Knowledge Networks, the Internet, and Development

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The discovery, publication, and application of new knowledge, the dissemination of best practices information, and the exchange of views and opinions are essential elements of development work that are effectively facilitated by Information and Communication Technologies (ICTs) such as telecommunications and the Internet. In the area of economic development, ICTs can help to create new jobs, new industry and service sector opportunities, and a more educated work force. They make the cross border flow of information possible and promote international trade, particularly in high technology. Trade in bits rather than atoms[1] is the type of trade that helps to attract foreign direct investment. ICTs can also contribute to political development by fostering good governance and streamlining bureaucratic procedures through intra-governmental networking. The creative use of ICTs, particularly the Internet, in the areas of health care, education, and environmental protection can substantially contribute to the advancement of developing societies.

The global economic significance of ICTs on developing countries is clearly demonstrated in the software industry. Programmers in India, Eastern Europe, and Israel are able to work as employees of multinational corporations without leaving their country or even their home. Clearly testifying to the "death of distance," these programmers write computer code on their own computer and communicate with their employers via the Internet or a proprietary Intranet.[2] These programmers are able to participate in the Information Economy not because they live in an industrialized country or because they have access to the latest high technology but because they have a technical education and access to the Internet. This example highlights the accessibility and potential of the information age as it relates to the developing world.

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This article discusses the increasingly significant role of Knowledge Networks in socio-economic development and analyzes the role of information and communication technologies, specifically the Internet, in enabling the creation and application of these types of networks. The article draws examples from wealthier nations but focuses on the implications of these technological trends for the socio-economic development in re-emerging and developing nations of Africa, Asia, Eastern Europe, and Latin America. However, the same issues and approaches identified below are also relevant and applicable across the digital divides that can be found even within the wealthiest countries.

DEFINING KNOWLEDGE NETWORKS

Knowledge Networks bring together institutions and people, potentially from all parts of the world and from all strata of society. However, it is difficult to further define a complex and multifaceted concept like Knowledge Networks precisely because the participants constantly shape and extend the activities of these networks in response to real needs and challenges. Howard Clark, of the International Institute for Sustainable Development, defined communications networks as the interaction "of people, dispersed over geographically separate sites, [equipped] with appropriate communications technology."[3] In defining Knowledge Networks, he differentiated four types: informal, information access, open, and development networks. Informal networks represent casual, ad-hoc interactions without structure. The knowledge these types of networks create often does not get disseminated. Information access networks include entities such as university or government libraries in that they are the repositories of existing knowledge but create no new knowledge. In contrast, open networks exist to conduct research in science, technology, or on policy-related issues but are not concerned with the practical applications of their research results. These networks have well-defined structures and governance policies and disseminate their findings through publications. Participation in open networks is selective and based on merit. Development networks focus on specific themes around which their various projects converge. These networks exist not only to create new knowledge but also to accelerate its application. Development networks are highly structured, have strong governance, and base participation on merit.

In addition to these characteristics, Clark asserts that effective Knowledge Networks have to possess other attributes. Undoubtedly, these networks should be optimized for a maximum rate of knowledge creation and sharing, so as to decrease the gap between developed and developing nations. Furthermore, they must create knowledge faster than other approaches can. In order to be sustainable, Knowledge Networks must also be cost effective, efficient, and must provide direct, tangible benefits to all their participants. Finally, a Knowledge Network

should involve several sectors of the economy such as industry, finance, universities, and government, to synthesize diverse point of views.

Clark states that of these four types of networks, only the open network and the development network can be classified as formal Knowledge Networks. However, it should be noted that some of his reservations about informal and information access networks can be positively addressed by the Internet. For example, the often hidden knowledge discoveries made through informal networks are readily, yet informally, publishable using web servers and electronic mail. In the case of information access networks, modern digital libraries provide more than access to information. They allow data mining, or the processing of information in such a manner that new correlations and new knowledge may be discovered within the existing information. These discoveries, in turn, can be readily disseminated to interested individuals in a Knowledge Network. Internet-based communications and information-processing technologies have upgraded the role of informal and information access networks and allowed them to approach the characteristics of formal Knowledge Networks.

Regardless of which category Knowledge Networks fall into, they are expected to shift organizational cultures towards collaborative activities within and among institutions. This often means multidisciplinary, multisectoral, and multinational participation as well as non-adversarial relationships with government and industrial sponsors.

In the area of development, Knowledge Networks are dedicated to the discovery of new knowledge and its application for the advancement of developing nations and regions. The key to their popularity and initial success in the development realm is the realization that all participants, people, and institutions in the North, South, East, and West, can and should learn from each other and should acquire the technology and the capacity for knowledge creation, aggregation, and exchange.[4] It is axiomatic that development-related Knowledge Networks are most effective when they transcend national boundaries and involve participants from both developing and developed nations. This requires the availability of efficient and compatible communications networks for all participants. The Internet has served this role as an all-purpose communications network admirably well. In addition to facilitating ready interactions among participants, the Internet also became an integral part of Knowledge Networks by serving as the primary tool of knowledge acquisition, sharing, and application.

KNOWLEDGE NETWORKS AND THE INTERNET

Joseph Stiglitz, former chief economist of the World Bank, emphasized the significance of the Internet as a powerful tool for sharing knowledge at the First Development Network Conference in Bonn, Germany in December 1999.[5] He

pointed out that this immense network of networks presents both risks and opportunities for development work. On the risk side, the growth of the Internet has been much greater in the United States and in other developed countries than in the developing world. This may make the Internet a tool of increasing rather than narrowing the gap between developed and developing nations. This factor, however, is counterbalanced by the opportunities provided by the greater and more readily accessible knowledge pool the Internet makes available to those with access to it. "Today, a child anywhere in the world who has access to the Internet has a modern Alexandria Library at her fingertips."

Stiglitz advocates "Scanning Globally, Reinventing Locally" as his main thesis in discussing the opportunities of Knowledge Networks in developing countries. In other words, the global knowledge acquired from the existing repositories, such as major libraries, databases, and other sources made available on the Internet, must be internalized, rediscovered, and translated to local conditions if it is to be usefully applied in development. Robert Chassell, co-founder of the Free Software Foundation, described a real-life example of this principle at the recent Global Knowledge Conference.[6] He explained how he ran simplified free software, or more accurately, open source applications on old IBM 486 machines, which are available at low prices in the developing world. By translating the software and hardware requirements to a locally affordable level, Chassell has made global knowledge accessible locally.

Stiglitz's "Scan Globally, Reinvent Locally" thesis may explain why the Internet is a particularly useful network in the development arena, even more useful than the traditional telephone or broadcast networks. In a paper comparing the telephone network and the Internet, David Isenberg, a former AT&T Bell Laboratories employee and now a telecommunications analyst, points out that the hierarchical telephone network is subject to rigid, automated internal controls and is optimized only for transmission of voice (data is transmitted as voice) over real or virtual circuit paths. To introduce any new service, approval must be obtained from the telephone company that must also do the implementation of the proposed new service.[7] The user has no input into network planning or service creation. A similar situation exists with broadcast networks: there is little or no direct user input into programming.

By contrast, the Internet is an essentially uncontrolled network, void of central authority. Indeed, one might argue that the Internet itself is predicated on the same global and local principle that Stiglitz is talking about. To be sure, the fundamental technologies of the Internet are the same globally. However, the various network elements are configured by the users according to their needs and desires, and not by a central controlling authority. Perhaps most importantly, the Internet is capable of running many different applications such as electronic mail, file-transfer, the World Wide Web, Internet Telephony, Internet Video, MP3

music (audio streaming), MPEG4 video (video streaming) conferencing, multicasting, and interactive media services. Furthermore, these drastically different applications are created and installed locally by the users without the involvement of any controlling authority.[8]

The global technology of the Internet and the local innovations and content created on it are mirroring the global-local principle of development-related knowledge acquisition and application. Consequently, the Internet, as the embodiment of the global-local principle, may be used by any country or region to collect global knowledge and translate it to local conditions. It is up to the users in the developing countries to create applications capable of carrying out the task of localization in a fashion optimized to their needs.

INTERNET ACCESS

The importance of the ICTs has been fully recognized by the development community for some time. In 1980 the U.N. Economic, Scientific, and Cultural Organization's (UNESCO) General Conference initiated the International Programme for Development of Communications.[9] In 1982, the International Telecommunication Union's Plenipotentiary Conference established an independent commission to study telecommunications development. The Maitland Commission, in its "Missing Link" report, recommended high priority, large-scale investment in telecommunications.[10] Indeed, there is a digital rush in the developing world, a feeling of urgency and fear of being left out of the information economy. Nicholas Negroponte, Director of the Massachusetts Institute of Technology Media Lab, along with many others, believes that the developing world can progress by skipping certain stages of industrial development and leapfrogging into the information economy.[11] The validity of this theory is yet to be proven. However, there is no doubt that ICTs, if properly adopted and implemented, can bring economic and cultural opportunities to developing countries. Education facilities may be greatly improved through distance learning and Internet access. Health care may be delivered to isolated and underserved communities. Industrial production may become more competitive by taking on a smaller scale, distributed version that would also reduce the pollution of the environment. This optimistic assessment of the role of ICTs in development was summarized by former U.S. Vice President Al Gore at the International Telecommunication Union (ITU) conference in Buenos Aires, Argentina in 1994 when he stated that the creation of the Global Information Infrastructure (GII), which for all practical purposes is the global Internet, "is an essential prerequisite to sustainable development for all members of the human family."

Paula Uiomen of the U.N. Research Institute for Social Development has given a more restrained assessment of the role of ICTs in the developing world.[12] She argues that the success of the Internet should not be measured by the number

of people connected to it, but by the extent to which its implementation improves the standard of living and well-being of people in the developing world. The issues she raises include the danger of the Internet accelerating the stratification of society into an 'information have' minority, and an 'information have-not' majority that does not possess the resources and skills to utilize the technology. Indeed, in order to realize the promise of the information economy, an enormous level of investment is needed in areas such as creating a viable telecommunications infrastructure, providing the personal resources required to acquire a personal computer, and improving the literacy rates of the population. The only way the sacrifices of paying for these investments in already debt-burdened developing countries will be worthwhile is if they result in socially beneficial applications such as health care, education, and greater participation in the political process. Furthermore, the simplification of Internet access through community-based facilities (telecenters) and more locally acceptable technologies (translation software, less virtual interfaces) is imperative.[13]

In order to maximize the effectiveness of the Internet in development work, the ability to access it must be readily available to both researchers and the population at large in developing countries. In these areas of the world, Internet access is closely related to teledensity, or the number of phones per 1000 people, because access is often established through dial-up, wireless, or mobile phone lines. Yet, Internet and telephone network considerations are not interchangeable because satellite and digital line (ISDN, T1, DSL) connections are also playing an Internet access role, especially at the institutional level. Furthermore, fixed wire network teledensity is not increasing rapidly in many developing countries because of the preference for cheaper and more readily installed wireless networks capable of providing Internet access. In general, the beginnings of a diverse infrastructure for Internet access are sprouting in developing countries, but access availability is still low, especially outside of large cities.

The Access Working Group of the Global Knowledge Partnership made six recommendations aimed at achieving universal access to the Internet, a situation in which even the poorest, rural communities and the most disadvantaged groups of the world would be connected to the Internet.[14] The following is a list of the recommendations:

1. Evaluation of the scope and nature of the access challenge;
2. Proper targeting of public and private investment;
3. Strategy, policy, and regulation to foster innovation and information flow;
4. Universal access, poverty reduction, and sustainable development;
5. Human resources and capacity building;
6. Supporting diversity of global information flows.

The first policy recommendation puts forth the need for an inventory of ongoing efforts in access improvement and serious studies of local access needs in developing countries. Only after these preliminary investigations are completed should plans be formulated for appropriate policies of access improvement. The second recommendation calls for the harmonization and targeting of public and private investment in access creation. The private sector may benefit from many opportunities in developing countries such as e-commerce-based marketing, the development of local Internet applications, and the enhancement of the existing networks. Of course, in order to take advantage of these opportunities, the private sector will have to invest in local access creation. The third policy recommendation concerns strategy and regulation. It calls on the international community to help developing countries join the information economy by influencing local policy makers to treat Internet access as a priority and to discontinue the control of publicly available information. Furthermore, diverse participation in standards-making bodies and other ICT governance is particularly important because the decisions of these organizations will determine the shape of access to the Internet in the future.

The fourth recommendation asks for public sector intervention on issues related to universal access, poverty reduction, and sustainable development. The fifth policy recommendation discusses education and training, proposing that the international community focus on training people in key employment sectors such as education, media, and NGOs because these people are likely to be the important facilitators of Internet access to the rest of the population. Finally, the sixth recommendation emphasizes the need for people in developing countries to access both the developed world's knowledge and knowledge that is appropriate and important for developing countries. Knowledge such as techniques to help local farmers improve their practices or aid citizens to successfully participate in the work of their government is of particular interest to developing countries. Implementing these recommendations in a pragmatic manner is likely to remove many of the existing barriers to Internet access that the poor and disadvantaged societal segments of the developing world currently experience.

There are many projects aimed at creating and enhancing Internet access in the developing world. Evidence shows that these efforts are starting to bear fruit. Specifically, a 1998 Global Development Network survey of all known development research institutions in developing countries found high connectivity and strong demand for online services to facilitate the creation and sharing of knowledge about development.[15] The survey population represented employees of NGOs, think tanks, independent and government research institutions, and university departments. A full 94 percent of the survey respondents stated that their organization had access to both electronic mail and the World Wide Web. About 40 percent of respondents reported that more than half of their staff used

the Web regularly. There was particularly high value attached to access of searchable online archives of research papers. Interestingly, preferences for electronic services differ little across geographic regions, indicating large economies of scale in the use of electronic products. The preference for face-to-face contact, however, is still strong. Indeed, when asked to identify their most valuable job activities, survey respondents opted for choices associated with high marginal costs such as meeting attendance. When confronted with the reality of their department having to pay for these activities, preference was shifted to low marginal cost associated electronic data gathering. Management clearly needs to balance the more satisfying and expensive personal contacts with the more efficient but perhaps much less satisfying electronic connectivity.

The utilization of readily available Internet access among development researchers was demonstrated by Darren Saywell, an English researcher involved in water engineering and development issues.[16] Saywell reported on three years of an electronic mail conferencing experience by members of the Water Think Tank concerning water supply and sanitation related issues. He found that regular participation was motivated by rapid information exchange, wider access to experts and specialists, shared experience, relative low cost, and automatic record creation and dissemination. The primary lesson learned from the experiment is that electronic mail conferencing is cost effective and efficient but successful implementation requires considerable preparation and discipline.

The Global Development Network survey of development researchers indicates that over 90 percent of them had both e-mail and web connection by 1998. From this data, one may conclude that Internet access among development researchers is no longer a major problem. However, the availability of access by the general population of most developing countries is still very limited. This is a major problem in development work. The lack of Internet access prevents the populous from being well-informed about political and economic news and prevents the general public from taking advantage of the benefits of distance education, telemedicine, and similar services. In addition, economic development is hampered because the Internet is also an important tool in business development due to its ability to provide nationwide, regional, and global exposure to even small businesses at a reasonable cost. However, it is important to note that while these costs are reasonable by the standards of advanced nations, they are still beyond the means of most citizens of developing countries. In any case, it appears that in the current circumstances widespread access to the Internet is becoming a prerequisite to successful development work.

The many ongoing efforts such as private sector and government partnerships for access creation, telecenters, and other community-based solutions are making a slow dent in the access problem. Indeed, the strongest rate of growth of the Internet exists in developing countries.[17] There is, however, a long way to go.

In January 1999 there were nearly 34 million Internet host computers in North America but only about 300,000 in Africa.[18] In many developing countries, Internet access and phone connections are billed on time and distance sensitive basis as opposed to flat usage fees. This, coupled with the relatively low per capita income in many developing countries, inhibits Internet usage. Other factors negatively influencing Internet demand are scarcity of computers and telephone lines, not being able to use English (the predominant language of the Internet), and generally low education and skill levels. Nabil Salah Mahmoud of the Murrow Center at the Fletcher School at Tufts University, has created a mathematical model for Internet access demand. Using the dependent variable of "number of Internet users per 1000 population," he found that the most significant independent variables were teledensity (number of phone lines per 1000 people), computer penetration (number of computers per 1000 people), adult literacy rate, and real GDP per capita.[19] The data used in constructing the model was obtained from the United Nations Development Programme's (UNDP) 1998 human development report.[20] The model has shown that while teledensity, computer penetration, and income levels have a moderate impact on Internet demand, the skill level and education of the population plays an overwhelmingly important role in determining Internet demand. Governments interested in fostering increased demand for Internet usage clearly should invest in increasing the literacy level of their population.

The access problem is particularly acute in poor rural areas where not only computers and phone connections are scarce but even electricity may not be available. The emerging Third Generation Wireless (3G) technology for advanced mobile communications services may eventually supply some of the solutions to the needs of these poor and underserved communities. The 3G technology will not use personal computers to access the Internet but will rely on display screen-equipped cellular telephones or palm computers instead. In addition, these Internet appliances will utilize batteries and cellular networks and thus will not require hard wire connections to the electric utility or to the landline telephone networks. Many of these appliances will be highly specialized, performing preprogrammed steps at the push of a button, thus lowering the demands on the skill level of the user. In other words, the 3G technology will liberate the users from having to know how to operate a personal computer and will provide them with unprecedented independence and mobility.

These Internet appliances will first penetrate the market of the developed world. However, based on historical patterns in ICTs, prices should fall rapidly, thereby making the devices more affordable to people in the developing world. Furthermore, it is possible that advanced mobile services will be available in some middle-income, developing nations before they will be available in all higher income countries. For example, services may be available in parts of Brazil before

they are available in the United States. The process of implementing 3G is likely to be rapid in some developing countries because the developing world is perceived by businesses of developed countries as being a significant market for e-commerce. The giant potential markets of China, India, and Indonesia are irresistible targets for e-commerce businesses. The demographic trend of population expansion in the developing world and population decrease in the developed world has highlighted the growing importance of the developing countries as consumer markets. It is likely that 3G will revolutionize Internet access much the same way as the transistor radio revolutionized access to radio broadcasts in the late 1960s and early 1970s. The social, political, and economic impact of the transistor radio has been immense, and a similar impact is anticipated from the eventual availability of wireless Internet access in poor nations. The developing world will be able to harness the unique power derived from the ready availability of information.

Both the nature of information and the structure of the Internet foster knowledge sharing and communications. The value of material goods declines through usage. Raw material deposits become less valuable upon depletion through mining. The value of finished products is determined by the cost of their duplication and they lose their value through wear and tear caused by repeated usage. Information is quite different. It is easy and inexpensive to duplicate and its value is not diminished but often increased by usage. The more that information is disseminated and the more it is used, the more valuable it becomes. Thomas Jefferson compared knowledge to light.[21] One can light a taper from a candle and spread its light further without diminishing the light of the original candle. Being that information, if properly used, is readily transformable into knowledge, Jefferson's analogy can be extended to describe the spread of information without diminishing its value.

Information is also empowering. Those who possess it have a clearer understanding of the issues and are more likely to be masters of their own destiny. They are better able to accomplish their goals than those who do not posses it. The Internet, because of its open structure, standardized technology, and uncontrolled and uncensored content, is a unique and ubiquitous tool of knowledge and information sharing.

At the same time, proprietary information, knowledge that is not universally shared but disseminated in a limited fashion, can give a significant economic and political advantage to those who possess it. Consider the knowledge contents of the confidential Intranets of companies and organizations where, using Internet-Protocol technology, the firm's employees and affiliates freely exchange results, plans, and status reports. The Internet and Intranets form an immense pool of information that, together with the accompanying tools of communications (e-mail and Internet telephony), are the basis of the so-called information economy.

KNOWLEDGE NETWORKS AND DEVELOPMENT

The flexibility and adaptability of the open structure of the Internet allows it to serve many purposes. It is a network that simultaneously facilitates intense e-commerce competition and Knowledge Networks-based development work. In the development area, the Internet has served as an agent in both widening and narrowing the knowledge gap between rich and poor countries. The crucially important role of Knowledge Networks is to discover, disseminate, and apply knowledge in developing countries faster than new knowledge is being created in the developed world. The future of economic and political progress in a large part of the world may depend on differences in the rate of knowledge creation compared to the rate of knowledge acquisition.

The greatest challenge of developing countries is not knowledge discovery but the introduction of this knowledge in a fashion that allows the local population to adopt and utilize it. This concept was articulated and implemented by the Canadian company Acacia, which was formed to narrow the digital divide in Africa. According to a project officer of Acacia, "Our approach is based on the understanding that rural, marginalized communities can benefit from technology but only if it is introduced in a comprehensive manner. That means not just dropping computers into communities that may be struggling to feed themselves but ensuring that policies are moving in a direction that will support the sustainability of investment in rural communities."[22]

One of the most important policy directions is the establishment of an educational infrastructure to support sustainable knowledge application. Distance education plays an important role in this area. Satellite-based systems can deliver course material even to the most isolated communities. The African Virtual University links 24 campuses and grants degrees in ICT subjects. The University of South Pacific, with its main campus in Fiji, provides primarily agricultural information to various Pacific Islands. The Caribbean region also has a similar satellite-based education network connecting the various island nations. Increased availability of the Internet allows moving some of the distance learning technology from traditional audio, telephone, or satellite-based video to the less cumbersome text-based Internet application that allows a more intimate and in-depth student-instructor relationship via e-mail. As greater bandwidth and processing power become available, more sophisticated interactive multimedia tools can be used for education.

One of the welcome attributes of the current development scene is corporate participation. An impressive number of companies, both large and small, are willing to enter into alliances with local companies and take a risk by investing in developing countries. These corporate alliances hardly qualify as Knowledge Networks but are important to the creation of the information economy in

developing countries. At this point, the primary focus of the corporate investments is on improving telecommunications infrastructure and Internet access. In the telephone infrastructure area, most investment is aimed at wireless businesses. One of the most publicized examples of such investments is the Grameen Bank, which provides micro-loans to women in remote Bangladesh villages to purchase solar powered mobile telephones. The women owners are trained in the operation of the instrument. The villagers then may use these phones for a fee to contact relatives or to find out the latest market prices for their produce.[23] Additionally, WorldTel, a Canadian venture capital company, made significant investments in wireless local loops in Latin America, Africa, and Asia in partnership with local companies. Another example of corporations from the developed world partnering with local companies in developing countries is the relationships that Millicom International, an English company, has formed with local telephone companies to become a leading provider of prepaid cellular services in Asia, the former Soviet Union, Africa, and Latin America. These are partnerships with relatively small business firms to improve telecommunications infrastructure and Internet access in the developing world.

Africa ONE Ltd. is contemplating a much more ambitious undertaking, in partnership with Lucent Technologies and Global Crossing, to establish a fiber-optic ring around the entire African continent. This undersea ring would be connected at 32 coastal landing points to the terrestrial networks of African telephone companies. New connectivity and bandwidth will allow direct connection for inter-Africa calls that currently have to be routed through the United States or Europe and will also greatly reduce the cost of international calls and Internet connections.[24]

Teledesic, a company owned in part by Bill Gates and Craig McCaw, is pursuing an even larger-scale project.[25] Its aim is to establish worldwide broadband access to the Internet using satellite technology. Most Internet sessions, particularly those related to knowledge acquisition, are asymmetric. That is to say, most information is flowing from the server to the user. The Teledesic system would therefore use relatively inexpensive satellite downlinks to transport information from the server to the user and avoid the use of more expensive uplinks by utilizing a telephone connection for the transmission of information from the user to the server. In other words, the local phone companies will be active participants in this system. The need to use about a dozen low-orbit satellites to provide worldwide connectivity has made the construction of this system expensive and, as a result, may miss the window of opportunity created by the current lack of alternative technology to provide general access. Successful penetration by wireless web appliances and increased diffusion of broadband technologies (ISDN, DSL) may preempt the economical use of direct satellite technologies for broadband access before they have a chance to go on-line.

In addition to inter-firm cooperation, companies also form partnerships with organizations from the public and non-profit sector. For example, the Japanese Internet company, Softbank Inc., has formed a partnership with the World Bank to invest nearly a half billion dollars in Internet start-up companies in about 100 countries, many of them in the developing world. The unique combination of Softbank's Internet business capabilities and the World Bank's development-related expertise greatly enhances the chances of success of the Internet start-up companies they decide to support. Another private-public partnership is World Space Digital Audio Broadcasting. This technology consists of radio signals beamed through very small aperture terminals (VSAT) to a satellite in geosynchronous orbit and then bounced down to earth to be received by digital radio sets. The content being transmitted consists of audio programming, text-to-speech conversion, and static web pages. The technology will bring digital information to most of the developing world and it is accessible to the rural poor. While some of the capital for the World Space venture was raised from private venture capitalists, capital was also provided by development agencies of the United Nations and the World Bank.

The original goal of World Space audio broadcasting was the dissemination of AIDS-related information in the developing world. This is one of many telemedicine projects attempting to bring timely medical consultation to some of the most isolated and underdeveloped areas of the world. The rather expensive broadband video link-ups used in telemedicine consultations of the developed world are clearly not applicable to jungle hospital situations. HealthNet, a popular medical network in the developing world, uses ham radio equipment to generate and beam signals to a low orbit satellite. The satellite beams the signal down to its destination where it is again received and broadcast by ham radio equipment. This relatively inexpensive and somewhat cumbersome set-up played an important role in the handling of the Ebola virus crisis in Zaire in 1996. The telemedicine applications illustrate how investment in access creation can readily support the functioning of Knowledge Networks.

The same observation can be made about universal access-creation and Knowledge Network-establishing activities of the United Nations Development Programme. Its focus has been the creation of pilot telecenters, which bring the Internet to rural and underserved populations following a public library model. One example of such a telecenter is the Egypt Technology Access Center,[26] which has been concentrating on capacity building through training and skill development in computer literacy. It has created an Internet technology dictionary in Arabic and promoted the creation of Internet content on sustainable development in Arabic. A second UNDP sponsored program is the South African telecenter, which has so far restricted its activities to policy advice to the Universal Service Agency that has the mandate to establish telecenters countrywide. The

telecenter in Odessa, Ukraine is dedicated to providing agricultural information through Internet access to Ukrainian women farmers. The Sustainable Development Program within the UNDP has acted as the first Internet Service Provider in many developing countries including Angola, Chad, the Philippines, and Honduras. In other countries it worked to establish and enhance connectivity to the Internet. The Internet Initiative for Africa helps 15 sub-Saharan countries to develop and enhance Internet connectivity and expand capacity. The country offices of UNDP are pursuing Internet access-enhancing projects in over 35 countries around the world.[27] UNDP has also established knowledge broker websites on sustainable development for use by the development community.

UNESCO has established a network of development-related university chairs for the exchange of information and knowledge. The most relevant to information technology is ORBICOM, a worldwide network of UNESCO Chairs in communications. There are 165 members from 50 countries, many of them developing nations. The board of ORBICOM consists of nine university and six corporate representatives. At least some of the research funding is provided by the private sector in the home country of each member. This organization is an excellent model of a properly functioning Knowledge Network involving many universities from both developed and developing countries and also private sector and government participation.

Non-governmental organizations (NGOs) are also instrumental in establishing Knowledge Networks. One example is the International Federation of the Red Cross. This organization consists of representatives from nearly 170 nations and has created a network that has been responsible for setting up systems of disaster management, relevant databases, and an information resource center. The next step will be the establishment of an appropriate telecommunications infrastructure that will allow the use of e-mail as the communications medium of choice among all members. Although Internet connections are becoming more available in the developing world, they are usually restricted to large cities. Many disasters occur in remote areas, presenting difficult communications challenges. One viable solution involves the use of CD-ROMs with prepackaged information for disaster relief. Other means of communicating with remote areas in real time include the use of radio modems and low orbit satellites (LEOs).

Another important NGO Knowledge Network is the Sustainable Development Communications Network (SDNC), formerly Spinning the Web Network. This network consists of a group of NGOs that are dedicated to using the Internet to meet the goals of sustainable development. Here again, content and access dominate the agenda with tasks such as developing new tools and content about sustainable development, building capacity for Internet use, and sharing knowledge. The SDNC is strongly involved in issues related to sustainable environmental development. Among its member organizations is the Regional

Information Center for Central and Eastern Europe, which helps solve environmental problems inherited from the communist economies and seeks to promote sound environmental practices in future undertakings. The Stockholm Environmental Institute is also a member of the network. Its work focuses on policy issues related to links between ecological, social, and economic systems at the global and local levels. In total, SDNC has a network encompassing 25 countries.[28] Access to environmental information, including state-of-the-art research on clean technologies may be best facilitated via the Internet. The United Nations Environmental Project (UNEP) International Environmental Technology Centre in Osaka, Japan has an interactive database on a full range of environmental technologies and related issues.[29]

THE INTERNET AS A META-KNOWLEDGE NETWORK

The Internet contains most of the knowledge accumulated in the course of human history. Yet it is a dynamic repository of this knowledge, readily able to accommodate and integrate the new knowledge being created daily. Using Internet databases, it is further possible to revise the various ideas and theories that have been proven to be incorrect by recent research. Perhaps most importantly, besides sustaining and dynamically storing knowledge, the Internet allows the reconfiguration and dynamic organization of data, information, and knowledge. These attributes make the Internet a constantly evolving and changing Knowledge Network, an overarching meta-Knowledge Network.

We have shown in this paper that increased access and more affordable connectivity to advanced ICTs and especially wireless and Internet services enhance the ability of development professionals and an increasingly diverse range of citizens of developing countries to access the world's storehouse of information—the Internet. The world will be enriched as the exchange of information leads in all directions; that is, within communities, regions, and nations, as well as within firms and industries. ■

NOTES

[1] Nicholaus Negroponte, *Being Digital* (Knopf, 1995).
[2] See Frances Cairncross, *The Death of Distance* (Harvard Business School Press, 1999).
[3] Howard C. Clark, *Formal Knowledge Networks—A Study of the Canadian Experience* (International Institute for Sustainable Development, 1998).
[4] Knowledge Networks—IISDnet, http://iisd1.iisd.ca/k.networks.htm.
[5] Joseph Stiglitz, "Scan Globally, Reinvent Locally: Knowledge Infrastructure and the Localization of Knowledge," First Development Network Conference, Bonn, Germany, December 1999, http://orion.forumone.com/gdnet/files.fcgi/226_GDNfinal.PDF.
[6] Robert J. Chassel, "Shaping Collaborative ICT Development and Initiatives for Global Prosperity," March 2000. Http://www.globalknowledge.org.my/Track%205%20(Chassell).doc.
[7] Ibid.
[8] For the sake of completeness it should be mentioned that, at least at this point, the rigid control of the telephone network results in high quality, reliable, albeit expensive and limited service, while the total lack of controls over the Internet yields essentially free and application rich but spotty quality service based on "best effort."
[9] Http://www.unesco.org/opi/eng/unescopress/98-58e.htm.
[10] "Inter-agency Project on Universal Access," http://www.itu.int/acc/rtc/acctref/acctref.htm.
[11] Nicholas Negroponte, "The Third Shall be First: The Net Leverages Latecomers in the Developing World," http://www.media.mit.edu/people/nicholas/Wired/WIRED6-01.html.
[12] Paula Uimonen, "Internet as a Tool for Social Development," Annual Conference of the Internet Society, INET 97, Kuala Lampur, June 1997.
[13] An excellent example of these new ICT-focused local development projects is the LINCOS project. This project, developed in part at the MIT Media Lab, drops a sea freight container filled with computers, communication links, and specialized technologies for applications such as telemedicine or distance education, anywhere in a developing nation. The centers can be solar powered, run off diesel generators, or connected to the local electrical grid.
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[25] Http://www.teledesic.com/.
[26] Http://www.tacc.egnet.net/.
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