allowing future users to truly interact with the content they find.

Agora Solution

The Agora solution aims to build up an infrastructure that increasingly turns the consumers of the Web into producers. In fact, we urgently need support to create an open-access infrastructure to make resources freely available online with little effort and in a way that guarantees the interoperability with other content and tools, thus creating added value for every user.

Towards and Beyond the Semantic Web

I have no time to discuss why and how we have to go beyond the vision of the Semantic Web as it is presently discussed. Let me say only this much: the future transformation of the Web will be driven not only by technical issues of speed and bandwidth but by innovative usage scenarios, just as was the case when the Web itself was invented here in Geneva at CERN. Making the Web more democratic, for instance, will also create a technological drive from the client–server asymmetry to peer-to-peer interactions, from browsers used by essentially passive clients to knowledge weavers used by active citizens.

Implementation of the Vision

Let me conclude with some words on the implementation of this vision and mention the Berlin Declaration.

The Berlin Declaration

The Berlin Declaration was signed in October 2003 by major national and international governmental, scientific, cultural, and educational organizations. They consider their mission only half complete if the information they produce is not made freely available to society. Otherwise, according to their view, science is simply unable to reveal its full impact so that investments in science fail to achieve the returns they could in principle attain. Let me quote from the Berlin Declaration:

"In order to realize the vision of a global and accessible representation of knowledge, the future Web has to be sustainable, interactive, and transparent. Content and software tools must be openly accessible and compatible."

"Our organizations are interested in the further promotion of the new open-access paradigm to gain the most benefit for science and society."

Recommendations

The Berlin Declaration also recommends specific measures for implementing the open-access paradigm. Scientists are being encouraged to publish their work in line with the principles of the open-access paradigm. The holders of cultural heritage are encouraged to support open access by providing their resources on the Internet.

ECHO Infrastructure

As regards my own field, the humanities, the Berlin Declaration has provided great encouragement for many archives, museums, libraries, and research institutions to make their contents freely available. However, it is also crucial that we have been able, within the context of the ECHO Initiative, to offer such institutions an open-access infrastructure in the spirit of the Agora solution, helping these institutions to overcome the competence and technology thresholds separating them from the Web. The infrastructure built up by the European Cultural Heritage Online (ECHO) Initiative allows Web-based collaboration on images and texts and automatically creates, for instance, links from any text embedded in the infrastructure to dictionaries for a variety of languages ranging from Ancient Greek to Chinese.

Dual Strategy

In the context of implementing the Berlin Declaration, the Max Planck Society has in fact followed a double strategy, aimed at fostering access to electronic information in the traditional journal format and, secondly, developing innovative models of open-access electronic dissemination with the support of a newly founded innovation centre.

German Signatories

Let me briefly comment on the present signatories of the Berlin Declaration. On the German side, it has been signed not only by the Max Planck Society but also by all major research agencies associated with the Max Planck Society, such as the German Research Foundation, the Fraunhofer Society, the Leibniz and the Helmholtz Associations, the German Science Council, and the Association of Universities. Together these institutions organize and fund the lion's share of German basic and applied research.

The Berlin Declaration has also been signed by the Berlin Brandenburg Academy, one of the national galleries and the German Library Association. All these institutions are under pressure from the ever-increasing scarcity of funding for science and culture to use their resources as effectively as possible and to regain control over the knowledge they produce.

International Signatories

At the international level, the Berlin Declaration has been signed by the French CNRS, the National Hellenic Research Foundation, as well as by other major research funding and governmental organizations from Belgium, Spain, Austria, Norway, Italy and Hungary. It is likely that Croatia will sign shortly. The Declaration has also been signed by transnational organizations such as the Academia Europea.

The core text of the Berlin Declaration has been closely agreed upon with the American Bethesda Group representing major research organizations in the US such as the Howard Hughes Foundation, the National Institutes of Health and the University of California. An international follow-up conference in 2004 will be staged together with the Bethesda initiative to achieve a closer co-ordination between all players involved.

The Next Steps

What are the next steps? This is very easy to answer: you can join the Berlin process, thus helping to pave the way to the science of the future, which will have to be based on the open-access paradigm if we want to exploit our scientific and cultural resources as effectively as possible in order to meet the global challenges of humankind.

How to Join the Berlin Process

Governments, universities, research institutions, funding agencies, foundations, libraries, museums, archives, learned societies and professional associations are invited to join the present signatories.

If you wish to do so, please contact the President of the Max Planck Society, Professor Peter Gruss, who has offered to co-ordinate the process. For further information, also about contact addresses, either consult the website of the Max Planck Society or the brochure we have brought with us. Thank you for your attention and do not forget:

Science is above all communication. »

H E Professor Atta-ur-Rahman, Minister of Science and Education for Pakistan

« Ladies and gentlemen. About three years ago, President Musharraf asked me to take charge of the Ministry of Science and Technology. I am a professor of organic chemistry heading a chemistry research centre. I asked him one question: "Sir, are you serious about science?" He said: "Of course I am." I said: "If you are serious, let it be reflected in the budget that is going to be announced very soon by the government." The result, ladies and gentlemen, was a 6,000 per cent increase in the budget for science and technology for Pakistan and I think this is historic. I think there must be very few countries which have had such a large budgetary increase, and work began in earnest.

The pace of development over the last three years has been rather intense. Two and a half years ago only 29 cities in Pakistan had Internet access. Today 1,600 towns and cities and villages in Pakistan, covering about 97 per cent of the country, have Internet access. Two and a half years ago only 40 cities had fibre. Today there are 600 cities and towns on fibre. Two and a half years ago the price of bandwidth was $US 87,000 for a 2 megabit line, today it is $US 3,800 for a 2 megabit line, making us by far the cheapest in that part of the world.

The latest UN report, the UNCTAD 2003, acknowledges that Pakistan is well ahead of most countries in that part of the world in terms of ITC diffusion and IT spread.

Science is magical in the way that it informs our lives. But in order for the magic of science to work, we have to have the Merlins, and the Merlins are our bright young men and women. We therefore must have opportunities to train them and to provide them with opportunities to serve within our countries. So we have launched massive programmes. Pakistan produces about 200 PhDs in the sciences every year. We are ramping that up to 1500 to 1600 per year over the next five years by identifying 500 supervisors and allocating each of them three students plus major research plans.

We have started a massive programme to send some 300 to 400 young people every year to study, mainly at European universities. We hope that about 100 will be coming to Switzerland next October. In five years' time I anticipate many changes taking place as they come back.

But we have to provide the facilities, the infrastructure, and also the salaries to ensure that they do come back. We have therefore introduced a tenure track system of appointments, which involves a 600 per cent increase in salary. Professors in our universities will be getting about 125,000 rupees a month, which is about five or six times more than they currently get, but it will be a performance-linked system.

We have also introduced a research productivity allowance, which is a rather creative way of rewarding the best people. We use impact factors and science journals as a science citation index and on the basis of that we have been giving allowances, which are about five times the normal salary. So a young man working in one of our universities or research centres can be getting a much higher salary than an older man who is not so productive.

Simultaneously with all this we have a satellite in space, which is at 38˚ East, largely for education. We are launching four new TV channels. Two of them will start broadcasting within the next four weeks for distance learning. The other two channels will also come on-line within the next six or eight months for the virtual university. So we will have four channels devoted to education. All the universities are being connected up with fibre. Forty universities are already connected up, which means that a lecture given 2000 miles north can now be listened to 2000 miles south. We are now connecting up so that we can access lectures given by professors in USA or Europe via the satellite.

Of course, to make all these exciting things possible we have to have the funding. The necessary infrastructure is now being created in the universities. With a population of 150 million, our real resource is our young people and our children and change will come if we provide them with the opportunities to educate themselves and to serve their country.

I would like to make three or four very brief recommendations for what I would like to see happen. Firstly, I would like to see free access to the literature, but this is not going to happen very easily because the publishers want to make money. So I would like to propose that journals that are more than a year old be made available free to the developing world. That, I think, would be a step in the right direction.

Secondly, universities in Europe and the USA should emulate MIT's example of open courseware, by making their information and lectures freely available on the Internet. In Pakistan, we have downloaded all the MIT open courseware and distributed it to our universities.

Thirdly, we should try and establish well-funded networks in different disciplines like physics, chemistry, biology and mathematics, to which international organizations and member countries should contribute so that they can really prove powerful resource-sharing tools.

Ladies and Gentlemen, we are moving very rapidly towards a largely paperless world. I am myself the editor of five European science journals and I am starting up two new online journals. One is called *Letters in Drug Design and Discovery* and the second *Letters in Organic Chemistry*, which will start publication next month. I am also starting a series of books that will be exclusively available online called *Advances, Frontiers in Medicine and Chemistry*. That is the way we are going and I would like to join hands with many of you in some of these exciting initiatives. »

H E B. S. Ngubane, Minister of Arts, Culture, Science and Technology, South Africa, and Chairman of the Commonwealth Science Council

« South Africa has established a new research and development strategy that shifts the country from an armaments-based type of recession development to one that addresses a better quality of life for the people, global competitiveness and technology for poverty eradication.

I believe that there are two goals for which we must strive in order to ensure that the information society is to benefit the poor as well as the rich, young and old, and indeed those who need the services of their governments and the agencies for development. We speak here from a developing world perspective, seeking to build effective and useful partnerships to deliver on the promise of the information age.

First, in order to achieve our goals, the developing world must participate fully in partnerships, networks, discourse, and debates around the information society. Such a role requires the ability for developing countries to influence the outcomes of the information society's development and for our people to participate at all levels within the information society. Closely tied to this is the need to move from a consumption or consumer role in the information society to creative and innovative modes of participation. This would be possible through proactive attention to the capacity for the utilization of science precision technology in the developing world. The foundations upon which these goals rest is access, and their attainment depends on access to information, access to services, and access to opportunities. This will underpin the information revolution that will help the developing countries to move significantly forward. Lack of access fuels the digital divide, exacerbates development backlogs, and denies future generations' full participation in the benefits of the information age.

Access to information requires information equity for all, irrespective of economic status, gender or geographic location or indeed educational attainment. An example of such an initiative is South Africa's digital Minimally Invasive Education project where, through a variety of partnerships, we are exploring ways of facilitating access and fostering computer literacy in areas where people have been excluded from the benefits of the information age.

Access to information, however, is not limited to these types of activities but also requires access to knowledge resources such as scientific journals, which I can tell you are increasingly out of reach in terms of cost to many African and developing world universities and colleges. Surely we can be more creative and effective in this area. The solutions to these challenges cannot be sought unilaterally but will result from a spirit of generosity and new types of partnership between creators, owners, distributors, and users of these resources and the product group of beneficiaries.

And of course it means also that the developing countries themselves must commit at least one per cent of GDP to science and technology and we did achieve this in our declarations at the NEPAD ministerial meeting held in Johannesburg in November. Access to services such as e-government, telemedicine and health information, educational services and e-business has been much discussed in many fora. And we welcome this.

The partnerships that will develop substantive and sustainable social services, infrastructures based on the information age, of course are not yet in place. As much as we promote the importance of public–private partnerships we should not forget that both the Internet and the associated World-Wide Web will develop from public investments in defence and nuclear research, particularly here. To establish effective partnerships in defining and delivering these services requires global public investment, not just in pilot studies but in large-scale demonstrations of these technologies in the service of mankind.

The ICT linkages and networks connecting universities and research centres are critical. While some developing world institutions still have no reliable connections, the use of high-speed research networks such as the GEANT network of the European Union and the Internet II infrastructure in the United States is moving ahead dramatically. Surely this growing divide can be addressed through global partnership. Our universities and research institutions are primary nodes of knowledge transfer and they need to be connected.

The importance of ICT networks for research and education cannot be underestimated. South Africa is establishing its own national research and education network and will link to GEANT. Similarly we need to develop Southern African Development Community (SADC) networks and an African research and education network. This was the subject of a new agreement at a recent NEPAD science and technology ministerial meeting in Johannesburg.

Market failure, especially in the telecommunications domain, leaves large sections of our society without access to information services and opportunities. Normal market forces will not rectify this. Interventions both from a business and technology perspective need to be made. Access to opportunities creates the basis of sustainable participation. The intellectual property regime that we need for this to succeed should foster the development of the creative and innovation roles of the developing world. Local content development and the technologies and processes that support this, such as human language technologies, are key components of such opportunities. We need to learn from global success stories and replicate these and maximize the benefit of opportunities provided by these successes to all.

One example of this is the closing of the gap between the developed and the developing world in the area of weather forecasting. This has happened over 20 years because in this case the availability of no-cost or low-cost access to remote-sensing data enabled us within the space of one decade to achieve parity in terms of the effectiveness of weather forecasting. We moved from being accurate within seven days prediction to five days and now we are at the level of three days' accuracy, which is almost exactly similar to the northern hemisphere countries. This was built on a consensus in the global weather community of free sharing of all relevant data, driven in part by the need for safe travel and the prediction of extreme weather events.

If only we had the same consensus about poverty, disease and ignorance we would certainly move the developing countries from the mire of underdevelopment and backwardness.

South Africa strongly embraces the open-source philosophy and this is supported by the national strategy on open source based on recommendations from the National Advisory Council on Innovation and other government structures. Open source is the ability to lower the barriers of entry into the information society. It provides access to a huge basis of knowledge resources and supports the philosophy of joint open development.

In conclusion, this is not 'business as usual' and incremental approaches will not take us to our goals. We need to understand and embrace the interrelated issues. Actions will range from increased science investment by developing nations through to implementation and new global partnerships. Human resource development, capacity building, a fair intellectual property regime, access and sustainability will be addressed. Within this new paradigm we need to guard against creating environments that will allow the mistakes of the past to be repeated. Again I stress that we need to move from developing world ICT consumption to creation and innovation by all to realize the equitable information society that is our future.

Thank you very much for the invitation to participate in this very important conference. We have a lot to offer, we want to be partners. »

Professor Fidel Castro Diaz-Balart, Member of the Cuban Academy of Sciences and Scientific Adviser to the President of the Council of State of Cuba

« Excellencies, Honourable members of the Panel, Distinguished participants in the RSIS, Ladies and Gentlemen,

I wish to express my deep appreciation to the patrons of this Conference and the Swiss Confederation for their warm hospitality. To all participants in RSIS, I am pleased to say how privileged I am to attend a conference of such importance and timely relevance.

Why Are We Here?

Around the world we are witnessing a technological, economic and social gap between rich and poor nations that is regrettably increasing. As pointed out in the RSIS Conference programme, on 7 March 2003 United Nations Secretary-General, Kofi Annan, challenged the World's scientists to address the 'clear inequalities' in scientific activity that exist between advanced and developing countries. One of the outcomes of the present Conference could be to draft a response to that challenge which must involve long-term strategies focusing on finding effective solutions to the problems currently under consideration.

The Background

I want to summarize for you the contents and highlight the main points of a document, which is a contribution to the RSIS and WSIS Conferences, entitled *Information Societies, Towards a South Perspective,* written in response to a request made to me by Professor Boutros Boutros Ghali, Chairman of the South Centre on behalf of its board. To draft it, I sought the collaboration of a group of internationally renowned experts, to whom I convey my gratitude for their valuable contributions. The document consists of four sections, a list of conclusions and recommendations, and an Executive Summary.

Challenges of Globalization

Throughout most of the South, the objective of putting science and technology at the service of development suffered a set-back during the 1990s under the impact of neo-liberal globalization, which despite its promises has weakened the nation state in critical areas and left the world vulnerable to disruptive capital flows and the vagaries of the market. The development of ICTs, on the other hand, has permeated the modern world scenario, leading to the emergence of information societies, but creating the digital and knowledge divide.

The building of information-knowledge societies is an essential means for achieving equitable and peaceful global communities, which, in combination with adequate infrastructure and economic development, prepare the conditions needed to humanize the process of globalization. But the construction of these societies is undertaken in a real world that is plagued with challenging problems. In fact, at the dawn of the 21st century, 20% of the world's population controls most of the world's resources.

The human population is growing and demanding an ever greater amount of energy. It has been estimated that by the year 2100 the world's population will be between 11 and 12 billion. Most of the demographic increase will occur in developing countries. Between 2030 and 2050, the total energy demand will double the present energy consumption, equivalent to ten billion tonnes of oil per year. Also, the composition and temperature of the atmosphere is being altered, leading to irreversible climate changes. At present, food sources for 1.2 billion people in many countries are threatened by desertification and water scarcity; these people include many of the world's poorest, most marginalized, and politically underpowered citizens.

As a consequence of this growing inequality the world is confronted with increasing violence committed by both state and non-state actors. Unless some drastic steps are taken to address this gap, the world faces a very uncertain future of wars and civil unrest.

So, the present generation of decision-makers is asked to act in response to a danger that will have a serious impact on succeeding generations. Solutions which find a basis in science are needed to solve real-life problems such as the eradication of poverty, the improvement of health care, the raising of educational levels, the introduction of technological innovations, and promoting wide-reaching and comprehensive education.

In this sense *our report expresses the very deep and strong desire of South scientists to construct information societies and to develop knowledge-based economies in our countries*.

Some developing countries are now engaged in the resolute pursuit of the goals of developing national science and technology capabilities and harnessing these in the service of national development, as part and parcel of comprehensive long-term national development strategies, with notable results. These advances have been essential ingredients in their ability to cope with contemporary challenges, including those presented by neo-liberal globalization.

But, in a significant number of developing countries, the situation has been aggravated by broader socio-economic problems such as high levels of external debt, the instability of financial markets, and financial crises with regional and global repercussions.

Education, Science and Technology

Over 850 million people, that is to say, 26% of all adults, are illiterate. It is necessary to begin massive educational campaigns that start with the eradication of illiteracy. This is essential to create a minimum cultural background, as the foundations on which higher education, scientific and technical programmes can be promoted. To create information societies, it is also crucial to eliminate illiteracy in terms of use of ICTs.

There is a disparity in investments, in outputs and in human resources in science and technology between South and North. Northern countries invest between 2 and 2.5% of their GDP in research, development, and application of science and technology. The investments of the Southern countries range from under 0.3% to 0.5%. In the North, 0.2% of the population is involved in science and technology, while in most South countries this figure is around 0.05%. As a consequence of this, South countries' total output of scientific publications and patents is below 10% of the world's share.

World science always brings a diversity of benefits, which can be intertwined with the specific characteristics of the societies in which it is developed. The present tendency to use the intellectual property system as a tool for the privatization of knowledge is threatening the efficiency and productivity of scientific creation on a global scale and jeopardizing it. Since science is increasingly becoming an essential part of modern general culture by putting boundaries on the above-mentioned diversity, it becomes an essential part of this problem, together with the intensification of the brain drain.

The document I am summarizing states that all these trends have weakened or eliminated the elements needed for self-reliance and for developing knowledge societies, which in turn undermines the ability of affected societies to use and harness modern science and technological advances in the service of development, as well as to overcome these challenges.

A Dual Challenge

We conclude that the challenge today is a dual one, namely: to use and benefit from the potential of information in knowledge societies and tackle the development problems and needs of the South, and to prevent this 'society' from becoming an additional source of divisions, inequalities, domination, backwardness and disempowerment in the contemporary world and within individual countries. As experience has shown us, the latter is a serious risk within the dominant globalization paradigm of unrestricted markets and 'level playing fields' in which grossly unequal players supposedly 'compete' with each other.

What can be done to respond to this dual challenge is our key policy message. It is addressed first and foremost to developing countries and calls for greater efforts to engage in self-reliant action, including efforts to promote South–South co-operation. Drawing on the experience and advances of some developing countries to assist others has a massive potential.

We believe that if ICTs are properly used, they can be of great help in efforts aimed at bridging the divide, especially in the area of science and research.

Outcome of the WSIS

In my concluding remarks, I want briefly to enumerate a number of conclusions and recommendations of our policy document:

– Developing countries must establish a set of strategic objectives for which the pre-requisite must be the implementation of massive education programmes.
– The mastering of science and technology must be guided by the most qualified groups of scientists and technicians. Scientific literature, particularly in electronic form, should be made more broadly accessible to South countries.
– Political will and access to financial resources are equally essential to guarantee sustainable development.

The development of all science-based high technologies requires a national core group of experts in the area of basic sciences. The upgrading of universities and technological schools is another step. The link between the development of science and science education, making use of technological innovations, must be emphasized. It is necessary to promote the creation of research institutes where a considerable part of all scientific activity is devoted to applying international science to the search for solutions to local problems. The creation of scientific and technological parks (or even techno-cells), as a link between universities, research institutes and industry, must also be promoted whenever possible.

Possible routes to achieve the South's empowerment and developing synergies could be:

- The creation of an organization for mutual scientific and technical advice and assistance in the South.
- The creation of various regional centres of international standard for training scientists of neighbouring countries in several areas of science and technology.
- The establishment of joint mechanisms for creating or improving already existing research centres of excellence and research groups, to promote South–South exchange of scientists.
- Improvement of our capacity to negotiate with Northern institutions for access to world science and technology, including free availability of scientific and technical journals by Internet for most countries in the South.

I would like to conclude my intervention by considering the following core question that the expert panel which I represent addressed to itself:

"Is it possible to have information societies in the South?"

We believe it is possible, but it is necessary, although perhaps not sufficient, to heed our recommendations, many of which together with other approaches, are not new for the developing world.

Regarding science and technology development, a political decision is needed to *create, master and use modern science and technology, including ICTs*. However, despite their efforts, only a few Southern countries have been able to make substantial progress in implementing them. It is time to find the way to start working systematically to allow the entire developing world to achieve these goals.

I feel all of us in this conference are committed to working towards achieving Knowledge Societies for All, but how to do it in a better and more equal and just way, this is our challenge. »

Dinner Speech

Malcolm Harbour, Member of the European Parliament

The Legislative Framework for Electronic Communications

It is absolutely essential for the dissemination of information that legislators get the legislative framework for electronic communications right. The EU provides a good model. The crucial policy is to provide a single framework for all electronic communication formats to encourage cross platform competition and to encompass convergent technologies. Information delivery mechanisms will keep changing rapidly. Some formats may be only transitory — the commercial models will change. Legislators should have the courage to let the market work. They should only intervene to deal with cases of demonstrated monopoly power or dominant position. They should use interventions, such as mandatory network access, that encourage competition. Above all they should be technology neutral — it is not the job of politicians to mandate regulation of technologies. Scientists will hopefully support this approach and lobby politicians if they feel that communications regulation is going in the wrong direction.

Research

The European Union has given high priority to information and communication technology research in its Framework Research Programmes. These programmes add value to national research efforts. In ICTs, they have been particularly successful in developing the technology and standards for mobile communications, which has given the EU a leading global role. In the current programme 3.6 billion euros will be invested in ICT research between 2003 and 2007, with 1 billion euros just released for a whole range of new projects.

To underpin this research, the EU has also invested in the GÉANT broadband research network and has been actively promoting global network development to link research centres. A crucial point made on Day 1 of the RSIS Conference is the need to stimulate research in every country to develop ICT projects that address local needs. Solutions must be tailored to geography, culture, infrastructure and language, to name but four factors. But ICT work can be greatly helped by access to technologies from other knowledge centres and solutions developed in one country can be shared with others. Researchers can also conduct remote experiments using facilities in other countries and analyse the data generated. A key outcome of the World Summit should be the clear endorsement of the creation of a global research network and the commitment by the key players to develop and fund it.

Knowledge-Driven Economy

It is clear from all the discussions at the RSIS Conference that, in a knowledge-driven economy, the information technology makes an impact at all levels in society and also encompasses the past, present and future. It is also clear that the evolution of the information society will proceed in very different ways in developed and developing worlds. In the developed world, our challenge is to stimulate personal consumers to use the technologies for commercial and public service applications. This growth should stimulate investment in technology and infrastructure. By contrast, in developing countries, the delivery of public services will be the key driver of infrastructure and investment. However, common to all IT applications is the need for data security and for citizens to be able to exert control over their personal data. Citizens will not interact with public authorities unless they feel secure about releasing highly sensitive health, financial or education records. They also want to control who sees their data within the different parts of the public administration! For commercial interactions, similar considerations also apply. Consumers are often reluctant to buy on-line because of worries about the security of their financial data.

Security issues also impact on intellectual property considerations. We want creative minds to generate exciting new content for all kinds of electronic delivery mechanisms. But they will also expect their returns. New business models have been developed to enable creators to realize value. These will reflect changes in consumer attitudes brought about by digital delivery. Musicians, for example, will have to adjust to the reality that on-line distribution enables them to release value from their works over a much longer period, because back catalogues can be made easily and freely available. But short-term revenue from new releases is being dramatically reduced by illicit circulation of private copies.

We also saw examples from RSIS presentations about the importance of applying IT to cataloguing and archiving our cultural history. Much of this will be a free resource but there are commercial opportunities here as well. But we need to encompass all areas of information technology in our thinking because they are generating large amounts of revenue. Take computer games. It was reported in 2002 that visual reality and visual reality games generated a staggering US$ 36 billion world-wide revenue. Interactive games are generating high levels of broadband traffic, stimulating infrastructure growth. The investment in virtual reality will spin off important tools for society, in medical training, in road safety and in building design. The latest growth in computing games is coming from avatars where game players can make virtual reality models of themselves or any other person they want to be and insert themselves into their game scenes. This opens lots of possibilities for combining historic events with new technology; we could recreate ourselves kicking the winning drop goal that gave England the World Rugby Cup! Or we can recreate and replay historic football games. I use these examples to emphasize that we must be creative in our whole approach to the knowledge economy. We must encourage creativity to get innovative people to grasp the tools available and exploit them. The computer games played in the developed world stimulate technological and infrastructure investment that can help the developing world.

Conclusions

CERN is to be congratulated for seizing the opportunity to bring us together for such a stimulating and wide-ranging event. As a European politician involved in IT policy-making, I am conscious that there are many lessons to be absorbed. But the key one is that the politicians must play an enabling role, not a controlling one. We can set the rules of the game and encourage strategic research. But we should be brave enough to give innovators their head.

Part II — Parallel Sessions[1]

Tuesday, 9 December 2003, 9.00 a.m. to 12.30 p.m.

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10 Contributions to Education

11 Contributions to Economic Development

12 Contributions to the Environment

13 Contributions to Health

14 Contributions to and Benefits from Enabling Technologie

The rapporteurs of the Parallel Sessions presented their summaries in the Plenary Sessions on Tuesday 9 December at 2.00 p.m.

Moderator: Dr Mohamed H. A. Hassan

1. An On-Line Forum on the RSIS Website had preceded the conference. The discussion groups on all five topics of the parallel sessions: education, economic development, environment, health and enabling technologies, were moderated and the ten participants considered to have made the most important contributions to the On-Line Forum were invited to the conference. Papers submitted by these participants are included in Annex II of these proceedings.

10 Contributions to Education

Chair	**Wei Yu**, Chinese Education Ministry
Rapporteur	**Mustafa El-Tayeb**, UNESCO
CERN Moderator	**Robert Eisenstein**
Speakers	**Robert Eisenstein**, Santa Fe Institute and CERN **H R H Princess Maha Chakri Sirindhorn**, Princess of Thailand **Atta-Ur Rahman**, Ministry of Science and Technology, Government of Pakistan **Mohammad Hassan**, Director-General of the Third World Academy of Sciences **Robert Martin**, Director of the Institute of Museum and Library Services **Wesley Shrum**, Louisiana State University
Website	http://rsis.web.cern.ch/rsis/

Session Summary (John Ellis, CERN)

Issues Raised

In preparing the parallel session on education, speakers were asked to address several key issues. These included:

– the role of Information and Computing Technology (ICT) in fostering education,
– the factors that make distance-learning initiatives successful,
– ways of bringing educators who work on various e-learning initiatives into contact with each other,
– ways of improving free access to scientific information,
– the roles of libraries and museums, and
– the roles of virtual universities and laboratories.

The session was presented in all forms of multimedia. The first speaker was in the USA while his computer was with us. The second lecture was a film shot in Asia and Africa. Other speakers made 'conventional' computer presentations, and our Chairman did not use ICT at all, but gave a classical lecture.

The speakers focused on the important roles that ICTs can play in facilitating education, and the specific necessity of education in science and technology. Various ways to bridge the digital divide were discussed. Particular emphasis was given to the need for free access to information, software and networks (while recognizing the importance of intellectual property rights), and the necessity for strategic collaborations that can increase the power of ICT applications in education.

Successful Examples

Several examples were given of successful educational initiatives based on ICT.

Many valuable educational and research materials are now available over the Internet. One good example is the OpenCourseWare made available by MIT, which includes materials such as syllabi, lecture notes, examinations and problem sets. Other universities also produce material suitable for distance learning: for example, Stanford University has an extensive range of courses available on video, and there are also initiatives from the University of California, the University of Illinois and the Open University in the U.K.

Another interesting application of ICT within the research community is the free but un-refereed `arXiv' digital archive of research papers in physics, mathematics, computing and quantitative biology, on arXiv.org . By contrast, the 'Public Library of Science' (PLOS) initiative makes refereed research papers available free to readers, but the authors must pay to publish, which is an obstacle to scientists in some countries.

Also mentioned in the session were several interesting structural initiatives based on ICT, including the African Virtual University, and we heard about exciting developments in a couple of individual countries.

Thailand has also been particularly active in developing distance-learning programmes using ICT. These include satellite-based training for some 3000 schools and the free offer, by a national Institute for the Promotion of Teaching Science and Technology, of Web-based learning material and CD-ROMs. There is also a central repository for websites of interest to educators in Thailand. However, the Thai experience emphasizes that, while digital education is good, mechanisms to promote the use of Web-based material are vital, as is the provision of material in the local language. Finally, hands-on experience and contact between educators and learners are also necessary.

The Pakistani government has recognized the importance of ICT for education, but also realizes the need for complementary infrastructure, trained human resources, an enabling environment, and universal access for the citizen. The government acts as a facilitator and enabler. Through its actions, Internet access has recently expanded dramatically — from 26% of the population in 2000 to 97% in 2003 — while the bandwidth available has soared — from 32Mb/s in 2000 to 600Mb/s in 2003 — and costs have plummeted, with a resultant increase in the number of Internet users from 120,000 in 2000 to 4,800,000 in 2003. The PAKSAT 1 satellite provides four free educational TV channels and all universities are now connected by an optical fibre backbone. In this way, the Pakistani government has been able to create a national Virtual University Network, which is a hybrid between distance and interactive learning. It is also seeking to help the Pakistani academic community in various ways, for example by providing online access to 31,600 research journals nationwide: more information is available on www.comstech.org.pk .

It was agreed that distance learning needs more than simply making material available online. Attention must also be paid to interface design, navigation and feedback. Also, assessment is crucial and programmes must be developed with clear outcomes in mind. Different programmes should share the results of these assessments to identify the most successful approaches, for example within South–South partnerships.

In the near future, the advent of distributed computing based on Grid technology, which is being driven by data-intensive sciences such as high-energy physics, will put enormous computational power at the disposal of the educational community. It will turn the World-Wide Web — invented at CERN to enable scientists from many different countries to work together — from a passive system into an active device, and will surely also have a profound effect on education.

Educational Roles of Museums and Libraries

These institutions are crucial for creating a 'learning society'. The Institute of Museum and Library Science (IMLS), an independent federal agency in the United States, provides grants and plays a national leadership role in helping the more than 15,000 museums and 122,000 libraries in the U.S. become more effective educational organizations through support of activities in areas such as capacity-building, lifelong learning, cultural preservation, and civic engagement. The IMLS mission is to create and sustain a nation of learners through supporting museum and library services. Libraries and museums play an important role in formal and informal education, including science education. A 2002 IMLS-funded survey found that, cumulatively, U.S. museums spent more than one billion dollars on K-12 educational programmes in 2000/2001 and provided millions of instructional hours.

ICT has led to a convergence of traditional museums, libraries and archival resources, in terms of their assets, their practices, their programmes, and their accessibility to learners of all ages. The International Children's Digital Library, for example, [www.icdlbooks.org] is an international public/private partnership that has created a digital collection of children's literature from around the globe, with topic headings and interface designed in concert with the children who comprise the project's audience. Field Trip Earth [www.fieldtripearth.org] is an online resource developed by the North Carolina Zoo that enables students, teachers, and the public to follow and interact with the daily work of wildlife researchers and conservation experts around the world. These library and museum-based projects are making new contributions to learning in and out of school.

Effective ICT practices require shared standards and frameworks and, in addition to supporting projects that use new digital technologies, IMLS supports efforts to identify best practices for the creation, management and preservation of digital resources — necessary components for a strong and vital learning infrastructure. In the U.S., this learning infrastructure has been enhanced by the creation of several online central repositories, including the National Science Digital Library, supported by the National Science Foundation, and GEM, the Gateway to Educational Materials (www.thegateway.org), funded by the U.S. Department of Education. These repositories are the product of multi-organizational collaborations, formed to address the educational needs of students and teachers more effectively through new technologies.

Also in this connection, ICTs now make possible the concept of a 'virtual laboratory', as exemplified by 'Bugscope', and telescopes or a microscopes that can be controlled from a distance. A public–private partnership has created 'Try Science' at www.tryscience.org , a gateway encouraging people to experience the excitement of contemporary science through on- and off-line interactivity with over 400 science and technology centres worldwide.

South–South Partnerships

The importance of South–South co-operation also emerged clearly from our discussions. This is important, not only in the ICT area, but also for training scientists and general capacity-building. Among the different modalities of South–South co-operation, one promising development has been the recent initiative by Brazil, Mexico, India and China to facilitate training in their respective countries by each offering 50 scholarships, some in ICTs.

Such South–South partnerships will be key tools for disseminating and sharing innovative experiences, as well as fostering a new generation of talented scientists. These are cheaper than sending students for postgraduate training in developed countries, which also entails the danger of a brain drain. However, in many cases, the necessary first step must be to build up the communication capacities of science academies.

Centres of excellence should establish networks to use ICTs to exchange information on specific issues affecting the South, such as safe drinking water and biodiversity. For this, however, access is required to basic communication facilities and infrastructure, and programmes are needed to provide that access, e.g., by purchasing computers, providing Internet connectivity, and designing websites.

Conclusions

There is general agreement that ICTs now play a key role in the learning process — including ongoing developments such as the Grid technology for distributed computing as well as established technologies — in both specialized educational institutions and organizations providing resources for learning throughout life. Projects that are on the 'new frontiers' of education focus on meeting the needs of the learner and providing a variety of pedagogical approaches that can accommodate different learning styles and situations.

There are many encouraging examples of ICT projects based at institutions of higher education, such as the OpenCourseWare provided by MIT and the video recordings from Stanford University, as well as virtual universities and laboratories. Other projects and programmes come from collaborations between libraries, museums, and other educational organizations. However, many issues remain, such as the need to negotiate electronic access to research journals, 'business model' incentives for different institutions to collaborate for shared educational and community goals, and the challenges of creating and adhering to common standards and frameworks. In addition, the developments made possible by ICTs do not alter the fact that libraries and museums must continue to play their traditional stewardship, exhibiting, and information-providing roles.

However, in order for developing countries to reap full benefit from ICTs, the world needs to develop the infrastructure for bridging the digital divide: one must not put the cart before the horse. Advanced laboratories, such as CERN, can play valuable roles through their expertise in ICTs, by their global network of collaborators, by making educational materials available on the Internet, and by validating sources of scientific information. However, it is also essential that developing countries help themselves and each other by expanding South–South cooperation. In this connection, the African Virtual University and a special initiative to connect African institutions are particularly welcome.

As the session moderator pointed out, the last 25 years of experience teach us that we have only just begun the revolution in the process of using ICTs to facilitate education, and it is clear that we must all work together to realize its full potential.

11 Contributions to Economic Development

Chair	**John Dryden**, OECD (Organization for Economic Cooperation and Development)
Rapporteur	**Dr Mohammad Nahavandian**, Institute for Humanities and Cultural Studies, Tehran, Iran
CERN Moderator	**Mike Doran**
Speakers	**Paul Rübig**, Member of the European Parliament **John Burley**, UNCTAD (United Nations Conference on Trade and Development) **Richard Dixon-Hughes**, ISO (International Standards Organization) **Feng-Chin Ling**, AFACT (Asia-Pacific Council for Trade Facilitation and Electronic Business) **Subbiah Arunachalam**, M S Swaminatham Research Foundation, India **Fidel Castro Diaz-Balart**, Cuban Academy of Science
Website	http://rsis.web.cern.ch/rsis/

Introduction

The Information Society was made possible by scientific and technological advances, and many of its enabling technologies were developed in order to further scientific research and collaboration. For these reasons, the international scientific community has a key role to play in the WSIS. The aim of the RSIS conference in this session is to allow members of the scientific and governmental communities, the civil society and business, to discuss the critically important role of science and technology in pioneering and furthering the development of the Information Society, and the future contributions it can make world-wide to economic development.

- What can science do to help maximize the benefits of information and communication technologies?
- What benefits can developing economies gain from e-business?
- What e-strategies have been found to work best in developing countries?
- In what ways can knowledge and technology transfer help bridge the economic digital divide?

The Chairman suggested three themes for the session:

1. ICTs for economic growth
2. The role of ICTs as promoters of innovation and as contributors to development
3. Access to information, literacy, and the human factor in the attainment of economic development

1. ICTs for Economic Growth

The Chairman stated that despite overinvestment in ICTs in the late 1990s and economic downturn since 2001 (during which productivity had held up well), there is increasing optimism that science and innovation-driven ICT development (Moore's Law) is steadily enhancing economic development. Wider use of broadband is spreading adoption of ICTs.

Paul Rübig

SMEs (in Europe: 75% of all new jobs, employing two thirds of all employees, 80% of all tax paid by SMEs) are the key to economic progress and it is important to have the right framework for their development.

ICTs and access to financing are the bases of SME success. Three levels of business are recognized: customer to customer (C2C), business to customer (B2C) and business to business (B2B). The main priority must be the latter. Trade facilitation for SMEs depends on a multilateral approach (Basel 2 Agreement); big business has strong lobbying possibilities at the WTO level. Access to financing is crucial for SMEs. The principle for economic development should be 'think small first'. The EU is fostering partnerships with SMEs in the developing world.

Issues: improved use of ICTs for economic growth; support for renewable energies and sustainable growth (Kyoto Conference); new investment flows; international treaty for SMEs.

John Burley

The impact of technological development on economic development has long been recognized. ICTs have a potential for increasing efficiency and have had an impact on growth, through the positive contribution of ICT investment to productivity. ICT use requires a supportive environment and improvements in other factors to maximize return on investment in them. ICTs have a sustained impact provided that the policy mix is correct. ICTs have fostered outsourcing, which is increasingly important for countries like India which can offer outsourcing services that boost the local economy. Free and open-source software is opening new prospects for developing countries in access to and participation in key software developments. However, the digital divide is a matter of serious concern (95% of e-commerce is in the developed world) and while Internet use is expanding rapidly (32% of users in developing countries in 2002, 50% by 2008), there is no direct linkage between Internet penetration into the developing world and levels of commercial use and thus impact on economic development.

Some reasons for this are:

1. lack of awareness of ICT benefits;
2. weak Internet connectivity and broadband networks;
3. high cost;
4. inadequate legal and regulatory framework;
5. failure to use local content, language;
6. social inequalities.

ICTs must not be seen as a panacea for development and cannot compensate for flaws and deficiencies in economic and governmental structures.

Some Conclusions

1. The need for a balanced approach
2. Each country must define its e-strategy
3. Training and education are of paramount importance
4. Free Open-Source Software (FOSS) is essential
5. A serious effort must be concentrated on standardization and inter-operability
6. More public and private investment is needed
7. Connectivity and telecommunications infrastructure are critical prerequisites.

2. ICTs — Innovation and Development

Introducing ICTs as promoters of innovation and development, the Chairman stated that scientific research had contributed to e-development (WWW), which feeds back to innovation since researchers use developments to create further innovations. There is a clear link between scientific and technological developments and further technological and economic development.

Richard Dixon-Hughes (ISO): Global Standards for the Information Society

Developments in ICTs are accelerating and major segments of the international economy are now totally dependent on these technologies which bring benefits in many fields. Nevertheless, overcoming the digital divide to enable all peoples to share these benefits is a major challenge. Research offers seemingly endless possibilities for improved technologies but the ICT industry can only adopt the fruits of scientific creativity when they deliver commercial benefits. International standardization facilitates adoption of technology by balancing commercial, technical and community interests through open, participative processes and is well suited to ensuring that our goals for the Information Society are met.

International standards have been and will continue to be essential as a foundation of the Information Revolution (e.g. information coding for use by processing systems; standards for defining and using databases, messages, and documents; standards for programming languages, systems modelling and processing platform interfaces; applications standards in health care, trade and commerce, finance, transport and mapping; standards defining best practice for the management and use of technology).

Many different organizations are now developing global standards to support the Information Society (e.g. ISO, IEC and ITU-T, W3C, IETF, IEEE, UN/CEFACT and OASIS, etc.).

Examples of major contributions of international standards to extending the Information Society include electronic multimedia (e.g. JPEG and MPEG) e-business collaboration (EDIFACT standards for international trade, transport, etc., and recent agreements sponsored by ISO, IEC, ITU, UN/ECE).

The cost of setting up an e-business solution needs to be lower than the benefit incurred. For many SMEs, high set-up costs can preclude participation in e-business. Being locked in to customized integration products inhibits e-commerce, the growth of standards-based approaches makes B2B connectivity affordable for SMEs.

Conclusions: On-going development of the Information Society requires a broadly-based, responsive, global programme of continual standards development based on active co-operation of standards bodies and on three principles: inclusiveness (accepting work of other organizations into the international standards framework); global market relevance (standards must address industry's needs); faster adoption through lower-consensus documents (that can be later refined into full standards following implementation experience).

Feng-Chin Lin (Asia Pacific Council for Trade Facilitation and Electronic Business, AFACT) then presented the HUB Model for SME B2B (Business-to-Business) Applications. He traced the major problems in supply chain management in the IT industry: many incompatible IT platforms, redundant investment in information systems and applications and multi-layered architectures which slow down information transmission in the supply chain.

The IT industry in Taiwan has 3–4000 SMEs, both suppliers and customers who trade on a global basis. The HUB model has evolved from a multi-tier linear activity model to a new framework based on a trading partner network. The HUB system services include, e-Procurement, e-Logistics, e-Design and e-Cash.

Currently 1200 trading partners, including 100 logistics service providers, are connected to the HUB and the services will be extended to China, Japan, Europe and the US through inter-network integration.

The single window for B2B information flow using the HUB concept could be implemented by SMEs in many industries in both developed and developing countries alike.

3. Access, Literacy and Diffusion to a Wider Population

Subbiah Arunachalam, M. S. Swaminatham Research Foundation, India

(**Film** of hub project in South India (Pondicherry) where local farmers and fishermen obtain essential information on weather, crop pests, etc. from a rural internet office.)

Partnerships and such broader educational possibilities as virtual universities and academies may help to bridge the digital divide, but in the case of rural communities, economic development and improvements in information (education, health, agriculture, safety, hygiene, etc.) require the expansion of knowledge centres manned by experts who are prepared to listen to needs and respond to them in a targeted way and on the basis of a two-way communication.

It is essential in such poor regions of LDCs not to put the technological cart before the horse: in areas where literacy is low, Internet access may be irrelevant, as well as being unattainable both in financial and practical terms. The number of users of such centres is a better benchmark of ICT impact for developing countries than the abstract percentage of Internet users. The prevailing principles are those of John Ruskin's *"Unto this Last"* as advocated by Mahatma Ghandi. Women in particular are seen as essential vectors of information to the family unit and thus to a small village community.

General Conclusion: IT alone is useless in promoting economic development; it is only useful in combination with other factors. A holistic approach and programme are therefore essential for rural communities in the LDCs.

Fidel Castro Diaz-Balart, Cuban Academy of Science

The Role of New Technologies in National Economic Development — The Cuban Experience

The speaker presented an overview of key research institutions in Cuba, stressing the importance of intensive education as a prime prerequisite for economic development, the impact of science and technology on industrial and economic development as well as the need for a critical mass of a core of universities and research centres.

Three basic strategies have been implemented to ensure that biotechnological research has an impact on the Cuban economy: a) closed-loop organizations with responsibility and resources for research, product development and manufacturing; b) global-market orientation to ensure cost-effectiveness of investment; and c) the filing of patents, demanding a tight relationship between fundamental research and industrial strategy.

Conclusions

The polarization of scientific activity between North and South is a global problem. Use of knowledge requires abundant and competent human resources, access to information channels, organizational resources, functional links between academia and industry, legal support infrastructure, negotiation capacity, etc. Scarcity of these commodities in the South is a formidable barrier to development. The capacity to use knowledge is increasingly linked to the capacity to generate it. Knowledge and technology transfer models are no longer functional. Scientific capacity has to be established. Co-operation between North and South should be established on the basis of: 1) joint research projects and research teams for the sharing and pooling of information with an industrial as well as an academic component as a mechanism for influencing technological and economic development; 2) co-operation structures focusing on frontier research projects of universal interest.

4. Questions & Answers

Q: How sustainable are the grass-roots information centres in India and can they be widely replicated?

A: (Arunachalam): Nothing is stable in the developing world. However, such centres foster social empowerment at the micro-social level. We are planning to extend the scheme into other rural areas, although we are finding that populations in some provinces, with lower receptivity to the value of technological development and education, are proving more resistant to such schemes.

Q: Are you not concerned by the fact that ICTs have generated a brain-drain from India?

A: (Arunchalam): India has a huge population with an untapped potential and inexhaustible pool of talent. Indians working in Silicon Valley assist families in rural communities financially and their experience serves as an impetus to others to reap the benefits of education.

Q: (Rubio, CERN): The disparity between the advances linked to the rapid rate of IT development in the developed countries and in centres like CERN (e.g. the Grid) is widening the digital divide with the LDCs. How should research institutions like CERN address this divide?

A: (Dryden): Partnerships between all the stakeholders (i.e. NGOs, centres of excellence, international organizations, EU, standards organizations) are the key as well as open access to publicly-funded research data. The availability of such data will further push back the frontiers of technological achievement. One of the key issues is the mechanism by which the partners can be brought together to create the information society. The research field has demonstrated the advantages of access to publicly-funded research data in the promotion of a given discipline or field of technology.

A: (Burley): The three key issues are 1) awareness at difference levels (e.g. political commitment, individuals with vision); 2) the magic of the market place and 3) training, exposure, education.

Comment: (Eliot, ICSU): Science is the basis of economic development because it is incremental by its very nature ("I stood on the shoulders of giants"), but requires investment and the right climate and legal framework. A major threat to such development is the tightening of EU intellectual property legislation.

Comment: (Barone, Greece): The Internet is still used by only a minority of the world's population. That should be taken into account when assessing the impact of ICTs in the least developed countries.

A: (Burley): The degree of Internet use is clearly and inevitably highest in countries with a large educated middle class.

Summing up by Mohammad Nahavandian

General statement of principle: "Grey matter is the most evenly distributed commodity."

Of the six speakers, three examined the policy aspect of ICTs and three gave examples of how these policies can be implemented.

The following main issues have emerged from the session:

1. Global policies are needed for global economic development: globalization cannot proceed unchecked or unregulated.
2. Unilateralism is no longer acceptable as an economic principle in the global market: the WTO development negotiations are still imbued with a sense of national priorities.
3. the need to think globally and multilaterally rather than in terms of the requirements of governments or non-democratic institutions (e.g. standardization, the domain names issue);
4. Localization of technical policies (application and adaptation to meet local needs).
5. The scientific community, international research organizations and centres of excellence must play a pioneering role; the intellectual property system has to be engineered to foster global development; however, the contribution of traditional knowledge to community life in the LDCs has to be respected and protected.
6. Attention must be paid to a sustainable relationship between economic development and the environment.
7. The beneficial impact of ICTs on economic development requires a fertile economic, educational, social, legal and political environment; the scientific community can act as a pioneer in creating the right environment for scientific and technological development and information exchange which are the motors of economic development.
8. National borders are of decreasing importance in the global economy and interrelationship of markets; the global good and universal moral values increasingly exercise the public imagination and emotions rather than purely national concerns; here too scientific society has played and must continue to play a pioneering role.

12 Contributions to the Environment

Chair	**Walter Erdelen**, UNESCO
Rapporteur	**Luigi Fusco**, ESA
CERN Moderator	**Hans Falk Hoffmann**
Speakers	**David Williams**, EUMETSAT **Peter Bernal**, IOC/UNESCO **Josef Aschbacher**, ESA **Stuart Marsh**, BGS **Stuart Salter**, IUCN **Luigi Fusco**, ESA
Website	http://rsis.web.cern.ch/rsis/

Session Summary

The chair, W. Erdelen (UNESCO) introduced the main goal of the session, namely to debate how sustainable development is linked to, and can benefit from, the present information management evolving towards global environmental knowledge management, accessible to all.

In the following the contributions of the speakers to the session are summarized:

D. Williams (EUMETSAT) introduced the Meteorological Community's vision

Meteorology is a mature, global community that endeavours successfully to get away from 'a world full of data and short of information'. Thus it could be a reference for other communities.

The international meteorological community is organized around an operational system handling and integrating space mission data and forecasting models for the generation of routine global and regional products (e.g. SST maps).

The strategy of sharing of resources and concerted efforts by global partners represents an important political and pragmatic step that has allowed the present maturity to be reached.

This approach was further promoted at the last Earth Observation Summit in January 2003.

The results of these efforts should become available also to those countries and their citizens with less developed communication infrastructures.

P. Bernal (IOC/UNESCO) spoke representing the Ocean Community

The international Global Ocean Observing System (GOOS) was created as a response to the Rio Conference in 1992. GOOS, as a single, permanent, global, public-oriented service, is being achieved with the active contribution of different segments of society.

At present Space missions are extensively used to generate large amounts of data while the community is mainly organized by geographic region.

Efforts to get better coverage are ongoing and to obtain access to *in situ* measurements. It was noted that improved marine observation and derived environmental information serve other large potential user communities such as energy, transportation, health, finance, etc. The reduction of environmental forecast uncertainty (i.e. improved medium-term weather forecasting, achieved by improving access to quality information) has substantially helped the tourism industry.

One issue, considered to be relevant across the environmental community, is related to the adoption of international standards in the area of data and information exchange and sharing.

J. Aschbacher (ESA) provided the European Space Community' perspective

He introduced the Global Monitoring for Environment and Security (GMES) results achieved at the last Baveno meeting in November. GMES is a joint EU/ESA initiative to develop operational monitoring systems comprising space, *in situ* and forecast models to support Europe's environment and security policies. The European environmental community is driving the GMES initiative in the various thematic applications on the global (e.g. verification of environmental treaties), regional (e.g. environmental indicators), and local scale (e.g. sea pollution monitoring).

Furthermore, ESA and the EU have approved a 'White paper on Space', which addresses topics such as Galileo, GMES, the digital divide, technology and science. The paper addresses the issues of sustainability, integration of technologies, user involvement and operational services for the institution and the community.

It was recognized that the need for a shared infrastructure and for a well co-ordinated information management tool across environmental users is a key element for environment information management.

S. Marsh (BGS) highlighted the Geo-Hazard Community's position

For the purposes of this presentation, geo-hazards address earthquakes, volcanoes, landslides, and subsidence. These disasters all hinder sustainable development, costing lives and livelihoods and damaging infrastructure.

The international response to geo-hazards involves the political sector at various levels, the United Nations, and all sorts of operational communities and science and technology. It requires access to integrated *in situ* and remote observations. Common user requirements include baseline hazard inventories and rapid information access, which imply more accurate observations in time and in space. Equally important is the process of transforming data into useful information and knowledge. This involves data management, integration and hazard modelling. But the biggest challenge is to create an integrated, global geo-hazards community capable of doing these things via capacity-building efforts.

S. Salter (IUCN) discussed the Biodiversity Community vision

Experience shows that when ecosystems collapse they do so in a very fast way. Furthermore, environmental stress translates quickly into social stress.

There is an urgent demand for an authoritative and accessible biodiversity and environmental decision-support tool.

The World Conservation Union (IUCN) is responding to the need. Using the network of 7,800 volunteer experts in the IUCN Species Survival Commission (SSC), up-to-date information is collected on a wide variety of species. This is then peer-reviewed and made available to decision makers worldwide. One product is the IUCN Red List of Endangered Species.

The issue of alleviation of poverty linked to environmental issues was also discussed. There is clear evidence that current development strategies often have unintended detrimental effects on the environment that ultimately may end up making the overall poverty situation worse. It is well recognized that development strategies need to have environmental stewardship as a core pillar. A clear, multidisciplinary approach will be needed to support this goal.

L. Fusco (ESA) complemented the vision on the role that Information Systems Technologies play in environmental monitoring

Environmental monitoring for sustainable development needs integration of all available mature technical resources, including space and other technologies, which can respond to the appropriate time and spacial scale (local, regional and global).

Close co-operation and data/information-sharing with all concerned parties and communities is an essential factor in achieving success. An effective demonstration of this approach is the International Charter for Disaster Management in which all participant Space Agencies respond in the most efficient way to the call made by Civil Protection bodies and other users, providing free data and information.

One of the always discussed, but never solved, issues related to data access is an unified and supportive data policy.

Comments

The workshop was further animated with contributions from the audience (e.g. Udo Herbert, Dep. Animal Science and Technology, Fed. Univ. of Technology, Owerri, Nigeria; Sandra Mejia, Rural Development/GIS Specialist, Managua, Nicaragua), who reported on "Environmental Information Management in Developing Countries" and on "Bridging the Digital Divide in Environmental Information Management").

Summary Statement

It was agreed that the following statement be reported to the Plenary Meeting as a goal for the future:

> **"Every citizen shall be able to easily monitor the state of his environment, from his planet to his country, to his village, to his street, to his house."**

Recommendations

The concrete recommendations made by the Environmental Session can be summarized as follows:

- The task of monitoring the Earth's status is a global issue. Earth science research should be encouraged on a global scale. Earth science is of concern for every citizen's immediate environment and condition of life and thus different from other sciences. Earth science should involve international bodies, institutes and single scientists from all countries, ultimately aimed at serving every citizen.
- Life on Earth depends on biodiversity and the living environment. Biodiversity is not properly funded and organized in terms of science.
- There is a fundamental communication gap between data providers, scientists and users/citizens. For example, the World Bank and other funding agencies are not using environmental information as they should.
- An improved technical and political link between data providers and data users is needed to improve access and share environmental information.
- Education and capacity-building need to be supported throughout with all possible resources and opportunities at all levels.

13 Contributions to Health

Chair	**Jim Kim**, World Health Organization
Rapporteur	**Harry McConnell**, Interactive Health Network, International e-Health Association
CERN moderator	**Manjit Dosanjh**
Speakers	**Luis Gabriel Cuervo**, The Cochrane Collaboration and BMJ Knowledge's Clinical Evidence **Dialo Diop**, Université Cheikh Anta Diop in Dakar, Senegal **and** Université Pierre et Marie Curie, Paris **David Dickson**, Science and Development Network **Mary Ann Lansang**, INCLEN Trust and University of the Philippines **Salah Mandil**, International e-Health Association **S. Yunkap Kwankam**, World Health Organization
Website	http://rsis.web.cern.ch/rsis/

Introduction

This session focused on the practical application of science to health with implementation of information and communications technologies seen as critical tools in health and development. Access to essential health information and the infrastructure necessary to attain this were seen as important for implementation globally. It was emphasized that information must be relevant to the user, include local knowledge and experience, be in appropriate languages for the population as well as use accessible media. The exchange should be a two-way process and the level of evidence of information be specified and quality maintained through peer review and open communication. Telemedicine, e-Learning and scientific applications were also emphasized and inclusion of developing countries in global efforts such as the Human Genome Project and disease surveillance was seen as essential. Nutrition, safe water and basic human needs were stressed as a major priority above technology; IT was discussed as an essential tool to assist in making these basic needs more accessible and to integrate health systems in developing countries. Appropriate measures of health care impact for e-Health were viewed as critical and technological measures, for example, 'hits' on web sites were not seen as sufficient indicators for assessing the effectiveness of IT in improving health and health care. Clear measures of outcome showing benefits to the health of individuals and populations must be integrated into programmes using ICTs in healthcare.

For information to be effective, it needs to be delivered at the right time, to the right people, and in the most appropriate format. New technologies and knowledge reduce the time between knowledge output and its dissemination to the end user; behaviour change and empowerment are among the new challenges required to influence healthcare providers and information providers.

General Summary

This session was preceded by an active online discussion group moderated by Dr Manjit Dosanjh, CERN. Many of the issues discussed online were further clarified at this lively session with much discussion generated.

All the talks can be accessed via www.cern.ch/rsis/health/

Topics discussed included:

- How can remote consultations benefit communities in remote and developing areas?
- What promise do information and communication technologies hold for the health field?
- What are the best ways to achieve greater equitable access to health related information so that the society as a whole can benefit from the latest research and breakthroughs?

The role of health in the information society was discussed from several different perspectives: that of the World Health Organization, the international community, non-governmental organizations, publishers, media, scientists, policy-makers, epidemiologists, medical practitioners, health educators, patients and society at large. Health is seen as part of the information society that involves everyone as stakeholders, the recent history of ICTs already making significant changes in the way that scientists, clinicians and patients access and use data was reviewed. Controversies over free vs. controlled access to information were discussed as well as the importance of security of data. The World Health Organization was described as playing a role as convenor or steward for e-Health and as a catalyst for action. The leadership role of NGOs was recognized in this area and the landmark agreement between commercial publishers was described as a critical first step to health entering the information society. It was pointed out, however, that the flow of information was inappropriately oriented towards industrialized countries while little emphasis has been given to data on health communication between developing countries. The paucity of South–South and South–North information flow was highlighted.

Capacity-building was seen as essential for maximizing the vast information and experience in developing countries. The lack of involvement of any Southern organization in the human genome project was given as one example as well as the lack of data collected in Africa on SARS, hepatitis C, and many other diseases and the unavailability of African publications in medicine. In order to overcome the infrastructure problems and lack of services in developing countries, market globalization was described as one factor holding back the South as well as the lack of recognition of health as a human right in many parts of the world. Publications in medicine need to involve more actively research from the South and data generated in developing countries must be given more priority. Evidence in industrialized countries cannot always be generalized to be relevant to the South. There was considerable discussion about the merits of this and the role of commercial publishers from a global perspective as well as health scientists and clinicians. The divide between rural and urban information as well as between different economic sectors within a given society was also discussed as another example of the digital divide in healthcare.

In this discussion, development was seen as the practical application of science to society's needs, with health viewed as one aspect of science applications that touches us all directly. Successful telemedicine projects were described such as the River Blindness campaign in Africa and a model of e-Health in Mexico working between urban and rural areas. e-Learning projects were reviewed globally and the critical issues surrounding sharing of information and appropriateness of information explored. The role of evidence and the importance of quality of medical information were emphasized. Examples were given (e.g. thrombolytic therapy) where solid evidence was ignored for many years because of a lack of sharing of information in the medical community and lack of capacity for systematic reviews leading to unnecessary redundancy of efforts and lack of appropriate treatment.

For health professionals, the gap could be filled in the short- to mid-term, provided priority is given to investment in ICT infrastructure (power supply, telephone, high-speed network etc.) which is a prerequisite for telemedicine, distance learning and training, and virtual libraries. For people at the grass-roots level, the challenge is a long-term and daunting one because, beyond access issues, they also face cultural obstacles such as illiteracy. Therefore, sound and image are the most appropriate means for disseminating health-related information (mainly frequency modulation broadcasting in local languages). Thus in order to overcome the shortcomings of ICT infrastructure and services in the South as well as imbalances inside individual countries (urban versus rural areas), the issues of market-led globalization and of basic human rights for the population (i.e. health and information) should be considered.

Throughout the discussion, the content, quality, and appropriateness of information itself were stressed. Accessibility of information as well as of the necessary hardware and software and connectivity to achieve effective health communications was discussed. Libraries and the media were seen as important aspects to be included in capacity-building, in addition to the medical and scientific communities talking to the general public and patients. Security and privacy were brought up as concerns in the context of human rights, mental health, and confidentiality issues. Use of local languages and incorporation of local knowledge were also seen as key factors that have been neglected in many efforts to involve healthcare in the information society to date. Two-way communication with developing countries was stressed and emphasis on integration of IT with essential health and human needs was considered a main priority.

Surprising Issues

Many examples were given of the South being left out in the global biomedical scientific enterprise. There were some criticisms of the current emphasis on making Northern-generated data and publications available to the South, with less emphasis on information generated from the South. The discussions strongly emphasized that basic health needs should be a priority in planning and implementation. There was little discussion of technological issues, for example of security, interoperability, or standardization.

Particularly Interesting Issues

The distinction between information vs. knowledge and how evidence-based information can be translated into action and behavioural change were discussed. It was considered important to better understand how evidence and information could be translated into better healthcare policy and improved quality of health care. The problems facing health with respect to the information society are not so much technological in nature as human. The divide is more in the quality and nature of the information itself and accessibility of information must include consideration of language, culture, and appropriateness. The importance of valid, reliable, evidence-based information relevant to health-care professionals at the point of care and available to patients was stressed. The promotion of learner-centred e-Learning and respect for local needs in medical and health professional education was also seen as a priority. Creating enabling environments and capacity-building were put forward as mechanisms to achieve this. Effective policy using e-Health principles, such as seen in the River Blindness experience, can have a major impact on health and healthcare, medical research, and education as well as disease prevention.

Conclusions

1. Capacity-building is seen as an essential tool.
2. Information and knowledge shared must be locally relevant, reliable, and accessible.
3. Though great progress has been made, we face new challenges and must work collaboratively to achieve the next stage of health information development.
4. More emphasis needs to be placed on human factors and behavioural change.
5. Facilitation and communication are keys to success.
6. Evidence and learner-centred e-Learning will further professional development and patient care.
7. Research collaboration can be greatly enhanced by IT strategies, and involvement of researchers from developing countries is important to harness this knowledge.

Recommendations

1. That we prioritize basic health needs, e.g. safe water, food, nutrition, sanitation as the most critical requirement in global health and that we integrate these essential needs with technology such that healthcare can be made more effective.
2. That we maximize the use of indigenous knowledge of information technology and medical-related issues. Both lessons learned and best practices should be shared and feedback mechanisms from all stakeholders should be in place.
3. Capacity-building is essential for e-Health applications and should include all stakeholders and involve the individual, institution, and health systems. Training for health professionals, patients, researchers, teachers and the media should be incorporated in e-Health programmes.
4. That communication be a priority — two-way communication with developing countries is especially important. Sharing of medical knowledge, experience of ICT use, and experience between developing countries and industrialized regions and between developing regions should be incorporated in implementation.

5. That we strive to understand the impact of e-Health application and actively develop and apply appropriate outcome measures relating to healthcare measures.
6. That we promote and cultivate learner-centred e-Learning and empowerment.
7. That we respect local needs, values, appropriateness of information and priorities.
8. That greater investment be made by governments and international aid agencies in the information and communication technologies needed to access essential information, and in training individuals in the use of ICTs for such purposes, especially in the developing world. Long-term and substantial financing should be available for initiatives focused on and driven by developing countries.
9. That we strive to maximize the use of existing knowledge through effective communication and dissemination.
10. That empowerment and support to partners in developing countries be a priority and that we maximize the use of partnerships in different regions, different disciplines and areas of knowledge.
11. That we strive for better integration of evidence and further efforts for effective evidence-based behaviour change for health policy, public health and clinical care.
12. That fundamental scientific information, especially related to health be made readily available on the World-Wide Web, especially that relating to the diseases whose main impact is in the developing world.
13. That the software tools for disseminating this information be made as widely accessible as possible.
14. That world-wide networking infrastructure for distributing this information be strengthened.
15. We request WHO and other UN agencies to act as catalysts for government, civil society and the scientific community, to convene all stakeholders and facilitate implementation of these recommendations.
16. National aid agencies in the information and communication technologies are needed to access essential information, and to train individuals in the use of ICTs for such purposes, especially in the developing world. Long-term and substantial financing should be available for initiatives focused on and driven by developing countries.

14 Contributions to and Benefits from Enabling Technologies

Chair	**Robert Kahn**, President of the Corporation for National Research Initiatives (CNRI)
Rapporteur	**David Williams**, CERN and TERENA
CERN Moderator	**François Fluckiger**
Speakers	**Robert Kahn**, CNRI, USA **Anthony Hey**, UK's e-Science Programme, University of Southampton, UK **Harvey Newman**, California Institute of Technology, USA **Francis Tusubira**, University of Makerere, Uganda **Katepalli Sreenivasan**, Director of the International Centre for Theoretical Physics, Trieste, Italy
Website	http://rsis.web.cern.ch/rsis/

Session Summary

This report starts with a brief summary of the talks, and then provides a synthesis of the themes and outcome of the discussion.

Managing Digital Objects on the Internet

Robert E. Kahn is President of the Corporation for National Research Initiatives (CNRI) in Washington D.C. and was one of the real fathers of the Internet.

Kahn predicts that infrastructure for managing information over indefinite periods will fundamentally alter our use of the Internet and greatly impact both business and society. He feels that 'digital objects' are the key insight (see the presentation for an explanation and example of a 'digital object') and that we essentially have many of the building blocks needed to create interoperable 'digital objects' already to hand.

e-Science and Global Grids in the Information Society

Anthony Hey heads the UK's e-Science Programme. He is at the Engineering and Physical Sciences Research Council, on leave from the Department of Electronics and Computer Science at the University of Southampton.

Hey covered many topics, starting from the perspective of the UK's e-Science Programme. He gave some examples of possible 'collection-based' science which could be enabled by e-Science tools, and suggested that publicly funded research results should not be restricted to the 'primary scientists' who had been responsible for generating the data.

He also described the recently founded Open Middleware Infrastructure Institute (OMII), which is tasked to develop robust Open Source versions of Open Grid Standards, which he feels will help to unlock global creativity. He finished with a 2002 quote from Tony Blair that "[The Grid] intends to make access to computing power, scientific data repositories and experimental facilities as easy as the Web makes access to information."

Networks and Grids for Science and Global Virtual Organizations

Harvey Newman is in the Department of Physics at the California Institute of Technology (Caltech). He has been responsible for many projects using advanced networking for particle physics over the past 25 years. He also heads the Standing Committee on Inter-regional Connectivity (SCIC) of the International Committee for Future Accelerators — the body which coordinates global particle physics.

Newman drew on particle physics to demonstrate the essential role which computer networking plays in sustaining the global virtual organization (GVO) which is constituted by the worldwide particle physics community, but he also emphasized the many different fields of research that have fundamentally similar requirements. The underlying challenge comes from the rapid growth in the volume of scientific data which is being generated by many disciplines, leading to a continually increasing requirement for network capacity to sustain each discipline's GVO. A broad deployment of fibre optic networks and a better understanding of the software needed to sustain high-throughput long-distance file transfers are key elements in the response to that challenge.

In the context of the work of SCIC, and the end-to-end monitoring activity led by Les Cottrell at the Stanford Linear Accelerator Center (SLAC), Newman provided several illustrations of the reality of the 'digital divide' inside the worldwide research community.

Operating at the 8th and 9th OSI Layers to Promote the Spread of the Internet in Africa

Francis Tusubira is the Acting Director of the Directorate for ICT Support at the University of Makerere, Uganda. His ~5 page discussion paper can be accessed at http://rsis.web.cern.ch/rsis/ and your rapporteur strongly encourages you to read that very interesting document.

Tusubira starts by noting that, despite ~15 years of efforts, the Internet has not yet really been deployed in Africa. Even in South Africa, which is in the leading position in sub-Saharan Africa, less than 5% of the population use the Internet, and in most other sub-Saharan African countries the number of users is less than 1% of the population (2002 data).

He believes that one of the main problems is that ICT is not perceived by African politicians and governments as having an important and beneficial impact on economic growth, when compared, for example, to transport infrastructures such as roads. He also comments that there is a major communication gap between ICT and development professionals in Africa. An effective interface could bridge that gap and translate ICT opportunities into real development benefits. He calls for scientists to step into the ring and become direct players in the development forum, rather than being satisfied with a marginal role as precursors or catalysts.

How ICTP Might Provide Concrete Help

Katepalli Sreenivasan is the Director of the International Centre for Theoretical Physics (ICTP) in Trieste, Italy. He started with a short overview of ICTP, which welcomed some 4,000 visiting scientists from about 170 countries in 2002. It also hosted some 40 conferences, schools and workshops.

ICTP has placed considerable emphasis on the issue of providing affordable and usable access for researchers in developing countries to up-to-date research results through eJDS, its Electronic Journals Delivery Service. eJDS addresses both the high cost of standard online access to journals, and the limited bandwidth which is available in many developing countries.

Sreenivasan showed plots of relative Internet performance for different areas of the world, confirming that developing countries, although making progress in absolute terms, show a rather constant time-lag (about one decade) with respect to most developed regions. He emphasized that this is making it extremely difficult for world-class scientists in developing countries to participate effectively in global research teams.

He explained that discussions among many organizations, including ICTP, UNESCO, WHO, FAO, IUPAP, ICSU and others, have led to a strategy where UNESCO will concentrate on the provision of infrastructure and ICTP will emphasize appropriate training and access to scientific literature.

Overall Themes from the Session

One preliminary remark is in order. Technology is important, and the impact which Internet technology might have in driving economic progress in the developing world can easily be underestimated. However, we must not be blind to the fact that many of the developing world's challenges are of a more fundamental nature — such as providing sufficient food, clean water, basic healthcare, protection from strife, universal education, etc. While Internet technology can provide significant help in many of those fields, the non-Internet challenges are already huge.

A first point of note was that, despite the title of the session being 'Enabling Technologies' we spent little time discussing technologies as such. The discussion was much more about issues related to the 'digital divide' and concerning the infrastructure needed to provide for truly global access to the advanced Internet infrastructure now required for participation in most fields of research.

The true 'technology' issues in the session were the presentation by the chair on 'digital objects', and a discussion about 'micro-payments' and the extent to which they might be an enabling technology. The claim was that information providers in developed countries might be more willing to forgo micro-payments to individual researchers from developing countries, rather than to have to negotiate rather complex agreements with the (groups of) universities where those researchers were working.

The Digital Divide: It Exists and it is Deep

Francis Tsusbira told us that Makerere University pays roughly $28,000 per month for its 2.5 Mb/s of satellite connectivity to the Internet. Your rapporteur can confirm that that is a rather standard price for such connectivity. On the other hand, the price that European networks have to pay for a corresponding amount of raw bandwidth, provided via a terrestrial fibre optic cable, can be as low as 5 euros per month. Furthermore, American prices are at least a factor two lower than those in Europe.

Looked at in another way, it is now becoming rather usual that European and American universities are connected to the Internet at 1 Gb/s, or 400 times more than is possible at Makerere. And we should not forget that, by African standards, Makerere is very well connected. Experience gathered in Europe over the past twenty years (during which period enormous progress was made in introducing competition into a telecoms market which was initially dominated by national monopolies) also points out that there is an inherent cost of acquiring bandwidth in (very) small volumes. That effect can be estimated as a factor 5 as one moves from kb/s to Mb/s, and a further factor 5 when moving from Mb/s to Gb/s, leading to an overall penalty of ~25 times if you are forced to buy capacity in kb/s chunks.

The GDP per inhabitant, measured using purchasing power parity, is some 20 times lower in Uganda than in Europe or the USA. [Specifically the Uganda estimate in 2002 was $1,200, compared to about $25,000 in the UK and about $36,000 in the USA].

Accordingly the relative cost of obtaining sensible Internet bandwidth to many African universities is up to 20,000 times that of obtaining similar connectivity in Europe.

Fixing it Requires Political Engagement Rather Than Technological Progress

Making any significant impact on the 'digital divide' requires not so much technological progress as political engagement by the research community.

The first thing that they need to do is to understand the national regulatory regime for telecoms, and the real level of telecoms pricing in the country. What is available and what is the price being charged relative to competitive prices elsewhere? It is also important to understand what technology will be appropriate for local circumstances. With enough understanding of the local market and regulatory situation, and backed up by international comparisons, it is possible to explain to fellow researchers, to students, to university administrators, to telecoms vendors, to politicians, and to normal citizens how excessively high pricing can act as a road-block to economic progress.

The research community must not be inhibited about 'selling' the extremely important role that advanced research plays in driving national economic progress, and also in highlighting the vital role that advanced Internet access now plays in participating in the global research community. The message needs to be that good roads and good Internet access are equally important requirements for successful economic development.

In terms of practical things that need to be done, the summary is that the research community needs to build alliances, and the experience from Europe is that one of the best alliances is to build campus-wide networks and to create a National Research and Education Network (NREN). The point is that driving telecoms costs depends a lot on buying in bulk. You do not need independent Internet connections to faculties, you need one Internet connection to the campus, and an efficient on-campus Local Area Network. And then you need all university campuses in a country to join together, and also the research centres, and buy their Internet access in bulk, and also to create an inter-campus national network (operated by the NREN).

And in all of that 'alliance building' it is vital that the network engineers, the campus ICT staff, and the real end-users are all working together. It takes time to build confidence in this approach, but it is the only way to drive down costs. And, as part of the process, you will find that it is even possible to create alliances with the telecoms vendors, who will start to recognize that the research and education community represents many of their most advanced users, who can help to lead the overall population forward.

It Will Probably Get Worse Before it Gets Better

The use of the Internet by the research community in the developed world is in a phase of extremely rapid growth. That is driven both by 'demand pull' — the fact that the volume of scientific data, information and knowledge is exploding — and by 'technology push' — the fact that advances in lasers, receivers, coding, fibres and interfacing is driving the cost of the bandwidth down. Even to avoid falling further behind with respect to the developed world, the developing countries will need to make very rapid progress in attacking the organizational and economic issues created by dominant, often monopoly, telecoms vendors and lack of modern infrastructure.

In the personal opinion of the rapporteur, the relative situation is likely to get worse over the next 5–10 years before it gets better. However, there are opportunities, which, if bold action is taken, could invalidate this pessimistic scenario. The important point is that the provision of a national optical fibre infrastructure has been shown, in various countries in Europe, to offer an opportunity to 'leap-frog' and for a country to make very rapid progress. The Czech Republic, Poland, and the Slovak Republic, all provide excellent examples — the Slovak national network moved from a Mb/s backbone to a Gb/s backbone over a two-year period without requiring additional funding.

In terms of organizations which can help organize the various national research communities to make progress, the rapporteur feels that ICTP in Trieste could play a very special role, since it brings together an understanding of the aspirations of world-class researchers with a strong sensitivity to, and interest in the needs of, the developing world.

Security

Many people in the audience and on the panel commented that much more investment in security was needed. As we move towards a very pervasive use of ICT in general and the Internet in particular, there is a huge need to ensure that the people accessing services, and offering to pay for goods, are indeed who they claim to be. In return the people need to be assured that their identity is well protected when they engage themselves online. The protection has to cover both technological issues — it should be impossible to intercept such information — and regulatory aspects — to what extent can someone who gets to know your online identity use that information for other purposes?

Publishing and Copyright

In the discussions many people made it clear that the high cost of accessing scientific information, whether online or offline, was a major source of concern in developing countries. There is a general feeling that the present model of scientific publishing is not sustainable, though most people are much less clear about what could form a viable alternative model.

In October 2003, the Second Open Round Table on Developing Countries Access to Scientific Knowledge (Quantifying the Digital Divide) was held at ICTP, Trieste, and the meeting website (www.ejds.org/meeting2003) contains a wealth of excellent information on these issues.

Many of the same issues were also due to be addressed, albeit in the narrower context of global particle physics research, at the HEPgrid and Digital Divide Workshop in Rio de Janiero, Brazil, on 16–20 February 2004. For more information see www.uerj.br/lishep2004 .

Open Access, Open Standards and Open Source

The panel had a discussion about the potential benefits of extensive use of open-source software for developing countries. Tony Hey had made the point that we should aim for at least one high-quality implementation of all open standards to be available in open source form. Hilda Cerdeira had challenged Hey as to where the resources for that high-quality implementation would come from. Hey's answer was that, at least for the areas of Grid middleware for which he

was responsible, the intention was that the Open Middleware Infrastructure Institute (OMII — see www.omii.ac.uk) would provide those resources, and he felt that there was a good chance that the Institute, which was just being set up, would be able to develop a sustainable model for its long-term funding.

Data Management

There had also been many comments from the audience and from the panel about the fact that users needed access to well managed and organized data, and not simply to a random collection of incoherent data.

While not underestimating the challenges which that poses, the panels feel that, over the medium-term, grids will enable broad access to tools which will help disciplines (and a multitude of sub-disciplines) to adopt uniform metadata standards, and widely-accepted ontologies.

Next Steps

1. As a first step we need to encourage researchers in the developing countries to recognize the reality of the present situation — that there is a 'digital divide' and that it is serious and likely to have a very negative impact on research and also on national economic growth.
2. We also need to encourage these same researchers to combine their forces in order to make progress. One point which might seem obvious, but is nevertheless important, is to ensure that universities and research centres in developing countries invest sufficient resources in their campus LANs. European experience has certainly been that the expertise acquired by staff working to support campus LANs proved to be extremely valuable for the development of many other areas of networking. Campus LANs also encourage faculties to work together, to learn from each other, and to pool their demands for wide-area Internet connectivity.
3. At the national level we believe that the creation of a National Research and Education Network (NREN) organization is an important step forward, allowing the country to build up a critical store of expertise. A more general discussion of the NREN issues can be found at http://www.terena.nl/conferences/nato-anw2003/Varna-statement.pdf , which is a document written in response to the complex situation in South East Europe. The NREN should be the place where an analysis is made of the wide-area technologies which are available locally, and of their cost, and where a national strategy is defined.
4. Similarly, a coherent national approach is needed from the research community to issues of open access, open standards, and open source.

Conclusion

There are few simple solutions in the field of Enabling Technologies for RSIS. The technologies themselves are changing very rapidly, and the economic factors are also volatile. In developing countries the resolution of the immediate problems depends at least as much on societal factors as scientific ones, and the research community must engage with the world of politics and national communications regulations. In that field, as in many others, unity is strength, and the creation of NREN organizations can help considerably in making significant progress.

Comments From the Floor

– The path to ICT-driven success in the developing countries must be a multi-step process involving many factors. Major progress cannot be achieved without formulating a clear vision of such a multi-step process. The first step is to introduce facilitating policies at national level. Secondly, programmes must be created that are modelled on successful programmes in better-off regions of the world but which take account of local needs and resources. Thirdly, ways must be found of improving education in rural areas as a support for more advanced development.

- For the future, teachers must be included in thinking about the use of ICTs in the health, medicine and enabling technologies fields. Educators at all levels and those who teach educators must be taught how to use available ICT technologies, must be included in the knowledge network, and must be involved in shaping ICT-based education and learning tools.
- The scientific community needs to address gender as an underlying issue at all levels.
- Developing countries cannot afford the increasing cost of journals. If scientists in developing countries published their results openly, they could run the risk of them being plagiarized. People in developing countries who publish their results on the Internet must therefore be protected. Moreover, free access to all published work might not be compatible with peer review conditions.
- Open publication of journals on the Web is a separate issue from the peer review process. Open publishing in fact implies an even more rigorous peer review process because arguments and reasons for rejecting or accepting a paper come under much wider scrutiny.
- Closing the digital divide and the development gap is a long-term task. Input on how to resolve the digital divide usually comes from governmental bodies or international institutions. In the long run, the scientific community's contribution to this issue will be essential on this since science operates on the premise that, in time, investment in science research brings technological innovation. Scientific communities must therefore contribute to policy-making in this field. The RSIS conference should be part of an on-going effort by the world-wide scientific community and in particular by organizations such as CERN and UNESCO.
- The measure of whether you have knowledge is whether you can create new knowledge. As available resources to resolve the digital divide are limited everywhere, creating a sustainable process of innovation must be the key approach.
- While access to and ICTs and ICT-based technologies is essential for developing countries, an equally critical issue is the need to identify and apply technologies that are *appropriate* to the environment in which they are to be used. The technology push is thus not appropriate in all contexts. The user needs to be in the driving position, communicating priorities and requirements. Good environmentalism, which in this context implies an appreciation of local conditions, is also good economics.

D. Williams, replying to a question on the underlying causes of the immense difference in pricing for Internet connectivity between Africa on the one hand and Europe and the USA on the other hand, added the following remarks:

> "The discrepancy is mainly due to a difference in the technologies used. Within much of Europe there are sufficient companies (studies show that at least four are required) competing to provide fibre-optic access, which is an inherently cheap technology. In Africa the potential heavy Internet users are much more widely spread and there has not been enough perceived interest to sustain the up-front investment needed to deploy fibre-optic infrastructure. The present technology of choice in Africa (satellite) is inherently expensive compared to optical fibres. In addition, the high price of bandwidth and, in many countries, regulatory rules which severely limit the deployment of ground stations, stifles demand. As a result the overall market is not very vibrant, and the economy of scale which comes from purchasing big chunks of bandwidth cannot come into play. The situation in Europe some 15–20 years ago was very similar to what we now see in Africa, but over time it evolved to the present rather satisfactory position. The fundamental role of the research community has to be: to understand which technologies are inherently cheap, to encourage their governments to support competitive investment in infrastructure, and a regulatory environment which allows essentially everyone to deploy their own infrastructure, and to work together to provide common shared technical solutions around each campus and around each country."

Part III — Plenary Sessions

Tuesday, 9 December 2003, 2.00 p.m. to 6.00 p.m.
Moderator: Frank Rose

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15 Response from the Scientific Community to the UN Challenge

Opening Address by Dr Koïchiro Matsuura, Director-General of UNESCO

« It is a great pleasure and an honour for me to be here with you today on the occasion of this conference on the Role of Science in the Information Society. Allow me to express my appreciation to CERN and its Management for this opportunity to share some reflections with you.

Over the months that have passed since preparations began for the World Summit on the Information Society, UNESCO has addressed itself to the very concepts underpinning the organization of the summit. On a number of occasions, I have drawn attention to the qualitative difference between 'information' and 'knowledge' as well as to the inherent plurality of policy options, cultural context and routes of development associated with the nexus between science, technology and society. Just recently, during the 32nd Session of the General Conference of UNESCO, a Round Table of Ministers was held on this very subject. There was wide recognition that modern science and technology and their applications are powerful and pervasive in their impact, but there was also an acknowledgement that the claims of human creativity, cultural diversity and political choice point us towards plurality not uniformity. The idea of a single, all-embracing information society towards which all nations are moving without deviation was found by the participants at the Ministerial Round Table to be neither an accurate description nor a desirable prescription.

UNESCO's current overall strategic priority is aimed at contributing to the humanization of the globalization process. I know that this lofty terminology can sometimes seem far removed from the lived realities of people in their homes and communities, but it does represent an important orientation. The debate over knowledge societies needs to be attuned to this overall concern, which insists that the building of inclusive, participatory and just societies must be done through processes that respect human dignity, plurality and solidarity as well as human rights and fundamental freedoms.

Let me stress that the building of knowledge societies must be inclusive. This means inclusive of all persons without distinction so that everybody is empowered to create, receive, share and utilize the information and knowledge freely for his or her benefit — whether this be for reasons of economic betterment, social recreation, cultural expression and enjoyment, or civic participation. Within this concept, information and communication technologies (ICTs) are to be seen as tools dedicated to human development, not as an end in themselves.

The growth of knowledge societies depends on the production of new knowledge, its transmission through education and training, and its dissemination through ICTs. Scientific research and discovery, and associated technological applications, are the driving forces behind the creation of knowledge societies but we must remember that science is itself a social construct. How science impacts on society is shaped by society, for example, through national policies on science and technology and through social and institutional mechanisms for organizing research and understanding its implications.

Roger Cashmore of CERN has said that "Without science, there would be no information society." How true. But the role that science plays in the making of knowledge societies does appear to be one of the best kept secrets of our time. How many people even know that Tim Berners-Lee is the inventor of the World-Wide Web? Or that CERN's decision to make the Web foundations and protocols available on a royalty-free basis was crucial to the Web's

very existence? As Berners-Lee put it, "Without this commitment, the enormous individual and corporate investment in Web technology simply would never have happened and we wouldn't have the Web today."

While science has made knowledge societies possible, science itself is being changed in the process. As scientific knowledge advances, this has an effect on the very way in which science is conducted. For example, synergy among the disciplines of science has been accelerated by ICTs. This is evident as a dramatic increase in cross-disciplinary invention, research and collaboration at a distance, as well as in the more rapid dissemination of information. The knowledge base of this growth is cumulative and increasingly inter-disciplinary. We are still far from restoring the unity of the sciences but the fact that new technologies are facilitating greater dialogue between disciplines is to be welcomed.

This inter-disciplinary communication should not be construed narrowly. Scientific disciplines should increase their contacts not only with one another but also with other modes and traditions of enquiry, especially in terms of the ethical, social and environmental implications of scientific and technological developments. The ethical dimension, by the way, corresponds to the principal priority of UNESCO's Social and Human Sciences sector and is central to the work of COMEST, the World Commission on the Ethics of Scientific Knowledge and Technology.

Scientific advance and technical innovation are closely associated with the emergence of new capabilities, which is not new. From the very beginning of the age of scientific discoveries, people have devised tools for improving health, raising productivity, and facilitating learning and communication. What is new is the pace of change, the range of its impact and the unprecedented character of some of the challenges and opportunities being generated. Today, science is marked by digital, genetic and molecular breakthroughs that are pushing far beyond yesterday's frontiers of knowledge. These breakthroughs are creating new possibilities for improving health and nutrition, expanding knowledge, eradicating poverty, and stimulating economic growth.

However, we are at a critical juncture. At a time when the current phase of the scientific–technological revolution shows no signs of slowing down, can we continue to ignore the fact that one in five of the world's people live on less than one dollar per day and one in seven suffer from chronic hunger? The international community responded to the pressing need to address this state of affairs at the 2000 United Nations Millennium Summit by agreeing on a set of key development goals with time-bound targets — for reducing poverty, raising levels of education, improving standards of health, enhancing empowerment, and reversing the loss of environmental resources.

Harnessing science and the power of ICTs can, both directly and indirectly, contribute substantially to realizing every one of the Millennium Development Goals. It can create new economic opportunities that lift individuals, communities, and nations out of poverty. Furthermore, it can ensure greater availability of health and reproductive information, facilitate the training of medical personnel and teachers, and help to empower women with the same rights and opportunities as men.

The task before us is to transform these possibilities into realities, on the clear understanding that the unequal distribution and utilization of knowledge are barriers to peaceful, sustainable development. In the words of the 1998 World Development Report: "Knowledge is like light. Weightless and intangible, it can easily travel the world, enlightening the lives of people everywhere. Yet millions of people still live in the darkness of poverty unnecessarily." Not only do the poor countries and poor people have less capital and income at their disposal than their rich neighbours, but their access to knowledge is also more

limited. Knowledge for development is crucial for the future prospects of developing countries so that they may apply the growing stock of global 'electronic knowledge' to their own advantage and solve their own problems in their own way.

In conclusion, I can assure you that UNESCO will pay great attention to the outcome of this conference. I wish you all a successful meeting. »

16 The Essence of the Web

Dr Tim Berners-Lee, Web inventor and Director of the World-Wide Web Consortium[1]

« Hello, it is good to be back. I am going to start with some of the original talk about the invention of the WWW and its genesis here at CERN and, in response to popular demand, I shall then say a bit about the Semantic Web.

So, first, what is the Web? It is fundamentally a decentralized thing and when we really use it practically it becomes a fractal thing. It used to be difficult to explain what the Web would be like. Now it is difficult to explain why it was difficult because that it is so obvious to everybody.

CERN was an exciting place to be for the computer scientist in the 1980s, with many information systems on different computers and on different networks, all incompatible. So the idea was to devise a means of being able to communicate and share information.

Now, there are different models of communication. One of the commonest models of communication is that I send you a lot of messages and then, once you have digested them and perhaps understood them, you send me a lot of messages back. But there is another way of looking at it: we decide to build something together and we draw up a document that has common terms that we understand. The idea of the Web was to be able to do that across the Internet. And because we are using computers, we hope that not only will we have the finished product but we will also be able to track how we got there. I termed this process 'interactivity' at the time but now I term it 'inter-creativity'. The challenge at CERN at that time, then, was to develop an 'inter-creative' system so that all the data about how things work available on computers or networks could be accessed by any computer in a compatible format.

So there was a lot of heterogeneity. Now, heterogeneity is a Good Thing. Diversity is a Good Thing. It is good to have a variety of types of computer and operating systems in a large organization like CERN where there are many visitors from a large number of different home institutes: you don't want to tell everybody to buy the same computer system or use the same mail-reading software.

In a way CERN in the 1980s was interesting as a microcosm of the world. It was also a good substrate for the growth of the Web. Almost everybody had some sort of workstation on his office desk, which was unusual at the time. Also, those workstations were networked. So CERN staff were potential Web users.

1. http://www.w3.org/2003/Talks/1209-rsis-tbl/
http://www.w3.org/2003/Talks/1113-sw-tbl/

The Web design involved taking the idea of Hypertext and the Internet, which had already existed for some 20 years beforehand, and all the information systems out there and then generalizing to make an abstract information system that would be sufficiently general and sufficiently flexible to allow all the systems to be part of it. I wanted every system out there to be a part of the World-Wide Web.

In asking something that big of everybody, I knew that I could not tell them all to write a standard generalized markup language (SGML) or tell them all to store it on some mainframe or on a Mac or a PC. I had to let people store their information however they liked. So flexibility and minimal constraint became a design constraint for the Web architecture and that is still the case. The Web constrains as little as possible so as not to constrain how you think, how you organize your data and what software to use, so as to allow you to invent new applications within the Web whenever you feel like it.

Here are a few Web milestones. I wrote a memo in 1989 suggesting the idea, which didn't get very far. But you have to remember that CERN is primarily a physics laboratory and not a software tools organization and so, quite properly, the initial response to the Web idea was: "If it is a good idea, you should be able to buy it shrink-wrapped off the shelf. If it is not available off the shelf, it can't be a good idea." But in 1990 my boss at the time, Mike Sendall, suggested I play around with a new type of computer, the NeXT computer, and test it out with Hypertext.

So I started programming in the autumn of 1990 and the first World-Wide Web program was released on 25 December. I then hawked the program around the high-energy physics community at CERN and put it out on the Internet for general use the following summer. At that stage the program ran only on the NeXT computer which was not very compatible with other systems. But in 1992 Pei Wei and a group of students in Finland produced two browsers that ran on Windows. Instructions about how to install Viola if you wanted to browse the Web on a Unix machine were then published in the *CERN Computing Newsletter*. In 1993 the National Center for Supercomputer Applications (NCSA) brought out the Mosaic browser developed by a team under Mark Andreessen and his support contributed to the Web's dramatic growth.

It was in about 1993–94 that people started to say: "Look, the Web is obviously going to take off. We are completely reorganizing our company around the Internet and the Web. We want to know where the standards will be defined. We need a group to meet with other people who think that this is important. Why don't you form a consortium?" So we formed the World-Wide Web Consortium in 1994. Initially it was organized between MIT and CERN and then with MIT and INRIA in France, and subsequently Keio University in Japan, as hosts. We now have many offices in other countries.

So, the idea of the Web is that there is only one Web. It does not constrain anything. It must be universal in many dimensions.

For example, it must run on any hardware and over any network. Originally, there were gateways from DECnet into the Internet but DECnet faded very quickly as the VAX/VMS machines got Internet on them. The Internet has done a great job by being ubiquitous and flexible, allowing a clean interface between the Web and the underlying network. Life is much simpler now.

It must run for any operating software and any application software, any browser. It is fundamental to the way the Web works that anybody should be able to write a browser but it amazes me, by the way, that people sometimes still make websites that only work using a particular browser.

The Web has to work for any language: it has to be international and it should be able to work with junk. Actually, it should not be forgotten that some junk can become important. It is important to be able to publish stuff that is not very valuable because the valuable stuff actually starts off that way. So, whether it is a very polished work or the grain of an idea, which may subsequently become a polished piece of work, it should still be publishable on the Web. A lot of information systems before the Web were conceived on the principle that only technical reports that have reached a certain standard should be published.

The Web must work for personal as well as public data. A lot of the important data in your real life is in your address book and your calendar. Some of the experimental data you may keep to yourself until you have tested it, of course, but then it must be accessible by anybody.

It also has to take into account that some 20% of people have some sort of disability. W3C have now produced guidelines on how to do that.

There is one other dimension along which data and information vary. The original name in French of the IT Department at CERN was Division de Données et Documents, DD (Data Handling Division in English). Documents are things that you read and data is stuff you put in a computer. Data is boring to read but documents are things that computers cannot process. Data is much more useful because you can process it and documentation is much more exciting because you can read it, surf it, listen to it, watch it, play in it and walk through it, depending on which medium you use. So the Web must encompass all those things. And this brings me to the Semantic Web.

The Semantic Web is all about machines exchanging data in such a way that they understand what the data mean. If I download a bank statement it comes down currently in some SGML format and I put it in my computer. However, the word ‘date’ does not explain what ‘date’ really means. So on the Semantic Web if you are going to publish that data, you don’t just say ‘date’, you actually use a form of XML which uses what is called the namespace. This means that instead of using a date you are using a name which is really a Web address. For example don’t say *colour*, say <http://example.com/2002/std6#Col> instead. Now you can argue about whether *colour* should have a *u* or not and what *colour* actually means. But when you use an XML tag for *colour* it means that somebody has defined and owns a specific meaning of *colour*. So you cannot make any assumptions about what *colour* really means and therefore you cannot use it. This technology called the Resource Description Framework (RDF). So the Semantic Web is about people sharing definitions.

The basic atom of the Semantic Web is just one piece of data. Most of the information now is in relational databases and the atomic unit of relational databases is the cell. The horizontal row is an object and the vertical row is a property and where they intersect you record the values for each of the given properties: subject, verb, object. My car — has colour — red. Three things, a triple. Then you draw circles and arrows and each arc represents a binary relationship with a subject and an object and importantly the arc has a type. So we have typed arcs. Both the subject and the property and the value are typically represented, identified by URIs and this stuff is called the Resource Description Format (RDF). It is a standard — a W3C recommendation, with which you can encode data in XML for data exchange.

When you encode a table, of course, you can encode it in circles and arrows because the circles and arrows are very flexible. And you can take a tree. Lots of data are in trees. The Semantic Web is about using the same URIs for things. The tree and the table can be merged when the same URIs are used for the same things in different files.

Also it is important to use URIs for the verbs. Think how many times somebody makes a table and writes at the top a US 'zip code' or UK 'postal code', and in fact when you write a five-digit zip code, it means exactly the same thing as the postal code but the computer is never told that it is. It is so useful to tell the computer that, particularly when, for instance, you have huge enzyme and protein databases and they share a very large number of concepts. So the Semantic Web is about telling the computer that "this means the same as that". Think of it as a semantic link informing the computer that this concept is the same as that concept.

You then have to find common terms, which is difficult because it entails defining standards. When you do this in a small group it is easy. When you do it with a large group it is not. So the proteonics group gets together the genomics group and they decide what really counts as a protein and what does not. You end up with different communities of different sizes with a certain amount of overlap. The fundamental difference between the Semantic Web and a lot of the knowledge representation projects in the past is that the latter tended to define things as one big tree that includes all animate and inanimate things in a single ontology, in one big Dewey Decimal classification system. But this does not work because everybody has a different way of looking at data.

So, the system has to be completely web-like. You don't expect total consistency. You expect people to have made inconsistent definitions and so on. Thus you may have lots of different applications in your life and they share concepts just like stations on the metro share different coloured lines. When you take a photo, all the camera does is to record the picture and the time at which you took it. If you correlate that date with your calendar, you can find out where you were and who you were meeting. If you can combine the camera and the calendar information, it might be useful for searching for photographs of particular people. If the camera tells you where you were, you can work out where the photograph was taken and so on. The Semantic Web is about connecting different applications together.

There is just one word of caution. In a company, the customer relationship management group shares a lot of data and concepts with other parts of the company. They share some technical concepts with engineering and they share the concept of the company part numbers which are in the catalogue, which is public, in the engineering data, which are not public, and in the theorem database, which is very private. But the company has defined its own part numbers and so has not shared these concepts with anybody else. So some concepts are not global in all respects.

So remember, this is not a tree. Your life is a web and your data is a web and so you need something that will express them as a web. At the moment people in enterprise software are trying to connect different pieces of given applications using lots of little XML handling programs. We recommend using RDF as a hub. The RDF language has been a recommendation for a while. RDF Schema is just being revised but it is basically very stable. The ontology level is called OWL, a more sophisticated language that is going through the last phases of the W3C process and is now pretty stable. We are about to start looking at the more expressive things such as rules and query languages. The really exciting moment comes, of course, when you can get everybody to use the same language in a particular discipline or medical application. Remember, initially it was not exciting using the Web. You had to have a vision of what happens if we all use it.

People ask: "What is the 'killer app' for the Semantic Web?" The whole idea is that there is *no* single killer application. The idea is connecting applications together. For instance, the Semantic Web will make it possible to track the experimental conditions in which scientific

data were obtained. It will tell you which bit of equipment you used to take a reading. So if you want to re-use old data, you will have information on the experimental conditions and other factors.

Some of the immediate challenges are the effort it takes to do the standardization. Some of the possible problems, from fear of patents. We have done a lot of work in the World-Wide Web Consortium to make sure that the infrastructure will be royalty-free.

There were three phases of acceptance for the Web: The first phase was: "Why should I use angle brackets for my document?" The second phase was: "Okay, we are using your Web; we are using the Web tools. They seem to work." And the third phase is: "Wow, did you see what I just did? Can you believe what is out there?" We haven't got there yet. Selling expectations is important. It will take time for people to realize that you can't just download a complete Semantic Web development kit and turn your company into a Semantic Web company overnight. But there are now a significant number of start-up companies that are totally based on Semantic Web technology. Some of the large companies, who used to pooh pooh the Semantic Web, are now saying nice things about it and starting groups doing it. We have to go not too fast and not too slow and to try to set and meet those expectations as well as we can. When we get to stage 3, I'll let you know and we can all celebrate. »

17 Visionary Panel Discussion: Science and Governance

Address by H E Mr Ion Iliescu, President of Romania

« Science plays an important role in the history of human civilization and in modern times it represents the foundation for the economic and social development of society. We have enough examples to justify the statement that the decline or disappearance of some civilizations stems from ignoring or marginalizing scientific and technical activity, from persecuting the scholar and replacing the creative spirit with acceptance of some dogma.

Today we are at a turning point regarding the way in which we approach the relations between science in society on the one hand, and creativity and production of added value on the other from the perspective of the impact of the new information and communication technologies whose spearhead is the Internet. The old World-Wide Web, the global network, is the producer and at the same time a consumer of scientific goods operating in both cases as the support and catalyst for creative actions irrespective of their nature. Creativity becomes the most important quality indicator when we assess the social capital of a nation.

Science is not effect in itself. It is neutral in relation to the moral and spiritual values of a material civilization and culture. This statement has important consequences for the present and for the future. The role of science is permanently growing. The world needs permanently renewed instruments of knowledge and new technologies that meet its material and spiritual needs.

Of course, as for the information society the priority topics of scientific research have a direct connection to all aspects of information: collection, processing, storage and handling. In all these processes, there is a need for new ideas, new technologies, new material and applications in a broad range of scientific fields: physics, chemistry, mathematics, informatics, the study of matter, logic, philosophy, linguistics and so on.

We will witness the emergence of frontier fields such as artificial intelligence or biotechnology. There is a clear difference between access to information and access to knowledge. If, thanks to the new technologies, access to information will be rapidly democratized, the same thing does not happen in the case of the access to knowledge as the increasing complexity of research and development activities serve to widen the digital divide.

On the other hand, due to their complexity, the problems facing humankind require a global response through the active participation of all concerned. Given the realities of the moment, it is hard to believe that the existing inequities in scientific activities between the developed and the developing countries can be removed without a methodical, open and steadfast approach to attaining the UN Millennium Goals. The firm political will of all governments and the strengthening and enlargement of public–private partnerships will be required to achieve this.

I believe that information and scientific and technological knowledge together with fundamental resources such as water, food, education and health must be considered universal utility goods governed by a regime that should allow access to them by all inhabitants of the planet. There is a direct link between science and democracy as there is between democracy and economic growth. Open societies with consolidated democracies will be favoured since the development of science essentially depends on the existence of a political and intellectual environment that is open, proactive, stimulating and tolerant of different and even critical approaches to reality. If the creation processes stimulate and are cumulative in time and space, discontinuities that are the product of political, ideological or religious constraints, particularly in the field of the access to information and knowledge, can result in development delays, poverty and social and cultural exclusion.

The creation of the information society and the development of the economy of symbolic goods and knowledge in the service of all the inhabitants of the planet entail not only the definition of the role and place of science in society but also the creation of a global mechanism for free access to scientific and technical knowledge, particularly that financed by public money. In order not to waste resources, scientific priorities need to be defined at planetary level, which should lead to the setting up of research programmes open to all global actors, public and private alike.

I would like to extend my appreciation to the initiatives taken by CERN, acting as it does within a large international cooperation framework that has led to important developments for the information society that are now making possible the emergence of Grid technology. This specific application will allow the sharing of IT resources regardless of their geographic location. RoGRID, a Romanian Grid consortium, which involves representatives from the research and development, academic and business communities, will, I hope, bring a substantial contribution to the success of the Grid project at global level.

The role of conferences like this one today is to define the values and structures of the Information Society. This is a complex and lengthy process, as we need to harmonize various opinions regarding the world, various moral and cultural values and divergent economic interests. In this process, governments are called upon to play a central role in their position as exponents of nations and their interests. In order to better attain the specific goals and missions of governing, governments must find in the Information Society the instruments for a more effective and transparent governance. The Information Society creates the premises and structures for the accession of new types of solidarity and civic responsibility. Civil society, its bodies based on a decision autonomy and independence from public power, can better express themselves in an information society that is decentralized and organized in a network.

This can offer us a solution to surpassing the limits of representative democracy by creating the conditions for the accession of participative democracy as early as possible in order to resolve the democratic deficit specific to current society. Globalization is not a process that is confined exclusively to its economic dimension. It is increasingly regarded as a danger for national and cultural identity through homogenization and structuring of a global popular culture. This danger is debatable. However, the issue of protecting and furthering cultural and identity diversities is a central one when we draft the structures of the Information Society. Diversity is an essential source of creativity and it must be used rationally, not conflictually.

These considerations led us to the idea of drawing up a positive utopia that should allow the full use of the opportunities offered by new information technologies without becoming addicted to them. In order for us to be creative as individuals we must preserve our lucidity, our critical spirit. We must have a firm and clear-cut system of moral and social political values. We must be open to the new and willing to have a dialogue, aware of our limitations as well as the limitations of technologies. As political decision-makers, let us not forget that our mission is to further and defend the public interest. In the process of drawing up decisions, we need feasible information and solid knowledge, both products of human creation, science and technology.

It is only in this way that we can say that we meet the exigencies of good governance. The Information Society must comprise the morality of science and the citizens' responsibility for democracy, development and peace. We cannot allow the Internet, communication networks and the information environment to be turned into vectors for spreading hatred, religious fanaticism, xenophobia and racism and into instruments of international terrorism and organized crime. The age that we are living in is not only one of the access to information but also one of a permanent search for a balance between economic imperatives and society's need to reorganize our relations with all our fellow men and women and for the increase in the level of our participation and involvement in the life of society. »

Address by Dr Tim Berners-Lee, Inventor of the World-Wide Web and Director of the World-Wide Web Consortium

« The University of Oxford used to refer to its physics as experimental philosophy, which I think is rather appealing. When we founded the World-Wide Web Consortium, we said that we do everything but the philosophy. However, with the Semantic Web we are doing more and more of it.

But the idea of physics being originally called experimental philosophy prompted me to consider that perhaps we should call the building of the Semantic Web 'philosophical engineering'. Both are related to the fundamental questions of who we are and why we are here: one seems to be basically analytical and the other basically synthetic.

Science is constantly asking the question "why?" When we talk about building the Internet society we are always asking the question "how?" And it seems to us that the question "how?" is forced on us by the need to have lunch and dinner and have a roof over our heads, whereas the question "why?" comes from somewhere deep inside. But when we analyse the questions: "Why are we here to discuss something?" and "How we are going to discuss it", we realize that "why?" and "how?" are inseparably the same question. They are the *yin* and the *yang* of the same thing. You cannot separate the analysis and synthesis if you really try to build anything. If you are trying to do engineering and create an information society and at the same time you are not doing science, there is a fundamental contradiction. I feel that science is completely inseparable from the Information Society. »

Address by Dr Walther Lichem, Austrian Federal Ministry of Foreign Affairs

« I am the odd man out here. I am a diplomat. Allow me therefore to address the topic of this conference from the global diplomatic governance perspective and make a few comments on that.

Every day I see a growing complexity in our global agenda. In fact it is becoming ever clearer to me that we traditional diplomats are no longer able to cope with that agenda. We have to broaden the decision-making process and reach out to those who produce and provide knowledge. This is perhaps the key issue. What we are confronting here is the need to build the bridge between knowledge production and the definition of issues on the one hand and the definition of policy options at the global level on the other. This has implications in terms of process. It also has constitutional implications.

This is also related to a second basic phenomenon which we are living at all levels of our societal organization. It is the evolution from societies of verticality, obedience and command to a society of horizontality, of societal interaction, of participation and of contribution and to a society where in fact something is occurring that one could call political processes at global level. Some of the rules of national politics increasingly apply to global politics.

In fact, the WSIS process has something of the dimensions of global politics. In my experience over the past decades, this global summit event is more truly global and inter-sectorial at the same time than any other. This reflects the new verticality. It reaches down to the citizen. Our new global agenda has the citizen as actor and as victim at the same time and it affects all levels of societal organization from the communes, cities, and nation states to the global level.

Let me first try to define the term used to describe this new participatory process. What is *global governance? Government* is a vertical process of known definitions entailing transfer of decisions to lower levels for implementation. *Governance* is a horizontal process of interaction between the public decision-making structures and elements of society at all levels that are affected by those decisions and contribute to that decision-making process, including at the global level. *Global governance* is therefore a process that has moved on from inter-state diplomacy with diplomats speaking from behind the names of their respective States.

In traditional political processes at national level, the providers of input for the decision-making process are excluded from that process for lack of legitimacy and mandate. What role should academia, the knowledge provider, play to prevent this happening at global level? It is perhaps highly significant in this context that apart from this RSIS conference, academia, one of the fundamental stakeholders of civil society, was largely excluded from the WSIS's preparatory processes. Similarly, while academia is represented by CERN as an intergovernmental organization, initially no reference was made to scientific academia in the first draft of the Declaration of Principles.

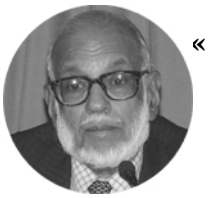
In my opinion, this raises classic questions for the future: where do we go and how do we go and what structures should we have for the way we want to go? If we assume that knowledge production and the institutions of knowledge production are indispensable elements of global governance, we must ask ourselves how we get there. Politics and political science will tell to you "Aggregate, articulate and access the processes." This means that the institutions of knowledge production must *aggregate and articulate* the broad issues and

address not just other scientists but also people like me, the non-scientists. They must not be content merely to *sit in on* the decision-making front. We need you to be *involved* in it. I believe that this bridge between us will increasingly define you too.

Now, as you know there is also something else emerging on the horizon: *knowledge politics*. That means politics to contain knowledge production. There is a fear that knowledge production is dangerous and national commissions are being set up see what can and should be done to control knowledge production. But the fact is: knowledge is faster than control.

If we look to the future, you the scientists must approach the political processes from within the freedom in which you operate. The key challenge in my view is how we are to construct this partnership in global governance. »

Address by Professor M. G. K. Menon, Indian Space Research Organization



« I shall be speaking specifically to the issue of governance. Many of the examples I cite are drawn from the context of India, one of the better developed countries amongst the developing countries in terms of the information society, but will be familiar to those from other developing countries.

The first point I would like to make is: when we talk of governance we have to look at the manner in which one governs. Is it to be a top down process as it has been in the past with kings, monarchs, oligarchies deciding for the people or should it increasingly become a democratic process where society at large decides its own future? Connectivity is of paramount importance for this latter process of democratization.

As scientists we take pride — and rightly so — in the role that science has played in the discoveries that have led to the technologies and applications of today's Information Society. But I ask myself: what is the use of all this information and this enormous power that information technology provides, leading to what is referred to as a knowledge society, if it is not used from the viewpoint of better governance to create a civil society in which human needs are met? To me ultimately the touchstone is the manner in which technology, and that is true for information technology, can meet human needs and create a good civil society, and I ask myself: can this be accomplished if large numbers of people are left out of the system?

Today they are left out in terms of actual and lost opportunities. If one looks at the world today, one sees that it is social injustice and inequalities that are at the root of most societal turbulence. The question is: how does one eliminate such social injustice and inequalities? The issue is not that everyone has to be equal, but rather that we must eliminate situations in which basic essential human needs in education, health care and employment are not met.

I have always felt that information technology is a force multiplier in all these fields, enabling one to accomplish things on a scale that would not otherwise be possible. As I was listening to Tim Berners-Lee giving his talk on the next move to the Semantic Web and beyond, I was reflecting on how all-pervasive information technology has become over the last ten years — and the immense contributions that he and CERN have made in bringing this about. And I asked myself the question: if this is the power of science, why is there so much social injustice, so many inequalities and why are so many human basic needs not met?

For example, I know that many people in Western nations do not realize the magnitude of the employment problem in developing countries as they evolve from rural to urban societies and from agricultural to industrial or post-industrial societies. Employment cannot be

ensured through huge per capita investment which would make it unaffordable to most countries, but through high-technology, low investment per capita, high-productivity programmes. This can only come about if one uses the knowledge increasingly becoming widely available.

Similarly, on the education front, almost 200 million adult Indians cannot read or write today. The illiteracy rate is reducing at the rate of about 1.5 per cent per annum. At this rate, it would take at least 20 years to reach a level of 95 per cent literacy, and in the meantime the absolute number of the illiterate is growing. We cannot eradicate adult illiteracy using the standard processes. But it has been demonstrated that if we use computer techniques in the right way, we can make a person literate not in 200 or 300 hours, but in 20 to 30 hours.

Yesterday Ismail Serageldin gave us an example of the hole-in-the-wall experiment of slum children who by just playing around with a computer and looking at the screen can teach themselves to browse the Internet in less than one hour. I am proud that this was pioneered in India by an Indian IT company, NIIT. It is important for us to remember that the information technologies are powerful tools for eradicating illiteracy, providing information and improving the knowledge capacity of enormous numbers of people. That is true of the health as well as the employment sectors.

Dr Borrero referred to geographical information systems utilizing satellite images and comparing this with ground-based systems. I was Chairman of a system called the National Natural Resources Management System (NNRMS) of India which was to use space-based data in conjunction with ground-based data for resource evaluation in many areas. Ask yourself what happens in a country such as India. You see a picture of a wheat field, but you need to know it is a wheat field; you need to know whether it is in good condition or being attacked by pests; you need to know the extent of grain yield. All this information comes from people who speak and write in local languages but you need to collect it all on a centralized basis if you want to correlate ground-truths with the satellite data. There is then a language problem, which is enormously complex in a country like India with 18 official languages and 10 scripts. But now there are information technologies under development that will enable us to overcome this.

Some 40-odd years ago in 1965, we did an experiment in education using satellite technologies which essentially entailed moving a US satellite overhead India to beam the pictures down on two and a half thousand villages in remote areas for viewing on battery-based television. The purpose of this experiment was to broaden the horizons of people who had never seen anything beyond their locality. This was a pioneering effort at conscious satellite-based education and awakening awareness. In a sense, when I speak of information technology I am not necessarily speaking only of the most advanced technologies of relevance to the research community. I am speaking of technologies that are relevant to vast numbers. You must think of this in terms of an iceberg. You only see the tip of the iceberg in terms of the elite and of those using advanced technologies but below that there is a huge submerged extent of people who are not able to use them.

Therefore, I believe that we must consider how we bring to bear the power of information technology in a variety of ways. For example, I use a computer but a lot of the time it does not work because there is a power cut. Information technologies assume the existence of stable electric power generation and supply but such conditions do not always exist in developing countries. Is it beyond technology to have these systems operate on simpler power supply sources — not with expensive and limited UPSs?

You also find, for example, that you have to solve the 'last mile' problem in terms of broadband access. You may even be able to provide broadband access capabilities through optical fibre networks but then you find that the 'last mile' problem cannot be dealt with unless you use wireless technologies and mobile telephones. So I look at information technology not just as the Internet and the Web but the access to it and in terms of all technologies used in conjunction and for society as a whole, particularly the millions of deprived in developing societies. I would like to quote part of a statement at the 2002 World Telecom Development Conference:

"The problem [of the lack of ICT infrastructure] that faces the developing countries is the high cost of building such infrastructure. What is required is low cost infrastructure. The requirement in developing countries is significantly different; to provide lower-cost basic access with a reasonable basket of important services such as Internet and voice communication. All the known techniques need to be harnessed to reduce the cost of telecom infrastructure."[1]

Thus one is not necessarily looking for the most advanced capabilities but for those that will make a real difference to people in their daily lives. So we cannot have governance, we cannot have a civil society, we cannot have a good society if human needs are not met. In order to meet human needs we need to apply these technologies on a locale-specific basis.

The last example I would like to quote is from the field of agriculture. The Green Revolution in India was based on the dwarfing genes in varieties of grain grown in Japan brought to Mexico with work of such people as Norman Borlaug, its application in India where they were hybridized with Indian varieties meeting locale-specific climatic and other conditions to achieve maximum grain yields and acceptability. The key requirement is therefore significant relevant adaptation to local conditions.

Similarly, in the area of governance, developing countries must recognize their responsibility and not just rely on developed countries to do the development for them. They have to recognize their responsibilities and put in place national policies appropriate for the purpose so that they can lead the development. But to accelerate this there has to be co-operation of a significant order, particularly involving the scientific community of the developed nations to find on a joint basis the relevant technological solutions. »

Address by Mr Talal Abu-Ghazaleh, United Nations Information and Communication Technologies Task Force and Arab Regional Network of the United Nations Information and Communication Technologies Task Force:

« Like Dr Lichem I am an odd man out here. Unlike him, I come from the business community in the field of professional services. I would like to present a layman's view to an august audience of scientists. I had prepared a visionary scientific paper, but I have decided to put it aside and talk to you heart to heart. If you find what I have to say nonsense, remember that one of the greatest leaders of the world, Churchill, once said: "The greatest lesson in life is to realize that fools are sometimes right." So grant me the benefit of the doubt.

1. Quoted from the Policy Statement by H E Agum Gumelar, Minister of Communications Department of Communications, The Republic of Indonesia.

I want to start with the question of the definition of governance. I have yet to come across a well-defined, agreed-upon definition of governance. There is work to be done on a defining what we understand by governance and also on resolving the conflicts it implies. I would like to cite three conflicts associated with the issue of governance.

First, there is the conflict between governance and democracy. If you want the rule of the majority, do you accept it even if the majority wants the worst? So the question arises as to *when* we should apply governance and when democracy. Secondly, there is the issue of legitimacy. If an election produces a leader who is a tyrant, a madman or a thug, should you accept him? In other words, do you want to be able to decide when legitimacy should prevail and when governance should prevail? Thirdly, there is a potential conflict between governance on the one hand and authority or rules on the other. Do we go by the rules or do we go by what governance dictates?

That is, of course, if we know what governance *is*. I have been conducting courses and seminars on governance in business and I am still a very young student on that subject. Shakespeare wrote: *"For there is nothing either good or bad, but thinking makes it so"*[1]. So it is also something that very much depends on your personal view and your own judgment. Having listened to all our distinguished speakers, whose views I very much respect, I am still not sure of the meaning of governance and how it is to be applied. It gets even more complicated when we come to global governance because we are no longer talking about governance in a community, in a business, in an institution or in a government context, but in an inter-state, intergovernmental or global context. That adds another perspective since we are then faced with the problem of *which* rules prevail.

I fully agree with President Iliescu when he speaks of transparency, openness, participation, fairness, independence and accountability, but how does a businessman, an accountant or a consultant put these principles into practice when it comes to every-day management of a business, a government or in the context of global issues?

Governments and businesses have to work in their own interests and I work for my own interest. There is no difficulty there. But a balance has to be struck between my interest as a businessman or as a private individual or as a government and fairness. Coming from the developing world, let me tell you in story form what the developing world is worried about with regard to global governance.

My name is Abu-Ghazaleh, which means 'father of the gazelle', and I always liken the relative positions of the developed and the developing worlds to a fight or race between the lions and the gazelles. The lion has to run just faster than the slowest gazelle to catch a gazelle. But the gazelle has to run faster than the fastest lion in order to survive. That is an unfair race. All you are asking of the lion is to be able to run fast just enough to catch the slowest gazelle. You are asking the weaker to run faster than the stronger just in order to survive.

I therefore call on the lions of this world to recognise that it is in the interest of the global community to apply the laws of governance. You have to think of maintaining both communities, because this world would be very ugly if the gazelles became extinct. In fact, the situation would be even worse because the lions would then start eating each other! »

1. Hamlet, II ii.

Further Comments by President Iliescu

« Over the last 50 years we have witnessed increasing social inequalities and inequities at a time when new technologies and new knowledge have contributed to a dynamic economic growth that is without precedent in history. In spite of this economic growth, poverty has not diminished throughout the world and the gap between rich and poor countries has continued to widen. So something appears to be wrong with the rules of the old economy. Globalization is not responsible for this. On the contrary, globalization and new dynamics engendered by the growth of knowledge and the development of new technologies could provide an opportunity for poor countries to have more access to this knowledge and these new technologies. But in reality the contrary appears to be happening. The digital divide has become yet another handicap for the poor in trying to reduce the gap.

What are the sources of these inequities and the reasons for this malfunctioning of the old economy? I think this is mainly to do with the rules of the market economy. The market economy has many virtues. It promotes initiative, creativity, the pursuit of quality and the spirit of competition. At the same time, it generates social polarization on a global scale. What can we do? Some correction has to be made to the rules of the market economy.

After World War II, Western European countries promoted the so-called 'social market economy' with the involvement of the state through fiscal and social policies aimed at reducing social inequalities. Which institution could do the same on the global scale? We do not have such institutions. International organizations such as the United Nations, the IMF, the World Bank, the World Trade Organization and the International Labour Organization do not have such goals and instruments to act in that way. We need a world institution whose main goal should be to introduce a correction to the market economy rules in favour of the poor countries in order to raise their potential to use their resources and to reduce the gap that exists between rich and poor countries. It is in the interest of the lions, the rich countries, to act in this direction. Otherwise, the market economy works only in favour of the rich. If we do not take some action in this direction, the gazelles, the poor, will migrate to the rich countries in their millions. I see this as the main problem facing the international community today. »

– **Question From the Floor**

The Web is both an instrument of universality and a source of controversy in exacerbating the digital divide. How is this conflict to be resolved?

– **Response by Tim Berners-Lee**

"We should not regard the digital divide specifically as an Internet problem. The issue of whether the Web will exacerbate or help to resolve the digital divide is still a moot point. It is true that the existence of the Internet changes the parameters; it adds an extra dimension to the divide and can accelerate the pace of change. Thus service industry jobs can migrate from one country to another faster. Thus when people talk about Internet governance, they are often not referring to ways of solving the problems of the world that are highlighted by the Internet. They mean such things as how the Internet operates, who pays for the links, which protocols to use and interconnection problems. But we shouldn't overlook the ways in which interconnectivity is already being used to reduce the gap. A missionary recently told me about someone who had taught himself to translate from his native tongue into English by finding two copies of the Bible on the Web. He now sells his services as a translator on the Internet, which brings in a lot of money into the village. That is a great story. However, while the existence of the Internet might make you change your plans about how you deal with the world's inequalities, it can't fundamentally resolve them."

– **Response by President Iliescu**

"The Internet and the Grid are tools and technologies that could help humanity to increase productivity but they will not solve social and economic problems and inequalities."

18 Summary of the Conference

The following text comprises a summary of the RSIS Conference submitted for the Proceedings by Professor M. G. K. Menon, Indian Space Research Organization

Object of the Conference

There have been spectacular advances in various fields that underpin Information Technology: computers systems; telecommunication systems; space systems; radio and broadcasting systems; and in the detailed areas of both software and hardware relevant to each of these sectors. These have been based on similar advances in the areas of microelectronics, lasers and optical fibres, magnetic storage, cellular telephony and mobile computing, user-friendly software, etc. What is particularly important is that these different areas are no longer compartmentalized, but have converged into one major stream of Information Science and Technology. As a result, the world is increasingly becoming what has often been referred to as a 'Global Village'; it would be preferable to call it a 'Global Neighbourhood' — when one realizes the need also for qualities of being good neighbours. With these developments, one is moving into a knowledge society. A consequence of this is that knowledge is now accepted to be a resource — but which has the unique property of not being lost or decreased by usage or sharing. Knowledge is becoming increasingly commodified — being now regarded as wealth, which is closely guarded through systems of patents and royalties, and by barriers organized through intellectual property regimes. This is in contrast to earlier periods of human history, when knowledge was for the common good, to be shared by all, and characterized by transparency.

Scientists are well aware that it is the discoveries in science, and the technologies and applications that these have enabled that have been the major driving force behind the rise of the information and knowledge society of today. It is the advances in mathematics, physics, chemistry, and now in biology, as also innovation corresponding to discovery, in engineering and technology, that have constituted the basis for the rapid advance to an information society. The discovery of the electron and the development of electronics that this made possible; the discoveries in electromagnetism and of electromagnetic waves that opened up radio and television broadcasting, quantum mechanical studies of the solid state and the discovery of the transistor, leading to increasing levels of integration in integrated circuits; the discovery of the laser and its opening up of broadband optical fibre-based communications; Boolean algebra and the digital language which underpins all facets of information technology; understanding of magnetic phenomena which has led to enormous information storage systems; advances in mathematics that have underpinned software development; the development of the Internet and of the World-Wide Web which has enabled information systems to become all-pervasive; the underpinning science and technology relevant to space systems; these are but illustrations of work in primary areas of science that have contributed so much to the information revolution that we are witnessing.

Whilst it has to be recognized that there have been many driving forces, including those of business, industry, entrepreneurship, societal needs and the like, it can certainly be stated that it is scientific discoveries and the technological changes that these have led to, which have provided the wherewithal for the development of today's information society.

Scientists would like to see science continuously grow and develop, from the base which it has already reached to enable a better understanding of Nature and also to ensure that the benefits from this understanding will benefit society. For science to grow and develop, it will need the basic ambience in which it has so far flourished — of transparency and openness; and there will be need for the continuing faith of society in science, and support for science that comes from this. Indeed, as we move into the future there will be a need for a stronger compact between science and society than what has existed in the past. It is not from the viewpoint of any ego that scientists would like to claim that science has been a major driving force of information technology which has led to the new information society. It is only to point out the role it has played and the role it can continue to play to advance information society and overcome the many limitations that still exist if it is provided with the right conditions and support.

There are many issues that are looming ahead arising from too narrow an appreciation of intellectual property rights, of copyrights, of issues that are handled in the World Trade Organization, the World Intellectual Property Organization and other such bodies where the principal stakeholders are governments, business, industry; and science seldom has a voice in these. It is the concern of scientists that decisions in these areas should not hamper the growth and future of science itself, for that would be like killing the goose that laid the golden egg.

Nature of the Conference

The Conference was organized at the initiative of CERN, with the fullest support and participation of UNESCO, ICSU and TWAS. In some sense this was a wholly new initiative for CERN, all of whose activities hitherto had been directly related to high-energy elementary particle physics, creation of the infrastructure technologies needed to pursue this area at the frontiers, and more recently the related aspects of high-energy astrophysics. As I saw it, the Conference was a remarkable success. All concerned with its organization and implementation need to be warmly congratulated — the Director-General of CERN; Dr Roger Cashmore, Director of Research, and all of the staff in CERN who have worked very hard.

CERN is normally very good at bringing together the highest quality scientists from round the world; it would not be unusual to find many Nobel Prize winners in this auditorium on any single occasion. However, for this Conference, with active involvement of its partners, CERN brought together many high level personalities not only in science and engineering, but from culture, politics, philosophy, social and developmental work. There were many distinguished international leaders like Adolf Ogi (Special Adviser to the Swiss Federal Council on WSIS Switzerland), Adama Samassékou (President of WSIS), Dr Yoshio Utsumi (Secretary-General of ITU), H R H Maha Chakri Sirindhorn, Princess of Thailand, Dr Nitin Desai (Special Adviser on WSIS to the Secretary-General of the UN), Mr Koïchiro Matsuura (DG, UNESCO) Dr W. Erdelen (ADG for National Sciences UNESCO), the President of Romania, Mr Ion Iliescu and many others. One of the most distinguished was undoubtedly Dr Tim Berners-Lee, the inventor of the Web, which he invented whilst at CERN.

This initiative and effort was something completely new for CERN, but handled with panache. It was essentially because, for its own work, CERN has always used the most advanced computational techniques: massive parallel processing, the Web and now the Grid. CERN has, therefore, been a pioneer in these and at the forefront of information technology capabilities. Even without this facet, CERN has been greatly respected for its ability to build sophisticated hardware to carry out huge experiments in basic science, and for doing this and for the analysis to elicit co-operation from an enormous number of scientists and engineers distributed in many countries in many laboratories, and demonstrate success. Its abilities in networking have been spectacular and it has throughout its existence kept up its *élan*. CERN, therefore, not only has the capabilities in information technology, but even more important, its own credibility in its field of action, with deep commitment to science, its future and to international efforts. It was most appropriate for CERN to take the initiative in this and to provide the leadership.

Organization of the Conference and Outputs from it

The Conference had two Plenary Sessions on two successive afternoons. The first keynote presentations at the start of the Conference were given by very distinguished leaders in different areas, some of whom I have already referred to. Then, there were a number of parallel sessions which dealt with the manner in which information technology might be able to transform present activities in various sectors: education, economic development, environment, and health and also one on enabling technologies. The Rapporteurs of each of the parallel sessions presented a summary of the discussions at the plenary session on the second afternoon. This was followed by a Visionary Plenary Session on Science and Government.

Clearly, the Conference was not a technical one on information technology. It attempted to fulfil its primary objective, namely to address the Role of Science in the Information Society. It is clear that with the increasingly strong coupling between science and technology on the one hand, and technology and the various activities of society on the other, those concerned with discoveries and innovation cannot function any longer in a compartmentalized stand-alone mode. Scientists should somehow get involved with the problems relating to implementation of their discoveries and their applications to ensure that maximum benefit flows to society. The Conference very clearly highlighted an appreciation of this new role of science, particularly with reference to the information society. It was for this reason that the Conference dealt with the various important areas of human, economic and social development, and the manner in which the new information technology through its highly pervasive nature might impact on these, and on what more needs to be done to ensure the maximum benefits.

In the area of education, it became clear that whilst everyone accepted it as a key element for development and for moving into the knowledge society of the future, there was increasing recognition of the significant backlogs as far as developing countries are concerned, in quality and quantity; there are also problems of a different nature faced in the developed countries. In all of these areas, technology can enable society to leapfrog into the future, without having to go laboriously through the various steps that society has followed in this field in the past. Various aspects of e-learning were covered such as web-based learning, open-university systems, open courseware and the like.

In the area of health, it was clear that telemedicine will soon come of age, and can enormously increase the availability of limited human resources of skilled doctors to be able to reach out to much larger numbers than has so far been possible; there are also great opportunities in specific areas such as safe drinking water.

In the field of environment it was underlined that one needs to understand the various aspects of ecological systems at micro and macro levels; and to understand the physiology of the Earth System. It is important to have timely availability and dissemination of information based on world-wide international collaboration. This would relate to areas such as climate, the oceans, desertification, biodiversity, coastal ocean management, pollution and many more.

For economic development it is vital that information technology is made much more widely available. There is clearly a digital divide in the world today. The Secretary-General of the UN has expressed confidence that this can and will be overcome. For this there is a need for specific national policies so that implementation can take into account local-specific aspects. Lowering of costs of IT systems and access are key elements in overcoming the digital divide. It is not more capabilities that are necessarily called for, except for special situations and applications. What is needed is to enable rapid, more equitable, widespread availability. For this, open source software can be an important element. For both economic development and for the sake of science itself, there is a need to ensure open access to all publicly funded databases.

Enabling technologies would be clearly necessary, and of great importance, to meet the various requirements in each one of these areas. Particular reference was made to large new projects like the Grid, in which CERN is playing a key role.

The general consensus that emerged is the need for greater equity to enable information technology to benefit global society as a whole and not be a means to create further divides between and within societies. The importance of this particularly came out in the Visionary Panel towards the end of the Conference.

The WSIS and Beyond

A clear message should go out to RSIS from the scientific community, a representative fraction of which is assembled at RSIS. As host of this Conference, the Director-General of CERN could deliver it. Whilst conveying the gist of what has transpired here, the message must also clearly state that scientific discoveries have played a key role in bringing about the information society of today. In this, the RSIS endorses what is already present in the WSIS Draft Declaration of Principles. Scientists are therefore genuinely concerned about the future of the information society, particularly as it moves into a knowledge society which holds abundant promise of a better world. Therefore scientists are willing to contribute in every way possible to ensure that the developments that take place are equitable, for the benefit of all of humankind, and avoid the possibilities of what has been termed a digital divide. RSIS should also endorse the WSIS Draft Plan of Action that relates to meeting the needs for science for its own progress. The scientific community should bring to the notice of the WSIS that the directions of pure research or discoveries cannot be determined beforehand; but faith in the fundamental concept that an improved understanding of Nature can be of ultimate benefit to society will result in an ambience and an environment in which science can flourish. The relevant applications that flow from scientific discoveries can be directed; and science would depend on the wisdom of society to ensure that these applications are in the right direction.

As important as the message to the WSIS is, it will be even more important to ensure that the momentum generated by the RSIS Conference continues, so that an even more affirmative message can go out to WSIS 2005 in Tunis. CERN and its partners, UNESCO, ICSU and TWAS, should, in their own spheres of influence, work on the issues thrown up at the RSIS Conference, and on the scientific efforts that are needed to deal with these. In this they will have even more willing partners, such as the InterAcademy Council and other bodies. Through these efforts, not only can scientific solutions be found, but governments can be influenced and public awareness and understanding created. Anything that is worthwhile accomplishing calls for effort. On the part of CERN this might appear to be a diversion from its thrust areas — but its scientific credibility is so high, its capabilities and accomplishments in the area of information sciences and technology so significant, and its abilities in networking of scientific effort so outstanding, that such scientific efforts will truly benefit the cause of a just and equitable society. It is a cause worth pursuing.

19 Key Message from RSIS

Concluding Remarks by Professor Luciano Maiani, Director-General of CERN

« In parallel to the World Summit, the present Conference was devised to emphasize the Role of Science in the Information Society.

We at CERN, together with our scientific colleagues at UNESCO, at the International Council for Scientific Unions and the Third World Academy of Science, felt that the voice of the scientific community should be heard at the World Summit, for at least four reasons.

- First, it was basic science that made possible the technologies underlying the Information Society.
- Second, the needs of the scientific community have often driven new developments in Information Technologies, such as the Internet and the World-Wide Web.
- Third, continuing scientific research is necessary to underpin future developments of the Information Society, from new electronic devices to the future architecture of the Internet, for example through the sharing of distributed computing resources via the Grid.
- Fourth, the scientific community has the potential to empower scientists from many regions of the world that have not been prominent in recent scientific research, but have important, valuable human resources and have original perspectives on many of the fundamental problems we all face — what Adolf Ogi termed ‘science sans frontières’, and what Adama Samassékou indicated as ‘indigenous knowledge’.

Our efforts to organize this conference were stimulated by the challenge made by the UN Secretary-General, Kofi Annan, to the world scientific community. As he wrote in *Science* magazine last March, while “recent advances in information technology, genetics and biotechnology hold extraordinary prospects for individual well-being and humankind as a whole, the way in which scientific endeavours are pursued around the world is marked by clear inequalities.” Annan called on the world’s scientists to work with the United Nations to extend the benefits of modern science to developing countries. One of the objectives of RSIS has been to respond to this challenge. Adama Samassékou reminded us here of the need for solidarity in confronting this task.

With input from the on-line forum we have conducted over the past few months, you scientists, policy-makers and stakeholders from around the world have reviewed the prospects that present developments in Science and Technology offer for the future of the Information Society, especially in education, health, environment, economic development and enabling technologies. I feel that RSIS has helped to develop a vision for how information and communication technologies can be applied for the greater benefit of all. These are some of the results that have emerged from the five parallel sessions.

1. In the field of education, there is consensus that education is necessary for development, that South–South cooperation can play a key role and that ICTs are essential in the learning process in all stages of life.
2. Health: ICTs can help in priority public-health areas such as safe water, for example in capacity-building.
3. Environment: planners and decision-makers need accurate and timely information; scientific North–South collaboration is essential to ensure the accessibility of data.
4. Economic development: open-source software should be made available; the exchange and use of scientific data could be a model for the rest of society.
5. Enabling technologies: it is important for scientists to engage in the policy arena and define projects with clearly visible benefits, for example the Grid.

As Princess Sirindhorn reminded us, *there is no single formula for development,* but I feel that *several general themes* have emerged as guidelines and have received clear support at RSIS:

– that fundamental scientific information be made freely available;
– that the software tools for disseminating this information be also made freely available;
– that networking infrastructure for distributing this information be established world-wide;
– that training of people and equipment to use this information be provided in the host nations.
– that general education is an indispensable basis for the Information Society.

Several of the objectives defined by RSIS are making headway.

The WSIS draft Declaration of Principles recognizes:

"that science has a central role in the development of the Information Society", and that **"many of the building blocks of the Information Society are the result of scientific and technical advances made possible by the sharing of research results."**

Moreover, the WSIS draft Action Plan aims to:

– promote affordable and reliable high-speed Internet connection for all universities and research institutions,
– promote electronic publishing, differential pricing and open access initiatives,
– promote the use of peer-to-peer technology to share scientific knowledge,
– promote the long-term systematic and efficient collection, dissemination and preservation of essential scientific digital data,
– promote principles and metadata standards.

On your behalf, I shall urge the Heads of State gathered at WSIS to adopt these aspects of the draft Declaration of Principles and Action Plan and to endorse fully the guidelines that have emerged from our discussion. We scientists must then commit our best efforts to implementing the Action Plan and demonstrating real progress by the time of the next WSIS meeting in Tunis in 2005.

I thank you for your engagement in this meeting, and look forward to working with you to attain these worthy goals. »

The Conference rose at 6.00 p.m.

The Role of Science in the Information Society Conference

Annexes

Annex I Supplementary Documents

Annex II Online-Forum Papers

Annex III List of Participants

Annex I — Supplementary Documents

world summit on the information society
Geneva 2003 - Tunis 2005

Document WSIS/PC-3/CONTR/113-E
31 May 2003
English only

CERN, UNESCO and ICSU (in cooperation with TWAS and ICTP): comments and inputs from the Scientific Community on the Draft Declaration and Action Plan

The international scientific community, represented here by the Third World Academy of Sciences (TWAS), the International Council for Science (ICSU), the International Center for Theoretical Physics (ICTP), the European Organization for Nuclear Research (CERN) and the United Nations Educational, Scientific and Cultural Organization (UNESCO), is very pleased to provide to the WSIS process the following comments and specific proposals on the Draft Declaration of Principles and Draft Action Plan.

This contribution builds on previous submissions form TWAS, ICSU and UNESCO for the first two preparatory meetings for WSIS. UNESCO is again making a separate submission at this stage, but has been fully involved in the formulation of the current input, which is reflected in its own submission.

General Background

Science is a key public good that underpins the information society. The fundamental scientific and technological components of the Information Society have been driven by the search for fundamental knowledge and solutions to specific problems. The Information Society tools, from electricity and radio waves to the World Wide Web and browsers, were all discovered or invented in scientific and academic laboratories.

Scientific research and technology drive today s economies and serve as twin pillars of progress for advances in knowledge for all humankind. Scientific knowledge often has international applicability. Information and communication technologies have the capacity to increase accessibility to scientific knowledge worldwide.

The essential role of science and scientists in building the Information Society has been understated in the Draft Declaration *of* Principles and Draft Plan Action. The scientific community urges governments to clearly acknowledged it in the Declaration of Principles and reflected in the Plan of Action of WSIS.

Information and communication technologies (ICTs) are also central to scientific research itself. ICTs enable scientists to perform basic and applied research, build partnerships and scientific international consortia, conduct experiments, collate data, coordinate laboratory activities, and communicate their findings to their peers and the public. The digital world in which we live is not only a product of science but also a fundamental force for shaping the scientific research agenda and determining how the future of scientific knowledge will unfold and be utilized.

The digital world offers novel opportunities for involving scientists in developing countries in scientific endeavors of their choice around the globe, provided some very basic ICT tools are at their disposal. Many of these can now be made more affordable.

Despite this potential, the knowledge divide appears to be widening. Increasing inequalities in access to ICTs reduce opportunities for individuals and institutions to develop and use scientific knowledge that could help foster innovation, facilitate efficient decision making, and support education and training. The digital divide addressed by WSIS shares many of the same characteristics of the scientific divide, defined by the enormous gap in scientific research, innovation and diffusion of technology.

In addition, present systems for the publication and dissemination of scientific information do not provide sufficient access to knowledge originating in many developing countries. While scientific data and information from one country may or may not be specifically relevant to another country s needs, all countries must be able to develop and communicate their own knowledge.

In order to reduce these inequalities and to achieve Sustainable Development and the Millennium Goals, science, technology and innovation will have to play a fundamental role, maximizing the possibilities and benefits of ICTs in the areas of basic and applied research, education, health, agriculture, technology, economic development and government.

Therefore, ensuring equitable access to scientific knowledge and to software tools for analyzing and disseminating this information is essential, as well as making available affordable networking infrastructure, information-processing equipment, software and training to universities and research institutions world wide.

2

The Agenda for Action Science in the Information Society , attached to this document, is the product of a workshop organized by ICSU and the ICSU Committee on Data for Science and Technology (CODATA), in partnership with UNESCO. The workshop took place in Paris on 12th. March 2003 and involved over 60 scientists, science managers and representatives of international agencies from all over the world. This Science Agenda for Action conveys the main messages of the Science Community for WSIS. Further information on the workshop can be found at www. icsu.org.

UNESCO, ICSU, TWAS and CERN are organizing a side event to be held at CERN on December 8th and 9th, 2003, whose preliminary programme is attached. Further information on this event can be found at rsis.web.cern.ch/rsis.

Long-term goals for the Information Society include universal access, open standards, open source, interoperability and decentralization, as already stated in the draft declaration of principles. Documentation on this can be found at www.w3c.org/consortium.

Specific proposals

Draft Declaration of Principles (Doc. WSIS/PCIP/DT/1-E)

- Include the new following paragraph in Section I.B.10:

Science has a central role in the information society. There should be universal and equitable access to scientific knowledge and equal opportunities for all to create, disseminate and use information .

- Reformulate Section I. A. 5. as follows:

We are fully aware that our individual and collective ability to create and share knowledge has become a driving force in shaping our future, and that concrete action and global commitment are now required, in order to ensure that science, knowledge and new technologies accelerate the attainment of the Millennium Development Goals that we set for ourselves at the Millennium Summit **.**

- Include the following new paragraph in Section I. B. 10:

The recognition of scientific knowledge as a public good. Scientific data and information should be as widely available and affordable as possible .

- Reformulate Section I. C. 22 as follows:

Access to knowledge and information, from science and other areas: all individuals and organizations should benefit from access to information, knowledge and ideas. The sharing and strengthening of global knowledge for development can be enhanced by ensuring equitable access to information for educational, scientific, economic, social, political and cultural activities .

3

- Reformulate Section I. C. 2. 23 as follows:

Access to public domain information: A vibrant and rich public domain is an essential element for the growth of the Information Society. Information, including scientific data, in the public domain must be easily accessible.

- Reformulate Section I. C.3.27, as follows:

All partners —public, private sector and civil society organizations have a stake in the development of information and communications and should be fully involved in decision making at the local, national, regional and international levels. Scientific and academic institutions have an important role to play in this context. Governments should work in close coordination with private enterprise and civil society .

- Reformulate Section I.C.6.38 as follows:

The existence of a supportive and predictable policy, legal and regulatory framework is an important prerequisite for enhancing trust in the development of the Information Society. In particular, knowledge generated by publicly-funded programmes should be recognized as a public good .

- On Par.43: delete the word radio .

- Include the following new principle, under section I.C.4:

Universities and Research institutions have a critical role in knowledge production, analysis, sharing and dissemination. The availability of world wide affordable networking infrastructure, high speed internet connections, information-processing equipment and training are an essential part of capacity building and education initiatives .

And in the Draft Action Plan keep the original wording of *[B. Objectives/45/a) benchmarks: all universities to be connected by 2005]*. This paragraph shall remain as such.

Draft Action Plan Doc.WSIS/PCIP/DT/2-E

- Include the following new paragraph in Section I.A.New 13.bis.

Ensure that any legal regime on database protection guarantees full and open access to data created with public funding. Restrictions on proprietary data should also be designed so as to maximize availability for academic research and teaching purposes .

- Include the following new paragraph in Section I.A. New 13.ter.:

4

provide long-term support for the systematic and efficient collection, preservation and provision of essential digital data, e.g. population and meteorological data, in all countries . *(par.4 of Science in the Information Society)*

- Reformulate Section I.A.2.14 as follows:

14. Open standards and open-source software: Development and deployment of open-source software and standards for efficient ICT networking and cooperation to optimize the availability of data and information should be encouraged: .etc. .

- Include the following new paragraph as a new Section I.A.2.16:

Promote electronic publishing, affordable pricing schemes and appropriate open source initiatives to make scientific information affordable and accessible on an equitable basis in all countries

- Include the following new paragraph as a new application in Section 7:

E-Science:
- ICTs have a central role in the practice, dissemination and advancement of basic and applied scientific research. Scientists build partnerships and international consortia, conduct experiments, collate data, coordinate laboratory activities, and communicate their findings to their peers and the public.
- ICTs are not only a product of science but also a fundamental force for shaping the scientific research agenda and determining how the future of scientific knowledge will unfold and be utilized.
- ICTs provide an historic opportunity to reduce the scientific divide: they improve and increase the transfer of scientific knowledge between developed and developing countries; they strengthen universities and research centers worldwide and they facilitate the involvement of scientists in developing countries in scientific endeavors of their choice around the globe.
- There is an urgent need to support scientific research on:

- the use of existing and innovative information technologies in key areas, such as health, education, and sustainable development.

- the socio-economic value of public-domain information and open access regimes, as exemplified by the World-Wide Web .

- Include the following new paragraph in Section I.A.8.44:

Encourage initiatives to increase scientific literacy and consumer awareness of how to select and interpret scientific information published on the world wide web, recognizing the key role of the media in communicating science as well as recognizing the key role of science in communications .

5

- Include the following new paragraph in Section I.A. 6.33 Internet Governance , after the existing paragraph:

Recognize that there is an important role for science in developing and implementing the new governance mechanisms that are necessary in the information society

- Keep the original wording of *[B. Objectives/45/a) benchmarks: all universities to be connected by 2005]* . This paragraph shall remain as such.

Science in the Information Society[1]

Scientific research is one of the key factors underpinning the development of the Information Society. The fundamental technological components of the Information Society: electricity, radio waves, the World Wide Web (www) and the web browser were all first developed in academic laboratories. Ensuring equitable access to scientific knowledge is essential in order to achieve the Millennium goals and the use of Information and Communication technologies (ICTs) now offers incredible opportunities in this regard. Scientific research leads to the development of new technologies themselves and to the production of data and information that, when combined with these technologies, can be of huge benefit to society as a whole. **The essential role of science and scientists in building the Information Society should be clearly acknowledged in the declaration of principles and reflected in the plan of action from WSIS.**

Principles

Scientific knowledge and data are of enormous importance in a global Information Society:

- To foster innovation and promote economic development
- For efficient and transparent decision-making, particularly at the governmental level
- For education and training

[1] This statement is the product of a workshop "Science in the Information Society", that was organised by ICSU and the ICSU Committee on Data for Science and Technology (Codata) in partnership with UNESCO. The workshop took place in Paris on 12th March 2003 and involved over 60 scientists, science managers and representatives of international agencies from all over the world. Further information can be found at www.icsu.org.

ICSU, the International Council for Science is a non-governmental organisation that was founded in 1932 and whose mission is to "strengthen international science for the benefit of society". The ICSU membership is made up of 101 national science academies/research councils and 27 international science unions. Whilst every attempt has been made to make the current document as authoritative as possible, the content does not represent the formal views of individual ICSU members.

6

Scientific data and information should be as widely available and affordable as possible: the more people that are able to share them, the greater the positive effects and returns to society. Scientific knowledge is a "public good".

The development of new IC Ts opens up **unprecedented opportunities** to ensure universal and equitable access to scientific data and information and to enhance the global knowledge pool. However, **excessive privatization and commercialization of scientific data and information** is a serious threat to the realization of these opportunities for the benefit of society as a whole.

Agenda for Action:

1. Ensure that all universities and research institutions have affordable and reliable high-speed Internet connections to support their critical role in information and knowledge production, education and training.
2. Promote sustainable capacity building and education initiatives to ensure that all countries can benefit from the new opportunities offered by information and communication technologies (ICTs) for the production and sharing of scientific information and data.

3. Ensure that any legislation on database protection guarantees full and open access to data created with public funding**.** In addition, restrictions on proprietary data should be designed to maximize availability for academic research and teaching purposes**.**

4. Promote interoperability principles and metadata standards to facilitate cooperation and effective use of collected information and data.

5. Provide long-term support for the systematic collection, preservation, and provision of essential digital data in all countries.

6. Promote electronic publishing, differential pricing schemes, and appropriate open source initiatives to make scientific information accessible on an equitable basis.

7. Encourage initiatives to increase scientific literacy and awareness of how to interpret web-based scientific information.

8. Support urgently needed research on the use of information technologies in key areas, such as geographical information systems and telemedicine, and on the socio-economic value of public domain information and open access systems.

9. Recognize the important role for science in developing and implementing the new governance mechanisms that are necessary in the information society.

7

the **role** of **science**
in the **information society**
CERN, Geneva, 8-9 December 2003

... where the Web was born

MESSAGE FROM THE SCIENTIFIC COMMUNITY
Luciano Maiani, CERN Director-General
http://www.cern.ch/rsis

I am speaking on behalf of the scientific community and the participants in the Summit Event on the Role of Science in the Information Society held at CERN, Geneva, on 8-9 December, organised together with our scientific colleagues at UNESCO, at the International Council for Sciences and the Third World Academy of Science.

We feel that **the voice of the scientific community should be heard at this Summit**, for at least **four** reasons.
- It was basic science that made possible the technologies underlying the Information Society.
- The needs of the scientific community have often driven new developments in Information Technologies, such as the Internet and the World-Wide Web.
- Scientific research will continue to underpin future developments of the Information Society such as the Computing Grids.
- The scientific community has a long tradition of global collaboration; future development of ICTs will empower scientists not previously prominent in scientific research, who nevertheless have valuable human resources and original perspectives on many of the fundamental problems that are common to humanity.

In March 2003 Kofi Annan challenged the scientific community to act. At the conference, Adama Samassékou reminded us of the need for solidarity in addressing this task. The scientists, teachers, policy-makers and stakeholders from around the world who attended the conference recognised this challenge and the need for solidarity.

Essential points that emerged were:

1. Education is the key to development; ICTs are vital in the learning process at all stages of life and South-South cooperation is as important in this process as North-South cooperation;
2. ICTs promote dissemination of health information, enhance capacity-building and permit telemedicine;
3. Planners, decision-makers and citizens need accurate, local and timely information on environmental issues; global collaboration is essential to ensure access to appropriate environmental data;
4. Education and dissemination of scientific knowledge and technological know-how through ICTs are a critical component of local and national economic development;
5. It is important for scientists to engage in the policy arena and develop new and affordable technologies to overcome the digital divide.

The RSIS formulated a vision of how information and communication technologies can be applied for the greater benefit of all.

Several general themes emerged as guidelines and received clear support:
- fundamental scientific information must be made freely available;
- software tools for disseminating this information must also be made freely available;
- networking infrastructure for distributing this information must be established world-wide;
- training of people and equipment to use this information must be provided in the host nations;
- general education is an indispensable basis for the Information Society.

Several of the objectives defined by the RSIS are already recognised in the WSIS Declaration of Principles and the WSIS draft Action Plan

The RSIS has mandated me to urge WSIS to fully endorse and adopt the guidelines and goals that have emerged. We scientists are committed to implementing the Action Plan and to achieving concrete progress by the time of the next WSIS meeting in Tunis in 2005.

I thank you for the opportunity to present to you the conclusions of RSIS, and request your help and support in turning the digital divide into a digital opportunity of knowledge, culture and sustainable development for all.

world summit on the information society
Geneva 2003 - Tunis 2005

ICSU International Council for Science

twas

UNESCO

VIEWPOINT

Science in the information society

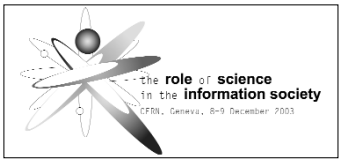
In hosting the recent RSIS conference, CERN took a bold step into the global policy arena. **Manjit Dosanjh**, **John Ellis** and **Hans Hoffmann** explain why.

On 8 and 9 December 2003, CERN hosted a conference on The Role of Science in the Information Society (RSIS, see p14), immediately prior to the World Summit on the Information Society (WSIS). Our efforts to organize this conference were stimulated by a challenge that the UN secretary-general Kofi Annan made to the world scientific community. Last March in the magazine *Science*, he wrote that "recent advances in information technology, genetics and biotechnology hold extraordinary prospects for individual well-being and humankind as a whole," but noted that "the way in which scientific endeavours are pursued around the world is marked by clear inequalities." Annan called on the world's scientists to work with the UN to extend the benefits of modern science to developing countries.

The open exchange of information, made possible by the World Wide Web and other information technologies, has revolutionized everything from global commerce to how we communicate with friends and family. We live in the age of the "information society", but without science there would be no such thing; it was basic science that made the underlying technologies possible. Moreover, continuing scientific research is necessary to underpin the future development of the information society – through the sharing of distributed computing resources via the Grid, for example.

The information society has the potential to empower scientists from regions of the world that have not been prominent in recent scientific research, but have valuable human resources and original perspectives on many of the problems we all face. This could create, in the words of Adolf Ogi, special advisor to the Swiss Federal Council on WSIS, "science sans frontières", making use of what Adama Samassékou, president of WSIS PrepCom, described as "indigenous knowledge".

Prior to the conference CERN conducted an online forum where scientists, policy makers and stakeholders from around the world



reviewed the prospects that developments in science and technology offer for the future of the information society, especially in education, health, environment, economic development and enabling technologies. These issues formed the basis for discussions in five parallel sessions at RSIS, which complemented the plenary sessions. The result is a vision for how information and communication technologies can be applied for the greater benefit of all.

Education is a key element for development. Information and communication technologies (ICTs) are vital for learning at all stages of life. Here, south–south co-operation is as important as north–south co-operation. In the area of health, ICTs can help in priority public-health areas by promoting the dissemination of health information, enhancing capacity-building and permitting telemedicine. In the case of environmental issues, planners and decision-makers need accurate, local and timely information – global collaboration is vital to ensure access to appropriate environmental data. To accelerate economic development, education and the dissemination of scientific knowledge and technological know-how through ICTs is a critical component of local and national development. It is important for scientists in all countries to unite to define their local needs in terms of ICT infrastructure and content.

Through these examples in particular, RSIS was able to formulate a vision of how ICTs can be applied to benefit all. The following themes emerged as guidelines and received clear support at RSIS: that fundamental scientific information be made freely available; that the software tools for disseminating this information be also made freely available; that networking infrastructure for distributing this information be established worldwide; that the training of people and equipment to use this information be provided in the host nations; that general education underpins all these goals and is an indispensable basis for the information society.

Several of the objectives defined at RSIS are already making headway. In particular, the WSIS draft Declaration of Principles recognizes that "science has a central role in the development of the information society." Moreover, the WSIS draft Action Plan aims to promote high-speed Internet connections for all universities and research institutions; the dissemination of knowledge through electronic publishing and peer-to-peer technology; and the efficient collection and preservation of essential scientific data.

In hosting the RSIS conference, CERN took a bold step forward into the policy arena. Since scientific research underpins the past and future development of ICTs and thereby the information society, we scientists have a particular moral responsibility to prevent the "digital divide" from further increasing the gap between rich and poor. Moreover, the information society offers scientists from all parts of the world the opportunity to contribute to the global scientific adventure of which CERN's Large Hadron Collider is just one example.

It is vital that the global scientific community engages fully in the policy arena, through the development of new and affordable technologies to overcome the digital divide. The scientific community should commit its best efforts to implementing the WSIS Action Plan and to demonstrating real progress by the time of the next WSIS meeting in Tunis in 2005.

Manjit Dosanjh, John Ellis and Hans Hoffmann were members of CERN's RSIS organizing committee.

http://cerncourier.com/main/article/44/1/29/1

Annex II — Online-Forum Papers

Submitted by the Invited Online-Forum Participants for Inclusion in the Proceedings

Environmental Information Management in Developing Countries: Reflections on the RSIS Parallel Session on the Environment

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Introduction

The Role of Science in the Information Society (RSIS) is slowly gaining attention and forming part of discussions among scientists, policy-makers and others interested in exploring ways to tap the rich benefits derivable through the application of information and communication technologies (ICTs) in different aspects of national life. Information from Environmental Information Systems management (EIM products) can find application in health, transportation, tourism/ leisure and finance (e.g. risk-rating). Discussions in the North and South, however, underscore what has come to be known as the digital divide, the wide gap between the rich countries in the North and the poor ones, mostly in the South, with regard to the accessibility and affordability of ICTs.

As part of the Conference on the Role of Science in the Information Society, we participated in the Parallel Session on the Environment. In this paper, we present our reflections on the information presented and the discussions generated as they affect our perceptions on the potential influence of modern technologies on environmental information management (EIM) in developing countries.

Status of ICT Use in EIM in Developing Countries

As an interjection during the session, we made a submission on the present scenario in developing countries with regard to the extent of ICT use in EIM in our countries, using the Nigerian and Nicaraguan situations as examples. We observed that:

- Many countries are not taking advantage of available technology.
- There is a need to develop the critical mass for use of ICTs in EIM, for example, not many scientists can confidently exhibit skills in image processing or other environmentally relevant skills for proper EIM in these countries.
- There is a need for public (user) participation in the definition of ICTs for use in order to ensure proper realization of the goals for investment in ICTs in EIM.
- There should be joint efforts in developing countries along regional lines towards devising strategies for addressing the issues and developing functional EIM systems.
- Collaboration with existing global and regional bodies in the North with mandates and expertise in EIM should be explored.

Initiatives with Possible Impact on EIM in Developing Countries

Several initiatives presented by different speakers during the parallel session have potential direct or indirect impact on the monitoring and maintenance of safe and sustainable environments in developing countries. Unfortunately, most of these initiatives originate and focus on the environments in the North. However, the world must realize that environmental and biodiversity issues have the characteristics of global public good. Maintaining the health of ecosystems everywhere is fundamental to international development.

Integrated Global Observing System (IGOS)

The Earth Observation Summit in 2003 was aimed at devising ways to share observed information with an end to building bridges across the known knowledge divides. IGOS brings together international development agencies of the UN, international research organizations, observation agencies, etc. to build an all-inclusive group of experts to achieve the desired objectives. According to the plan:

- User communities are to define their specific needs. This is fundamental for the acceptance of recommended technologies and cooperation during implementation at all levels.
- It is evident that the world is full of data but short of information, hence efforts should be directed at managing the huge data derived from different sources to generate useful environmental information to aid good policy decisions.
- In the area of climate and environment, the concept of concerted efforts is recognized since many countries are under the influences of similar environmental conditions. Moreover, environmental disasters often do not recognize national or political boundaries.
- Political and pragmatic steps need to be taken by the communities themselves if there is to be speedy movement from the low EIM capacities obtainable now to better conditions ahead.

The **Intergovernmental Oceanographic Commission (IOC)** has come up with the **United Nations Global Observation of Ocean Systems (UNGOOS)**. This is the global setup for monitoring the world's oceans with the Commission providing a regulatory function. This initiative recognizes the benefits in joint efforts and hence focuses on shared observation networks, shared sustainable missions, joint products, shared governance involving FAO, UNEP, IOC, etc. and provides a global public-oriented service. Information generated from UNGOOS can be very useful for planning and evaluation of ocean activities including fishing, drilling, etc., which have a direct impact on the economies and livelihoods of many developing countries.

Global Monitoring for Environmental Security (GMES): The priority areas of GMES are:

- European regional monitoring
- Global monitoring
- Security-related activities (not necessarily military security)
- Horizontal support.

This initiative recognizes that lack of access to water, food and energy threatens sustainable development and therefore peace. The TIGER Initiative has the monitoring and availability of safe water to the populace as its main objective, one that is very crucial in most developing countries.

The potential for modern space technology in ensuring stability and peace is being explored. There is need for open access to information especially from space. This should support sustainable development as well as reconstruction in conflict areas. However, it is important to note that user communities should be driving the policies. There is strong evidence that communication gaps exist between the data providers, scientists, and users.

Global Monitoring for Food Security (GMFS): With success on GMES, efforts are being directed towards possible success with GMFS. Food security and poverty reduction have been receiving attention at international policy decision levels with projections, monitoring and evaluation carried out at different institutions in different parts of the world. However, there is need for proper assessment of the impact of environmental changes on sustainable food production which is very important in ensuring food security in the developing world. The issue of biodiversity needs to be highlighted a lot more in environmental discussions and not just the abiotic aspects which have always been focused on. Perhaps, the work of the World Conservation Union's Species Information Service (SIS) would be useful in the GMFS.

World Conservation Union's (IUCN's) Species Information Service (SIS): The need for SIS was underscored by the fact that no 'authoritative', accessible, credible, up-to-date, comprehensive environment or biodiversity information/knowledge system exists. Yet we need to realize that when ecosystems collapse, they do so precipitously. Efforts need to be geared towards preventing this. It is understandable that it is difficult to implement environmental protection laws in any country, much less a developing country. Hence, environmental stress arises and translates quickly to social stress and this does no one any good.

A key to SIS is that it is based on an existing well-functioning knowledge network that is then enhanced, transformed and leveraged by modern ICT systems. It is a vertical integration of the information system with an existing well-functioning scientific and conservation network. An important feature with relevance to developing country conditions is that radar pictures could be used to monitor migrant or transhumant livestock in the tropics which has implications on the ecosystem.

Conclusion

The overall key message in this session was to present some applications of space technology and related initiatives for the management and monitoring of natural resources. We think it was very useful to get this overview, but it would have been value added if the speakers had presented some successful applications at local level. It is also essential for us to know about the level of participation of the different stakeholders in implementing these technologies. For example, what is the level of financial involvement of the user communities, national governments and other agencies in the implementation of these high technologies in EIM? Can they be affordable at present income levels in these countries?

We are in agreement that there should be involvement of the politicians to support the application of modern technologies for EIM in their regions. Evidence suggests that what is happening in most developing countries is misplacement of priorities and lack of political will to engage in technologies with potentials for enhanced development in their entities. This should not be so.

The role of the donor community in helping develop successful strategies for using space technologies in development should be emphasized. It has been suggested elsewhere that the rich nations should do more to avert environmental dangers elsewhere in the world. Trouble anywhere in the world blows ill-wind around. What goes around, they say, comes around.

Future discussions during upcoming meetings and at every opportunity should look into these issues.

Web Application Technologies as Information Tool in Health Care Delivery

Dr Folaju O. Oyebola

Since the advent of the Internet in 1969 as a military project, information exchange has been revolutionized even to the amazement of the pioneers themselves. The drawback has always been the digital divide between the two worlds in terms of skill acquisition and transfer of this technology to the developing world, as it is estimated that only five million individuals in this part of the world have access to the Internet.

The multimedia aspect of the Internet is playing a significant role in the application of computers to medical practice (Graham, 1997) otherwise known as medical informatics. Nowadays, there are online opportunities for patients and public to search and contact doctors on the Internet without visiting the hospital, which is a far cry from what obtained some decades ago.

Medical information exchange could be among the health professionals themselves and with the patients or public depending on the target groups (Hersh, 2002). "Information is knowledge and knowledge is power." The benefit/risk ratio of producing a well informed society including health practitioners cannot be quantified. As for the patients, it is their fundamental right to be well informed about their health, giving consent and making a final decision about their health.

The Internet is currently playing a major role in the dissemination of health information to people through various websites like Yahoo Health, CNN health etc. http://www.yahoo.com : www.cnn/health.com .

The only fear about this privilege is the possibility of self-medication in developing countries as the public can still buy drugs over the counter without any formal prescription.

Health practitioners in this part of the world are plagued with problems of getting standard training, lack of the latest textbooks, journals, bibliography, medical equipment etc. to meet the future challenges in their practice. The use of the Internet can be of immense benefit to access medical information for various uses ranging from current opinions, self-development programmes such as distance learning, CME, telemedicine etc. (Oyebola, 2003).

The beauty of online courses by various universities in the developed world and others like Supercourse is that they have saved us a lot of hard currency required to sit for those courses abroad and to some extent may stem the brain drain and also afford us standard training comparable with that obtainable abroad. The Supercourse project has reached about 140 countries with more than 10,000 members including those in the developing world. www.pitt.edu/~super1/ .

Problems of Accessing the Internet in Developing Countries

Considering the advantages as mentioned above, it is also imperative to point out that internet connectivity or rather its availability in the developing world is plagued by several factors like affordability and accessibility of both the hardware and software as well as the connectivity. Most countries lack an IT policy as their policy-makers are still skeptical and maintain a conservative attitude to the information superhighway.

Some Internet Solutions

As indicated earlier, some websites are actually specialized in disseminating medical information such as the West African Doctors Network, which is a private initiative of Francis Steve George based in Norway, with the sole goal of improving communication capability among the doctors in the sub-region. This author also franchised a similar setup as a sub-web for the Nigerian Doctors, named Nigerian Doctors Network to reflect and disseminate local contents.

http://www.wadn.org

The concept here is the fact that the Internet is filled with all sorts of information and an individual may be lost in this sea. It is reasonable and more convenient for the end user of any information, not only in health but generally, to sieve through or identify relevant information. This becomes necessary where the facility is not easily available and expensive.

Other available websites that specialize in disseminating medical information include:

- African E-Health and development site: http://www.datelinehealth-africa.net/betav1
- Health Internet work: http://www.healthinternetwork.net . This subsequently gave birth to WHO/HINARI.

- HIV/AIDS Treatment in Practice: www.aidsmap.com
- Population and Reproductive Health on the Development Gateway: http://www.developmentgateway.org/pop
- INASP-HEALTH: http://www.inasp.info/health
- MEDLINE: Online resources for both patients and physicians: http://pubmedlineplus.gov

Telemedicine

This is valuable for a second opinion in remote places where the specialists are not available to improve the quality of practice, and could be used for consultation, case discussion etc.

http://path.sourceforge.net ; http://kizuki2.krot.org

Kurt and his colleague created a room for discussion of pathology cases with a base at the University of Basel, and professionals from the Solomon Islands, Tehran and other developing countries are benefiting from it.

http://telepath.patho.unibas.ch

Electronic Health Records

This has equally revolutionized medical practice for easy access of patients' data both by the consumers and health-care providers enabling the former to participate in decision-making. So many utilities that were never dreamed of have been added such as a decision support system and all these features could be accessed online as well.

Discussion Forum

This is an important worldwide forum for chatting and sharing ideas and is a common tool on the Internet nowadays. There is the WHO Health Information Forum (WHO-HIF) with the main purpose of health information exchange irrespective of any specialization. Nigeria has taken a cue from this by establishing the Nigeria Health Information Forum (NIG-HIF).

E-Books

Also available on the Internet are electronic books, atlases, besides millions of journals turning out the latest research work everyday. http://gfmer.ch

Mobile Web

Introduction of PDA devices that are WAP enabled is definitely an invaluable asset to health workers in remote locations.

Future Directions

The range of medical information resources using Web technology is inexhaustible and as a matter of fact being underutilized by the developing countries as a result of the digital divide. It is believed that access to health and medical information even in remote areas is very feasible using this tool.

The policy-makers and the information society should encourage society in general by bringing down the costs, encourage funding, North–South collaboration, facilitate research and training. The drive would definitely improve patients' outcomes, reduce costs, and produce a well-informed people and professionals.

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A Paper Presentation to RSIS Towards the World Summit of Information Society (WSIS) in Geneva

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The leapfrog jump achievement of science in the last century has been a source of amazement to us all especially in the information world. Gone are the days when a community is informed by the sounds of gongs in the market place, there was also the era of listening to a monologue sound box (radio) and later the combination of audio/video as in the television.

In the last two decades, science has revolutionized and brought us multimedia, which is a combination of audio, video, text, images, graphics etc. And of course the Information superhighway using the technology of the World-Wide Web as developed by Tim Berners-Lee, the Godfather of the Internet.

This has definitely changed a lot of things and has empowered mankind in a new measure, the 9/11 incident came to my notice in Nigeria through www.cnn.com in less than an hour. The Ikeja, Nigeria, bomb explosion re-echoed through out the world in the same manner whereas almost one and half years after, some Nigerians living in the country, especially the rural dwellers, are yet to know of this ugly incident. What a contrast?

"Information is knowledge and knowledge is power," says the adage but the limitation of this new science has brewed the 'digital divide'. The divide unfortunately is not exclusively between the North–South but even exists within the developed world, that is, the privileged and the less privileged.

Since knowledge is power, it is the responsibility of the information society to empower the entire world towards a well-informed egalitarian society by bridging the digital gap.

Science has brought a smile to this generation and humankind has moved serially from the Dark, Stone, Bronze, and Industrial and presently to the Information Age, and the latter has changed all facets of communication.

The use in the remotest part of the world of GSM phones, PDAs for health workers, satellite television, V-sat, world space satellite radio, video phone and real-time conferencing will surely stem the rural–urban migration and is already reversing the trend and hopefully will decongest our cities in the near future.

The world is now a global village and what affects the North can equally affect the South leading to new changes in the world not only in the way we communicate but in some other issues like socio-economics, health etc. The latter became obvious to us during the SARS epidemics in Asia whereby the whole world was duly aware of the ravage and resulted in the cancellation of international conferences, low business and tourism in the entire region. Although it affected the countries badly and the region is yet to fully recover, it has helped the whole of mankind by preventing the worldwide spread of this communicable disease.

Fortunately, science is a dynamic field and work continues. The information society has the Herculean task of further research to sustain and improve the level of development and more importantly work on the aspect of capacity-building and training to bridge the wide gap in the developing countries. It is imperative to formulate the required policy needed to transfer skills and knowledge to the less privileged both in the developed and developing world.

Summary of the On-Line Forum on Education and an Overview of Contributions of Participants to the On-Line Forum on Education

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Following is the overview of contributions to the On-Line Education Forum which is intelligently invigorating and appears to have aligned with the theme of the RSIS and to some extent is a guide to achieving global knowledge transfer with the effective use of ICTs.

Education

We want to meet the challenge of Kofi Annan, for the deployment of the Superinformation highway to be inclusive of all of the world's citizens, and to build bridges that create possibilities for all nations.

If "The Information Superhighway is the new vehicle for social and economic activity and communications technology and the information it carries will affect and improve the lives of individuals of all ages, as well as the educational system, business environment, and the very fabric of community life" then it should be accessible to everyone.

In March of this year, United Nations Secretary-General, Kofi Annan, issued a challenge to the world's scientists. While "recent advances in information technology, genetics and biotechnology hold extraordinary prospects for individual well-being and humankind as a whole," he wrote in *Science* magazine, "the way in which scientific endeavours are pursued around the world is marked by clear inequalities." Annan called on the world's scientists to work with the United Nations to extend the benefits of modern science to developing countries.

The Role of Science in the Information Society (RSIS) conference is in part a response to that challenge. Prior to the conference, participants from around the world collaborated in discussions on-line in the RSIS forums.

Summary of the Forum

The forum brought the world to the learner, the school, the university, or the learning places, and to those who are exploring the world of technology, globally and personally.

Many of us were thinking of ways to use technology all over the world by being active participants and collaborators. We excitedly shared our ideas.

No matter what their socioeconomic or ethnic background or country, no matter where we live, the learning field for all participants at all levels in many places in the world was levelled and extended through this forum.

The only limiting factors were time, the infrastructure and the knowledge of the use of the technology infrastructure to make an educational difference. We were introduced to people, places, and ideas we might otherwise not be exposed to. We learned by collaborating, in a community of participants.

Research has now confirmed what many instinctively knew — that learners who are actively engaged in learning, learn more. Networked projects, in which people work with others and conduct their own research and analysis, can transform participants into committed and exhilarated learners. That happened to us in the forums.

By being involved in a community of diverse global learners and participants we became this 'community', this collaborative group of people. Perhaps the inquiry as to the process of the use of technology in our own disciplines started the conversation. We became a dynamic virtual community where discussion, resources and experiences were shared, examined, explored, expanded, and our approaches evaluated in a collaborative environment.

We know that technology makes it possible for participants to teach or learn at more than one location simultaneously. It vastly expands opportunities for students in small, remote areas to take courses on subjects that, for economic reasons, are generally available only to students in more affluent, populated, urban, and suburban areas. The RSIS can be involved in global projects to change the use of technology worldwide. We have not done it as a project but we can involve e-learning, m-learning, Grid technologies and regular pedagogy.

In addition, those who have developed projects can start a new quest which is to enable educators to take a look at learning in many ways by establishing a database of worldwide initiatives.

World Community

In the forum, we were collaborating, in a community of thought. We became a knowledgenetwork or collaboratories, that spanned the world. Science, education technology, and pedagogy linked in certain ways.

In the study of the sciences, Roger Bybee has declared the five e's.

In this model the process is explained by employing five e's. They are: Engage, Explore, Explain, Elaborate and Evaluate. In using the forum we did more than that, we expanded our knowledgenetwork or collaboratory and we extended our ideas to excite and help others to be involved to expand the thinking about the process of education and how it affects learners worldwide.

Early travellers, merchants, explorers brought ideas, technology, and knowledge in slow ways to change the world but technology can be instant, once deployed and affect us all, in the economies, in the environment, in health and technologies. The process of learning to use emerging technologies for global purposes and to coexist, using worldwide ideas is important. Think SARS, mad cow disease, environmental pollution, literacy and media balance.

It is impossible to deny the tremendous effect rapid technological growth has had on our society. This explosion of new technologies has changed the way we live — from the way we do business to the way we communicate with each other. Technological advancements are also affecting the way we teach and learn in global ways.

Impact of Technology on Education

From time to time, someone invents a product or develops a practice which has an unforeseen and massive impact on society.

The results of the printing press, and all of its old and modern successors, are so much a part of our lives it is difficult to imagine an existence without the ability to read, and the books, journals, and newspapers that support a reading public. It is also difficult to imagine how one could organize instruction without textbooks and various associated readings. For teachers and students alike, learning at all levels of education has been primarily a process of reading what experts have written, discussing what has been read, and listening to teachers explain or expand upon textbooks. In most cases, schooling has become a process for understanding, retaining, and reporting what is found on the printed page. This we explored and discussed.

We Discussed the New Definition of Literacy

We explored and discussed the ideas of new literacy in education and we think we must study the science of learning, of educating with new technologies as the tools for change.

Inventions of the twentieth century have the potential to influence society as much as did the printing press. The computer, video, and telecommunications of various kinds are having an impact on every aspect of our society: work, leisure, entertainment, household tasks. These inventions are also transforming the way we approach knowledge and sources of expertise. Today, people are no longer required to read about an event; they can see media versions of it unfold before their own eyes and make their own interpretation. Consequently, the ability to obtain and interpret information quickly and accurately is even more important than in the past.

There is no longer a question about whether the new technology will be used in education.

We feel that there should be projects of dissemination that are global models that demonstrate the possibilities.

I believe the forums should continue.

We should create models of dissemination.

Examples

- Literacy projects.
- Science instructional projects that are collaborative.
- Perhaps as the infrastructure is important to the educational process, demonstration projects that are not just national are more conducive to having people understand the use of emerging technologies.

In a limited way we could use the Grid and other new technologies to demonstrate the possibilities for creating more visionary involvement.

The forums planted the seeds for more involvement, infrastructure and immediacy about global interaction.

Overview of Contributions by Participants at the On-Line Forum on Education

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The On-line Forum on Education had a clear message to all the participants which said that knowledge transfer is an essential ingredient for faster development of developing countries and underdeveloped countries. The forum also underlined the use of information and communications technologies and their influence on distance learning and free information exchange and also encouraged forum participants to discuss experiences from these developments and also to chalk out definite future activity in these areas and to build bridges between concerned, like-minded people to meet on a single platform to address issues of ICTs and their utility in knowledge transfer and free information exchange and their usefulness to humankind.

The on-line forum was also an opportunity to interact with the finest minds in the area of learning with the clear intention of making a fine fabric of knowledge. Overall, experience at the on-line forum was motivating with many of them writing about open-access initiatives for electronic dissemination of knowledge.

Some of the significant contributions and information at the on-line forum talked about alignment of online journals — open access and research keeping in focus the developing countries, integration of technology to make the power of the Internet more meaningful by consolidating educational information in one place resulting in the formation of a global technological university, an essential utility for developing countries. Satellite technology and the Internet have been harnessed to create the African Virtual University (AVU) and its quality learning on the Internet.

Some contributors spoke of online database and knowledge networks, urged scientists to promote universal access to scientific knowledge; the African virtual university and its usefulness; and one can read about ICT at work; open source development and its positive effect on narrowing the digital divide, on-line depository of journals etc, 'open archiving', or the deposition of scholarly research papers to make it accessible; the Indian experiences of the Virtual Center for Technology Enhanced Learning; open university initiatives; and how inexpensive handheld computers may bring about ubiquitous computing.

Other contributors mentioned an ICT-based, world-wide classroom concept for the use of developing countries in getting a quality education; research database as educational tool, to maximize the use of ICT; the effects of intellectual property policy on the conduct of science, digital libraries, e-publishing, print publishing and its cost; simulation software in technical education and its effect on easier understanding of the core technology; continuing education, standards for educational institutes, science education and rural development, knowledge economy, Web integration and higher education, social construction and education.

Access to online education and developing countries, on-line text books, online databases and knowledge networks, gender issues and women in technology education, Global Technological University Internet-based student-focused, single-point-contact websites were also mentioned. This in a real sense makes free information exchange and knowledge transfer a possibility and at a faster pace considering the integration of all the available information into a single entity.

On-line participants were varied and from different backgrounds with solid experiences and with creative concepts for utilizing ICTs in the area of education and its relevance to developing countries.

An action plan in general was mentioned by most of the on-line forum participants who are of the opinion that collective effort and consolidation of all the scholarly material and active involvement of world organizations like UNESCO and others would make all the difference in bringing about the revolutionary changes and narrowing of the digital divide and its positive effect in accomplishing intelligent and knowledgeable developing nations.

Some Comments and Recommendations for the Development of ICT in Developing Countries

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The world-wide impact of ICT is acknowledged, but still the digital gap between Northern and Southern countries prevails. One of the main challenges for the near future is to make technological development pro-poor, pro-poverty reduction, for that we need more commitment from the donor community to persuade national governments to include ICT fully in national development plans and donor assistance programmes.

New technologies are emerging and rapidly maturing, in some cases even faster than users can absorb and integrate them; they are expensive commodities, developing countries can not keep trying to catch up in technology without a national policy that leads to its implantation.

The different actors (governments, NGOs, private sector, donors) need to join their efforts and develop partnership mechanism to operationalize ICT in the solution of local, regional and global problems as well. Modern technology is available for the present to enhance our present efforts. Today there are many more opportunities and facilities to make computers and computerized information like GIS serve communities to jointly learn more about their environment and encourage joint efforts in its management.

ICT promises to increase the capacity of governments to deal with economic and social challenges. E-government is an especially promising area of ICT application for developing countries. It permits more efficient and transparent administration at lower cost, fosters broader public participation, and helps give the poor improved access to government services and a greater participation in public decisions.

On the other hand, in recognizing the human and financial constraints facing developing countries, this initiative could address the following challenges to be part of an agenda for actions:

To promote strengthening of capacity building through the standardization of regional initiatives for the exchange of knowledge and reliable information, exchanging successful experience within the domain of ICTs, (use of GIS, remote sensing) mainly those carried out at local level.

This joining of efforts can facilitate also the exchange and strengthen indigenous expertise familiar with the regional context, avoiding the hiring of permanent experts from developed countries, most of the time recommended by the fund provider. The key to success in the implementation of information systems of any kind is the existence of a skilled and motivated workforce with competence in the use of information.

To promote strengthening of on-going initiatives of statistical organizations (example: Central American region) in setting up a common agenda for the standardization of statistics production (census, surveys, ICT indicators) and technology infrastructure. This approach in the socio-economic context of Central America, where governments are engaged in poverty reduction programmes, free trade signing, are key priorities in order to meet these challenges. Good information is necessary to make the right decision and negotiate on a fair basis.

Again, I would like to stress the need to ground ICT at the local level, considering that many decisions have to be taken at this level for the improvement of the well being of the people and their communities. The importance of user involvement, not just in the last stage of testing a prototype, but throughout the system development, is a great challenge to shift from a technology-driven to a socially-driven approach.

Therefore, it is the scientists' and ICT experts' responsibility to ensure that policy-makers and the public make their decision based on the best available information and how well they help solve local and global problems.

Rural Women in the Indian Himalayas — The Case for Information Societies

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As this conference is being held in Geneva, Switzerland, I felt that it is appropriate to focus attention on people who live in the mountains, especially women. This is not an academic paper but a few thoughts based on my observations.

Twenty-four per cent of the Earth is defined as mountainous and 1 in 10 of the world's population live in these areas. Almost 80% of the 600 million mountain dwellers live below the poverty line. Of the 18 regions identified in 2002 by the UN as being in desperate need of humanitarian aid, 11 of them are mountainous. In the poorest mountain countries average income is just 7% of the world average, more than one third of all women are illiterate, and almost 1 in 10 children die before the age of five [1].

In 2001, the Human Development Index (HDI) rank of India was 127 out of 175 countries, indicating low life expectancy at birth, low educational attainment and low income. The Gender-Related Index (GDI) rank of India in the same year was 103 out of 175 countries. The Indian population is 48.1% women and 51.9% men. Only 9.2% of households were headed by a female in 1992/93. Female illiteracy is 54% while male illiteracy is 31%. The labour force participation rate of women is 22.7% while that of men is 51.6%. In rural India, agriculture and allied industrial sectors employ 89.5% of the total female labour.

As the Indian Himalayas is mainly rural, we can safely argue that this region is poor on account of being mountainous as well as being rural. In these regions, a pair of bullocks work 1064 hours, a man 1212 hours and a woman 3485 hours in a year on a one-hectare farm [2]. In fact as you travel across the Himalayas, it is very common to see women (young and old) carrying huge bundles of grass, twigs and other material strapped to their backs and making their way up the mountain paths. They can also be seen herding cattle, working in the fields, looking after children, going to school or college and also running small wayside tea stalls.

Information and Rural Mountain Women

Although predominantly illiterate, women have tremendous knowledge in certain areas. This is also passed on from generation to generation. Some examples are given below:

They are responsible for agricultural diversity as seed selectors, in seedling production and storage of seeds. In addition to various tasks in the fields they also are involved in taking care of animals, grazing, fodder collection, cleaning of animal sheds, processing milk and livestock products. They also collect and process dung and fertilize the fields with this. Additionally, they make cooking fuel by mixing dung with twigs and crop residues. Women have a bounty of knowledge of forest products as they are involved in collection of non timber forest products for fodder, fuel, medicine, building materials and for usage as household and farm implements. They are intimately involved with the environment being in charge of collecting water and forest products. In fact, the Chipko movement, a women's movement to protect trees from unnecessary felling by timber merchants, was started in Tehri Garhwal more than twenty-five years ago by Gaura Devi. Illustrating regional variations, it can be seen that in Mizoram in the North East, hill women have the knowledge of animal ecology that male hunters acquire. Women engage in small-scale rural production like basket, broom, rope making and shawl weaving. They also process honey and wax. These goods are often sold through local co-operatives or at the village market. Women contribute to food security in a myriad of ways ranging from production of grains to their post harvest processing and vending. They are also primarily in charge of ensuring nutrition to the next generation.

The World-Wide Web and Indian Himalayan Women

Most rural villages do not have access to safe drinking water or electricity, let alone, telephone lines or PCs. However, the bigger townships do. But, individual computers are owned only by the wealthy and even cyber cafes are used only by those with some access to funds.

More crucially,

- The language of the Web is English
- Information is predominantly 'Northern'
- Where does the knowledge base of these women exist on the Web?
- Will usage of the Web cut into traditional modes of sharing and communication — within the family, through marriage into another village, fairs and festivals etc.?
- Will computer literacy make young village girls and boys scoff at their parents' knowledge and make them misfits unable to continue working in their predominantly agricultural communities?

I am not arguing here that IT cannot be used in these communities. Rather I am encouraging us to envision a new concept of what information is, who generates it, who controls it and benefits from it. Once we are clear about that, IT can be made to work for the needs of these women.

A Few Tentative Directions

I illustrate an example of usage of IT in a rural area (non Himalayan) below with some degree of success. Maybe something similar could be conceived of.

START Project (Science and Technology Applied for Rural Transformation). About 2500 villages of Madhya Pradesh, Chattisgarh and Jharkhand are covered. They have succeeded in a comprehensive mapping of village resources and infrastructures. Local NGOs train villagers to conduct surveys indicating agricultural production of the area, farm size, numbers of household, cattle and wells in the region. This information is fed into a Geographical Information System (GIS) software at IIT Mumbai to prepare village resource maps. They spend about Rs. 500 ($US10) mapping each village. These maps are then used both by local villagers as well as government policy planners.

If similar 'maps' can be made of the knowledge base of the hill women, these could become a useful database and can then be shared widely. An example comes to my mind. On a recent trip to Joshimath, I noticed that the apple trees in the entire region had been infected by a disease. However, almost 100 kms away in Chaubatia in the Kumaon Himalayas there was no such problem. Setting up an e-group of apple growers of that area would be helpful in finding solutions to such problems without necessarily travelling to that area.

The Web needs to be made more user friendly so that even 'illiterate' women can handle it and feed it with their songs, stories and data and play it back. Women can also use it to market their goods to greater numbers of people. This will generate more income especially during the lean winter months. It can also provide much-needed information on

health-related matters and perhaps there can even be e-classrooms to teach the basics during the harsh winters when people don't go out much and may have more time to study.

The technology for this needs to be developed and made accessible to the poorest women. In patriarchal societies, where women have virtually no say in any decision-making, are not part of the local government or co-operatives, one needs to think of ways to make this possible. (Despite the fact that in almost 90% of families it is women who engage in dairy related activities, they only form 14% of dairy cooperative members — all India figures.) Very often introduction of high technology means sidelining women. The challenge before us is not to do that.

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[2] SD Dimensions: Asia's women in agriculture, environment and rural production- Facts on India 2001.

Annex III — List of Participants[1]

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1. This list has been put together with the best information available to us. We apologize for any errors.

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