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PROSPECTS and STRATEGIES

Improving Basic Education In Developing Countries Through The Use Of Computer-Based Information Technologies

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-- Monica Bradsher

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Introduction

"Basic education" takes on new meaning against the backdrop of revolutionary changes in technology, business, and society in the emerging Information Age. What must a person -- child or adult -- learn in order to survive in a rapidly changing world of global market competition, automation, increasing democratization and instability, increasing population, and limited, fragile natural resources? The changes affect even the most remote communities, and lifelong learning becomes a necessity.

> Developing countries can no longer expect to base their development on their comparative labor advantage -- that is, on cheap industrial labor . . . The comparative advantage that now counts is in the application of knowledge. (Drucker 1994)

Developing countries must adjust quickly to this new imperative or risk exclusion from the global economy and severe competitive handicaps for their products and services. Fortunately, the very technology that is forcing these changes also offers opportunities for Third World nations to "leapfrog" directly into the Information Age, bypassing some of the stages of development in the Industrial Age. Succeeding in the new era, however, requires a shift in the way governments and international aid agencies think about development and invest in it.

> It is the *development of people,* and of groups, communities and institutions, that is the primary purpose of development -- to permit them to achieve (among other things) lasting increases in GNP. This means more than increasing human productivity in a narrow economic sense. It includes their empowerment to understand and manage their own processes of change, as well as managing their physical and financial resources. (Woods 1993)

One of the strategic objectives of USAID is Human Capacity Development Center (HCDC) is the development of improved and expanded basic education systems. HCDC will respond to developing countries' requests for assistance through a series of initiatives, from helping shape the Global Information Infrastructure to addressing issues in the areas of health and democratization. This report, however, focuses on just one aspect, education, which framed by the following central question:

> **How might computer-supported systems of learning be used to help a developing country sustainably achieve learning objectives for basic education, broadly defined to include functional literacy, numeracy and essential life skills for children and adults?**

This report provides background information and suggested strategies that might be used by USAID field missions in advising developing countries about educational technologies. These technologies vary in capabilities, cost, and relevance to local needs. In fact, it is *impossible* to prescribe a system that is relevant for all countries or even all parts of one country. It could be argued that any learning system should be configured to fit an individual's needs, much like tailoring a suit.

Extending that analogy, imagine being a consultant to another country on a new kind of clothing. Before making any recommendations, you would want a lot of background information, starting with local climate patterns and cultural preferences of styles and colors. Above all, you would need to involve local people in designing and choosing the clothing; otherwise a lot of money could be wasted on things that people might accept with a polite smile but never wear. You would probably need to show clients some inspiring promotional materials, including pictures of similar people wearing the new clothes and a catalog of clothing items that fit or could be tailored to local tastes. Seeing people in their own community actually wearing the clothes and claiming benefits would be the best way to accelerate adoption of the new style.

Similarly, there is no one-size-fits-all computer-supported system of learning. An advisor on educational technology will need to be armed with information that will help clients visualize a feasible but very different future, then help them develop a plan for achieving that future for themselves. The advisor will need to help people assess their situation, review their needs and resources, the latter may not be obvious to the people themselves, and develop their own vision of the future. This report contains the following sections:

I. **Overview:** a vision of the new paradigm for basic education

II. **Shopping list:** a brief catalog of relevant technologies

III. **Scenarios:** main components of an idealized plan for each of three imaginary countries or settings within a country or countries:

Country A - rural, very low per capita income, low literacy rate, limited schooling at primary level only, high absentee rate for both teachers and pupils, no telephone lines, no or limited electricity supplied by local gas generators

Country B - some industry but predominantly agricultural, low per capita income, high disparity of income levels, nearly universal primary education but limited access to secondary education, widespread electrification, but limited and unreliable phone lines

Country C - urban, industrial base large but not competitive, high disparity in income distribution with majority of people very poor, extensive infrastructure of formal education from primary through college levels, existing supply of under used or unemployed mid-level technical and scientific workers, nearly universal, overtaxed and unreliable electrical power and local telephony

IV. **Policy Assessment:** anticipated policy barriers, desirable host-country policies

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VI. **Summary:** main characteristics of the challenge and USAID's comparative advantages in helping meet it

I. Overview: The New Paradigm for Basic Education

Formal education, is a key element in human capacity development. It also is arguably the most resistant to reform or innovation of all sectors of any country's economy, rich or poor, advanced or developing. It is far easier to change the architecture or equipment of a school than to alter curriculum, schedules, or teaching styles. Many reasons have been advanced to explain this resistance. Parents and educators and politicians are reluctant to change schooling as they have known it; no one wants to risk a child's future by gambling on some untried system. Nevertheless there is a growing sense that schools are not preparing children adequately for today's world.

> They say our schools are failing, but that is wrong. Our schools are as good as ever. The problem is that the world has changed. . . . Our educators are doing their best, but they are trying to serve 21st century students with boring 19th century methods -- blackboards, chalk, pencils, and too often outdated textbooks. (Lesher, 1992)

> Teaching content, time, and place have been fixed, and student achievement has had to be the variable. . . . The solutions needed in education worldwide, however, do not appear to lie in the traditional system. The system itself is the problem! " (Woods 1993)

How can any government afford to change the system? Education competes for resources with obviously urgent needs -- food for the indigent, lifesaving medical care, national security, protection from crime. Increasing funds for public education seems to be out of the question; many governments actually are being forced to reduce spending on education, however painful, unpopular or shortsighted that may be.

The single greatest barrier to change, however, is not financial; it is psychological. Most government officials are imprisoned mentally by the assumption that education takes place in school buildings and consists mainly in teachers delivering information and testing students' mastery of prescribed content and discrete skills. To add computer-related skills, provide up-to-date content, and extend the opportunity for learning to all age groups is patently impossible within that kind of top-down, teacher-directed system.

> . . . the limited number of trained staff that each ministry and department has been able to employ, train, and manage has been the factor most limiting its ability to reach and influence its intended beneficiaries. People . . . are confined by what they know; their individual communication skills; their mobility; whom they like; who likes them; whom they meet; their age; their health; and cultural obstacles (such as barriers between the sexes and between ethnic groups in some societies). (Woods 1993)

Effective use of technology is one way to extend the characteristically human capacity to communicate. Technology allows the best teachers to reach more students, makes vast searchable memory banks accessible, permits distant teachers to collaborate and complement each other's strengths, and broadens discussion to include more viewpoints. All of these benefits are especially important in countries with a limited supply of qualified teachers.

The following characteristics help define the emerging paradigm for basic education:

- Learning how to locate information, how to evaluate the accuracy or significance of information, and how to use information to solve problems become as important as -- but certainly do not replace -- reading, writing, and using numbers;

- The teacher's role changes but remains important and respected. The "sage on the stage" becomes the "guide on the side." Formal schooling focuses on preparing children to become independent, self-directed, lifelong learners; and,

- Place and schedule decline in importance. Learners may receive instruction or guidance in school or in community information centers, museums, libraries, homes, or some combination of those places.

A. Private Sector Initiative Will Drive Change

The new paradigm will not be achieved suddenly or by decrees. Change will be driven by individuals' self-interest, including profit. Governments worldwide are having to cut back on public services, and economic trends favor stimulating private initiative. Therefore, it seems inevitable that most of the capital required to build a new information infrastructure will come from the private sector and will be directed first toward commercial ends and secondarily toward job training. Formal education will have little power to lead the way, and will benefit from that investment and change as a by-product. Self-education in informal or non-traditional settings will probably grow and change more rapidly than institutional education. The shift to a market-driven model is already evident in the privatization of the Internet. It originated as a linkage among institutions of government and higher education, and now is forced to sustain its own growth commercially without government subsidies in the United States and many other countries. When NSFnet, the backbone of the nonmilitary Internet, was decommissioned in the spring of 1995, the press hardly noticed, but universities began paying steeply higher rates and charging access fees to schools that had been getting a free ride using university Internet access nodes.

To attract private donations or investment, both formal and informal education must appear effective in meeting the needs of the learners. Informal settings are better able to demonstrate that effectiveness because expectations are not so high. Demonstrated demand (attendance, purchases) is often sufficient evidence of success for informal education, whereas in schools effectiveness is usually measured with tests that have little or nothing to do with learners' wishes or their felt. In fact, the more developed the formal education system is, the less likely are its administrators to embrace the inherently subversive new paradigm. Therein lies the greatest pitfall. One can see computer technology has been introduced -- at considerable cost in many American school systems but has not been assimilated. Without a clear vision of the survival skills for the 21st century, technology may do more harm than good, as indicated in this tongue-in-cheek warning from Dr. Eddyth N. Worley:

> Through the use of technology, you will have the ability to provide poor content, inappropriate practice, and ineffective teaching strategies to more students quicker!

Success in introducing educational technologies, in both formal and informal settings, depends on starting small and demonstrating effectiveness at each stage of expansion. A key factor is designing an information or learning system that resonates with the values of the community and the intended users.

> The learning technologies change the users and empower them. A lot of communities and countries may say they want individuals empowered but may not want to do all that involves, and present restrictions. Successful implementation in communities occurs where the vision has been packaged to emphasize their values; parts that undercut values may be de-emphasized. (Dede)

Appropriately packaged learning technologies allow people to do what they have never been able to do before; they are financially sustainable because people will pay for what is important to them. Where local communities have seen opportunities and built new capacities that are meaningful to them (often bypassing established institutions), the growth cannot be stopped. For example, a neighborhood investment association in West Cleveland, OH, worked with small businesses in the area to develop a local community computer network. With some modest starter funds, they set up a program to train people in refurbishing low-cost computers to provide access for many residents who could not afford home computers. The greater challenge was to interest the largely blue collar community in using the computers. The network succeeded because it involved posting who was selling what at yard sales, who had car parts for sale, timely and useful information that fit the values of the neighborhood. The project was low level, low-end technology, and has proved to be sustainable. An important byproduct has been increasing the neighborhood skills base; an automated box factory in the area needs workers with some computer skills. (Gapen)

In schools, success depends on appealing to the self-interest of teachers and administrators, often downplaying at first the empowerment of students. This is not easy in communities that measure educators' productivity primarily in terms of test scores. Even in the schools where computer technology has been most effectively integrated into curriculum and instruction, it is hard to find statistical proof that the technology is responsible for producing superior outcomes on standardized tests compared with schools using traditional methods, though results are no worse. Most interesting is that using technology adds new dimensions to the learning and teaching processes beyond the ones usually tested, as illustrated by the following excerpts from a recent U.S. Congress Office of Technology Assessment report:

- Teachers find that technology can help them improve student learning and motivation, address students with different learning styles or special needs, expose students to a wider world of information and experts, and implement new teaching techniques;

- Teachers find that their students are doing more than learning generic technology skills or subject-specific technology applications. Rather, they see them developing . . . problem-solving skills; broader scientific literacy and mathematical understanding; strong communication skills; personal responsibility, integrity, and initiative . . . ; and,

- (Students develop) workplace competencies (that) include working with resources, acquiring and evaluating information, working with others in groups or teams, understanding complex relationships and systems, and using a range of changing technologies.

On surveys, teachers typically report changes in their own teaching styles over a period of several years that is, having higher expectations for their students, being able to devote more time to individual students, and feeling more comfortable with having students working independently. Given time and enough equipment, many teachers gradually change of their own accord to a more student-centered style that emphasizes learning how to learn independently.

However not all teachers take to technology rapidly. Some become more resistant if their initial experience is frustrating or is forced on them. Most teachers need time and support to change. Equipping a school extensively is not enough by itself. Fred Goldberg, a former teacher who has pioneered the development of NYCENET, the telecommunication system for New York City public schools, says, "First there's an *unlearning* curve before you can get teachers to start the learning curve."

In the few schools where building-wide e-mail has been introduced, principals report a sudden change in the remaining technophobes on the staff. The convenience of sending messages to the office, staying informed about school policies and events, and reducing the number of meetings changed their minds. For most people, the vision of the future must include some very concrete advantages for themselves or they have no interest in it. In developing countries, where people have less to lose financially by changing and where people have had less access to mass communications, persuading anyone that computer use may bring concrete advantages is easier than in the U.S. The difficult part is persuading officials and potential users that educational technology may become affordable and feasible locally. Until those doubts are addressed, the reaction to the lofty new paradigm may be anger rather than inspiration: "Why are you showing me wonderful things that I will never be able to use?"

B. Leapfrogging into the Information Age

The rapid pace of technological change offers hope that education in poorer countries can leapfrog straight into the new era at considerably less expense than the developed countries have experienced, today's computers provide vastly more value in speed, storage, and multimedia capability at less cost. The newer computers are easier to use and can be networked more reliably.

Developing countries may save money and frustration by avoiding the mistakes commonly made previously in introducing computer technology. Educational technology experts agree that in allocating funds, human factors -that is training and technical support for teachers or information center staff, relevant and easy-to-use software applications and authoring tools- deserve at least as much attention as hardware. The usual error is to use all the funds to

buy computers, so that more people or schools will have them. More isn't better if the hardware goes unused.

Another common error to avoid comes from the top-down mentality of school systems and governments, which creates the tendency to design systems without involving those who will be affected. It works better to think of carrots, not sticks, incentives rather than decrees, attracting consumers of information rather than forcing employees to be more productive. The mentality for success is entrepreneurial rather than bureaucratic.

Information technologies present exciting opportunities to reinvent education to suit local needs and values. In many developing countries, the content and teaching methods used in schools were first introduced by a colonial power intent on extracting natural resources and exploiting cheap labor. After achieving independence, the new indigenous leaders may have adapted the education system to some degree in the interest of nationalism, but probably held onto some aspects of colonial administrative policies and procedures. They were intent on maintaining their own hold on power and trying vainly to catch up with the requirements of the Industrial Age. The formal education system may never have suited the local culture, and still maybe unsuitable for current development goals. Instead of continuing and extending this model, such countries have an opportunity now to use technology to bypass past failures and limitations and develop an education system which is responsive to their economic, political and social development needs in the Information Age.

For example, people from traditional cultures emerging from colonialism often characterize Western secular culture as being cold, impersonal, and too focused on the individual and competitiveness. The desire to retain the warmth and sense of community in their traditions can shape the way they use technology. They may favor the intimacy of e-mail exchanges with real people over cruising the Net looking at impersonal data bases. Pride in being able to contribute to international projects, instead of always being on the receiving end in contact with the West, may be highly motivating. Collaborative group projects supported by computer software tools may be more successful than seating individuals at terminals to follow programmed instruction lessons. Educators in such countries may also wish to develop engaging software or to desktop publish original print materials in support of new curricula about their own history and culture.

That is not to say that there is no place in a developing country's schools for good educational software and supportive print materials from the West.

> In South Africa, IBM's "Writing to Read" learning system is helping some schools to address a specific issue of inequality. Of the 12 official languages in South Africa, English is the one used universally. Most children arrive in first grade not knowing any English. They are taught in their home language for two years and then must switch to English as the language of instruction. Many leave school at that point. Using "Writing to Read" as a vehicle for learning English in the primary grades has substantially reduced the drop-out rate. (Sabater)

Besides avoiding mistakes and some costs, developing countries can benefit from looking at successes already achieved in other countries, such as Argentina, India, Israel, Egypt, Spain,

Turkey, and Chile. There is no one formula for success. In some of these countries, a local effort succeeded and grew; in others, the national government spearheaded the effort.

> To replicate models of success is difficult, but Chile is a good model for successful national efforts. The nationwide effort in Chile worked because the Ministry of Education had a Minister with a clear vision, money from loans and internal funds, and enough people who knew their subject. They started small and grew slowly. The technology component was a small fraction of the overall plan; they spent more on books than on computers. Technology was a component in a broader effort, which involved improving buildings, teacher training, texts and other types of books, and beginning to put computers in schools. The technology factor didn't start too large, but on a smaller level with three years at a pilot stage, with each year successively adding to the number of schools involved. By year three, 50 schools, and now it's up to 150 schools. (Hernandez)

Spain also had leadership at the national level, envisioning a large framework with emphasis on community and home relationship to the school. In Israel, the nationwide effort began years ago and was mainly driven by the need for a major retraining effort to absorb the large influx of immigrants. Funding support and the commitment of pioneering scientists drove a focus on science education, not just technology. (Kahn)

For countries that lacked such leadership or commitment to education at the national level, local initiative provided the main impetus, often without the knowledge of national authorities.

> Tolga Yurderi of Istanbul set up the first BBS in Turkey, then upgraded it to be the first Fido BBS, which is polled from Germany every night. Then he became the first 'regional' Fido coordinator for the 10 Fido's now in Istanbul. Sevgi Ozier is his 'Sysop' now, and she is skilled with people on-line. . . . It looks like Tolga will also be the first Internet connection (provider) in that country. Now here is the point. Tolga and Sevgi are only 22 years old, not out of college and yet they are so far ahead of others (in Turkey) it isn't even funny. (Hughes, 1993)

In Argentina, the process of introducing and expanding use of information technology "started at a regional level; the visionary was a teacher at a local school. The Ministry of Education may not have been aware of what was happening, but a national vision was a catalyst. Equal access was a driving force behind the effort." (Gragert) The area in question, Chubut, was selected for development at the national level. While seed money certainly helps, identifying pioneers is critical to making the effort sustainable after outside funding ends.

What if cost were no object? It still would take time to reinvent education for the Information Age, but the pace of change certainly could be quickened. Imagine the following "ideal" system:

- a longer school day and year-round classes with a different approach to staffing, including a technical support group and paraprofessionals (to supervise students while they are working independently or resting) and more flexible hours for teachers so that they have time to prepare and to plan with colleagues;

- a color laptop computer including CD drive for each student and teacher, for use at home

and at school, with the capability to be plugged into a school network equipped with servers holding large collections of software and having access to outside telecommunication services from school, plus one system for large projected display in each classroom; and,

- satellite uplink and downlink capable of remotely maintaining and updating school software collections on servers, and also used for two-way video conferencing, including teachers' professional development, with programs taped for future reference or for absentees.

Unfortunately, such a system is a fantasy for nearly all schools everywhere, because of the cost involved. However some pieces of it, such as rethinking staffing and scheduling, may be easier in some countries, where labor costs are low and teacher unions are weak or nonexistent. As for the technology equipment, schools everywhere are well advised to start small and find out what works before getting more of it. Tailoring that first step means choosing building blocks appropriate to the local culture and circumstances.

II. Shopping List: A Brief Catalog of Relevant Technologies

The distinctions between major technologies -- computers, telephones, radio and television -- are becoming blurred as all of these tools increasingly incorporate capabilities of the others. Desktop and even laptop computers can now display color photographs, run video clips, and deliver natural-sounding voices and high fidelity music. Telephone systems depend more and more on computer-managed switching and carry data from one computer to another. Telephony is no longer limited to copper wires but also includes fiber-optic cables that can carry video and wireless connections via satellites and cellular transmitters. Radio and television are not just one-way broadcast media; they can be two-way interactive connections. And all of these technologies now permit storage and retrieval -- time-shifting to suit the convenience of users.

Among the most appropriate tools for improving basic education, are computers, computer-based telecommunications, interactive distance education and stand-alone software packages.

A. Computers

A computer is not a one-trick pony like a filmstrip projector or a phonograph. It can be linked to various peripherals (hard drive, printer, modem, CD-ROM drive, videodisc player, camera, microphone, image scanner, projection device) to play a wide variety of roles: tutor, reference library, interactive chalkboard, publishing center, entertainment arcade, communications link to the outside world. Depending on its central processing capabilities and the peripherals attached to it, a single computer with appropriate software can serve any or all these functions for an individual user or for a group, such as a class of students or a neighborhood.

There are several ways to extend the benefits of a single computer to a number of people:

- Take turns using it;
- Enlarge the screen display so that a group can view and discuss it Projectors, LCD displays for use with overhead projectors, and computer-to-TV-monitor adapters are dropping in price and improving in quality;
- Have proficient users search for and retrieve information from distant sources on request and deliver the information orally or as printouts; and,
- Program the computer to serve as a store-and-forward device, automatically retrieving mail or information and keeping it for individuals to read or print when they have their turns at the computer.

The choice of computer model and peripherals depends on who will use it, for what purpose(s), cost/budget constraints, and the environment where it will be used -that is, climate, electrical supply, access to replacement parts and technical expertise, space limitations, security from theft. Here are two examples:

> A professor of English in provincial Russia needed frequent access to a computer in his part-time role as liaison between a number of local schools lacking phone lines and National Geographic Kids Network. Because he was a novice computer user and had young children, we sent him an easy-to-use system for the whole family (Macintosh Performs with color monitor, printer, and modem at a bargain price). Because of his difficulties in getting the computer to communicate with the printer and the lack of Macintosh expertise in his region, we replaced the Performs at the same price with an IBM monochrome Thinkpad (laptop) and printer. He has plenty of friends who know DOS and can help him as needed, and he is relieved to be able to hide this valuable property from potential thieves and from his own curious kids in their tiny two-room apartment. (Bradsher)

> In rural Chile a few years ago, a Macintosh system with color monitor proved the best choice for a community information center. At the time, it was easier to create a graphical user interface on the Mac than on the DOS platform. The challenge was to persuade villagers to use a program to access different kinds of local information. A menu that looked like a painting of a local village plaza was the answer; people felt right at home using the mouse to click on familiar buildings and obtaining information they would expect to find there. (Villalobos)

If the main uses envisioned are basic applications (word processing, spreadsheets and e-mail), a second-hand computer considered obsolete in the business world can be quite adequate. It is becoming common for businesses to donate older, slower computers (monochrome, DOS, 286 processor) to schools and also NGOs that collect computers for use in need situations. Use of dated equipment deserves careful scrutiny, especially in developing countries. If collected computers are to be shipped from a donor country, what is the cost of shipping and import duties? Will the computers come with appropriate software already installed? Are computer-literate people available at reasonable cost to reconfigure the hard drives of the donated machines? (Donated computers often still contain the previous owner's personal files and applications that may clash with software to be installed for the new user.) Only by looking at the total cost/benefit picture can one decide whether the saving in purchase price of a used computer outweighs the risks and other costs.

Designing and building computers locally may be an attractive idea to the government of a developing country. However, because computer manufacturing is such a rapidly changing business, it's unlikely that a developing country will be able to keep up with global competition and technical advances unless its computer industry is built by foreign companies or is limited to assembling parts under license to a foreign company. Such arrangements may not feed national pride, but create jobs and save shipping costs. On the other hand, it may be worthwhile for a country with extreme climate conditions to develop specially adapted computer models. Big international firms build technology for the market in developed countries that have air conditioning and a stable electrical supply. Failure rates for such computers may be so high in a developing country that the cost of special design specifications is justified.

Computers can be connected to each other in a Local Area Network (LAN). The simplest LANs, connecting computers directly with cables, permit several workstations to share a single

printer. More complex LANs include one dedicated "server" computer to store and manage software shared by cheaper computers with limited memory or storage capacity. Keeping a LAN up and running, especially with DOS-based computers, can take a fair amount of time and may require more technical training than is needed to operate a single system competently. In places where such labor is scarce or expensive, it may make more sense to spend a little more money on individual computer memory than to invest in a LAN for sharing a server's storage. Sharing a printer by walking to it instead of sending files through cables is an inconvenience that most computer neophytes put up with happily. The important thing is to keep the computers operational, not only to maximize the investment but also to avoid discouraging new users.

B. Computer-based Telecommunications

Breaking down barriers of time and/or distance in communication is likely to be the most compelling reason for using computers, especially in countries that have little or no telephone service and where topography tends to isolate communities. The importance of community and extended family in traditional societies also predisposes them to see advantages in using computers for communication.

Stand-alone computers and/or LANs can be linked in a Wide Area Network (WAN) to facilitate sharing software applications and data and to permit people to send written messages to each other. A WAN can connect distant parts of an organization, such as a company with branch offices or a multi-campus university system or a regional system of schools. Widest of all is the Internet, a worldwide network of networks that serves as a conduit for the transfer of messages and files, including vast amounts of publicly available information that users can find using software searching tools.

Any two computers may be linked directly by some sort of cable or indirectly via modems. A modem (**mo**dulator/**dem**odulator) is hardware that converts computer (digital) signals to telephone (analog) signals and the reverse. The most common arrangement today is to connect a computer to a modem to a telephone jack with appropriate cables. Telecommunications software allows the user to "dial up" through the phone line to a distant computer and its modem. Other kinds of modems connect computers without wires by transmitting signals via certain radio frequencies. New wireless modems designed for use inside a building can connect a computer to a printer or to other computers, making possible wireless LANs -- and potentially great savings in cost in buildings with inadequate electrical wiring. Other kinds of wireless modems allow computers to communicate with satellites and cellular phones. Whether accessed by dialing through a wired or wireless modem, the target computer may be equipped with software for storing and forwarding messages in the form of a public bulletin board or a more personalized system of storing messages in individual mailboxes (electronic mail or e-mail).

Teachers begin using e-mail readily once they learn how to make a connection. Because they can pick up or send mail at their convenience, it opens many channels of communication. E-mail can be used for building personal relationships with other teachers (normally isolated from each other by the walls of their classroom and by their schedules) for sharing teaching ideas and

asking experts for advice. It can also support the curriculum, involving classes in collaborative projects with distant classes. Because all of this is such a departure from traditional teaching, most teachers do best if given a tested curriculum module (such as those offered by I*Earn, Global SchoolNet, and National Geographic Kids Network) to follow the first time they venture into this exciting, but frighteningly new, arena. Ed Gragert of I*Earn reports that many teachers at first prefer to just "put a toe in the water" without committing to a collaborative project or even to writing messages. They "lurk" in the background, reading announcements or messages but not actively participating for the first year or two.

Commercial on-line services in the U.S. make their money by enticing subscribers to stay connected for long periods "chatting" with others connected at the same time or "browsing" the Internet by connecting directly to remote computers to view their directories or multimedia World Wide Web pages. In universities and government offices, Internet users may stay on-line for long periods without a cost penalty because their institution pays a flat yearly fee for local Internet access, usually through a fast, dedicated line.

Most people in developing countries, like most schools and rural households in the U.S., cannot afford the luxury of long periods on-line. Composing and reading messages off-line reduces connect time and phone bills, keeping the actual transmission time to a minimum. Sending and receiving during off-peak hours (for example, at night) also saves money and may be less frustrating because lines are less likely to be busy. Hardware and software configurations that automate these processes and minimize costs in these ways are available even for older, slower computers. "Off-line reader" and "news-reader" software can be programmed to transmit and receive files at night, storing them to be read later off-line. Even with a low-end or old computer it is possible to send very brief messages that launch automated searches for information from distant computers. The responses, sometimes many large files, can be received at night, possibly at high speed, when the computer automatically dials into a storage area, or mailbox. (Odasz)

C. Interactive Distance Education

Distance education used to mean one-way broadcasts of radio or television programs with content geared to a course of study, often a series of lectures. New technologies (especially compressed digital video and audio) permit two-way interaction between a teacher and a distant class or classes at a reasonable cost.

For example, in mostly rural Vermont, video studios on community college campuses are connected by fiber optic (T-1) lines capable of carrying the equivalent of 25 simultaneous conversations. Much of the cost is borne by private companies that use the system during business hours to deliver job training at a fraction of the cost of providing more trainers or transporting widely dispersed workers to a central location. Public educational institutions use the system in off-peak hours and on Saturdays at a much lower price. A teacher or trainer can lead classes in six or more parts of the state simultaneously. The teacher can hear any student who pipes up with a question and can then choose to see the video feed from that student's class.

In every classroom, students view two monitors -- the teacher and the classroom the teacher is viewing -- and can hear audio from all sites. Such sessions can be taped in each location for playback by students who missed the lesson or want to review it.

Video cameras have become easy to use and have fallen in price, opening the way to capture good teaching practice or allow students to share what they have learned in an audiovisual medium. People far from any TV studio can contribute to educational programming by creating and mailing tapes to be broadcast. The VCR becomes invaluable as a tool for archiving broadcasts and for exchanges of homemade tapes.

Other hybrids exist. Two-way radio with one-way video broadcast, for example, allows students to ask questions and discuss issues with other classes. Adding e-mail to an existing radio or TV instructional broadcast allows teachers to send materials to be printed and to answer students' questions, though not necessarily immediately. And two-way distance education can be conducted without video or audio in a scheduled "on-line conference" in which many computer users are connected and write messages to each other in real time.

These new forms of distance education are giving rise to "virtual" universities, where instruction is not delivered in person or in a traditional classroom. It is already possible for a person in a developing country to earn a college degree in certain subjects in the United States or Great Britain without leaving the native country. In the future, the reverse may be true. An inspiring teacher in a developing country may be able to compete successfully for tuition-paying students around the world.

D. Educational Software for Stand-alone Computers

The days when computer users needed to know how to program in machine code or arcane languages are over. Today there are many thousands of software programs stored on diskettes, tape cartridges, or compact disks read by lasers (CD-ROM). Software can be telecommunicated from one computer to another without being recorded on diskettes, an advantage in places where mail delivery is unreliable. Direct transmission also saves the costs of duplication, packaging, and storage. For very large files, it's worth looking at cheaper alternatives to sending them through phone lines.

You could use asymmetric links, in which one sends a short request via phone, but instead of downloading by phone, use digital transmission over FM transcarriers where time is free, although slow. In the U.S., we don't transmit computer files through TV broadcast much for regulatory reasons, but this may not be a problem in developing countries which don't have the same regulatory restrictions. (Foote)

The most essential applications -- word processors, spreadsheets, data bases, dial-up telecommunications tools in English and other major world languages-- can be obtained for little or no cost as "shareware" or "freeware," another advantage to latecomers to the Information Age. As for other types of educational software, the off-the-shelf price of mass-produced commercial

software is a bargain if the product is appropriate to meet local needs, in comparison with creating one's own software. Development of reliable and easy-to use software can cost many hundreds of thousands of dollars. Commercial publishers usually offer discounts for buying in large volume.

Several other kinds of computer software have uses in formal and informal education:

- References -- Dictionaries, encyclopedias, atlases, etc., now can include sound, color illustrations, and video clips;

- Interactive books -- Choose to hear a word or passage or story read or defined or translated into another language while the text is displayed, choose style and size of type, choose to see text labels on pictures. Carnegie Mellon University's "Project LISTEN" has developed an automated reading coach that displays a story, listens to a child read it, and helps when necessary. Refinement of this intelligent individualized tutor promises applications in adult literacy, foreign language learning, and computer-assisted writing (Hauptmann, et al, 1994);

- Interactive tutorials -- Self-guiding lessons, usually including tests of mastery and levels of difficulty;

- Drill-and-practice games -- Number facts and arithmetic algorithms, spelling, geographic names and locations;

- Productivity tools -- Illustrating (drawing, painting, animation programs); accounting and financial planning ; class schedule makers; storage, organization, and quick retrieval of information (data bases); teachers' grade books and test makers; and more;

- Simulations -- Representations of natural processes (the water cycle, food chains, formation of chemical compounds) or human endeavors (building a city or a railroad or a zoo, making decisions within an earlier historical period) that can be altered by the user to explore cause and effect; and,

- Authoring tools -- Speed up and simplify the creation of any of the above types of software.

The preceding list is arranged roughly in order of the amount of training needed, from items that a visitor to a library could use instantly to tools requiring practice and time to master. Without training, people tend to choose first the applications that seem most like media already familiar to them and that require the least change in their usual way of working or finding information. Learners of any age tend to choose media that best match their learning style and abilities. Many educated adults prefer keyboard commands, lists of options, and text (quickly scanned, then printed out for close reading) to the graphic menus and multimedia presentations usually favored by the young. Illiterate and semi-literate adults share with primary grades children the same need for multisensory, graphical interface systems, though the content that

interests them is likely to be quite different.

All of these kinds of software are available in English, Spanish, French, and other European languages. To serve the needs of people who don't speak one of these languages and to support curriculum about local culture and history, a developing country is well advised to encourage domestic software development. The market for an educational software program in an indigenous language will probably be too small and poor to support development costs comparable to those incurred by commercial software publishers. Widespread un-licensed copying of software is very common and hard to control in developing countries, further reducing the profitability of software development. The most realistic solution may be to have older students develop software. They learn from the process, their labor is cheap or free, and so is the resulting product. Identifying and distributing the best of these homegrown products will be easier if the country develops its telecommunications infrastructure. Until then, the government or NGOs may need to set up clearinghouses or distribution centers to spread the benefit of such effort. "Marketing" is important even when the goal is not a commercial one.

III. Scenarios: Three Imaginary Countries or Settings

The following vignettes are about imaginary places, composites of real places with real problems, and include some suggestions based on real successes. Each of the "countries" described might actually be just one part of a country. In fact, all three of these settings exist in a number of countries. These vignettes assume little, support if any, from the capital city. One can hope that progress in the most advanced ("Country C") part of a real country might filter out to the poorest rural ("Country A") region. Self-help and local sustainability will be important ingredients, These vignettes assume little if any support from the capital city. The main value of these vignettes is to stimulate the imagination by describing recognizable problems and visualizing some solutions. In tailoring any plan for a specific real place or country, for example, one might find an idea in the Country B vignette that could help in a place more like A or C.

Country A

At first glance, using a computer to improve basic education in Country A seems wildly impractical. With no telephone lines and only local gas-powered generators to provide electricity, how can anyone hope to operate such a delicate piece of equipment? People here are hard-pressed to grow or buy enough to eat, much less pay anything for education that may seem to have no immediate payoff in their rural, agricultural economy. Children can't always take time to attend the village school; they're needed in the fields or at home for more urgent tasks. The poorly trained teacher at the school is paid a pittance and can't afford to pass up other opportunities to earn money even if that means not showing up to teach half the time. The country's education ministry can't afford to credential teachers at a higher level. The defense ministry and the ministry of communications view with alarm any notion of people using a computer to communicate with foreign-built satellites.

Even a modestly successful intervention can make a noticeable improvement in Country A. There is no well-developed educational system, no entrenched bureaucracy or teachers union resisting change. There is TV here, though most people go to see it in a local bar or village center equipped with a generator. Through TV, people have seen glimpses of the outside world, including computers. They want a better life and more opportunities for their children, but they don't want them to abandon the village or their traditional religious and family values.

A needs assessment reveals several priorities to be addressed through a communications intervention: basic educational needs; information regarding food, crops to sell and to produce; health and emergency aid; and weather as it relates to food. In looking at potential access points, it seems clear that the effort can't start with the school. It also seems clear that a sustainable intervention will require an economic base, some source of continuing revenue. Thus, instead of starting by installing computers anywhere, the first step is to establish connectivity with the outside world using radio or wireless telephony.

In one survey of calls made over a rural satellite network in Peru, businesses generated one-third of the calls and business users estimated that each call saved about $7.30 compared to alternative means of communication. (Mayo)

When people want or need information badly enough, they will pay for it, within their means. Like a coin-operated phone, the cordless phone or two-way radio linked to the world can pay for itself by attracting lots of small tolls -- messages to relatives in the city, to the nearest hospital or rescue service, to entrepreneurs who might buy village products. Perhaps a particular kind of information can make a big difference to the local economy -- getting the word out quickly that a large crop is ready for harvesting and demands more field hands before it might spoil; putting potential tourists in touch with urban travel offices and emergency medical assistance if needed.

Wireless phones (satellite, radio telephone, or cellular) have the advantage of being relatively easy to understand and use; no keyboarding skill or computer literacy required. In a village where oral tradition is dominant and few people are literate, wireless two-way voice communication is more likely to win quick acceptance than computers. How might the new communications capability be applied to education? Effective application depends on involving the local people and building on the strengths of their culture. Who are the effective leaders of the communities in this area? What are their values? What sort of education enhanced by connectivity can win their support?

A wireless speaker-phone arrangement could link a distant qualified teacher to a classroom or to a teacher who is poorly prepared and lacks materials. The distant teacher could provide help to a number of communities, particularly if the voice contact is supplemented by personal visits, the master teacher as circuit rider. The teacher might deliver audio-cassettes with additional lessons. Audio tape is a cost-effective aid in places where student attendance is intermittent; students can listen to lessons they have missed, and the information can be played back repeatedly. Oral instruction for adults is especially effective where oral traditions are strong. Over time, a CB radio network could be used to build a social structure, teachers and community leaders of various villages in touch with each other and the circuit rider, which would support the eventual use of computers.

The next step would involve a search to choose a village with facilities and identifying places that could serve as information resource centers, building on existing resources. It would be better to choose a place frequented by all age groups in the community rather than a school building. Computer systems designed for conditions like this already exist. One could start with a solar-powered computer if no generator is available. A solar-powered transmitter/tuner allows the computer to send and receive files from a low-polar-orbiting satellite. The transmitter doesn't need as much power to send to a low-orbiter as it would to reach one of the big communications satellites in high orbit. This system, including an ink-jet printer, can put the village in touch with the world in new ways, including asynchronous communications and text. A message transmitted from the village will be carried by the satellite until it passes over a larger computer in a big city. That computer automatically receives the message and sends it on to the addressee through the Internet. A reply is relayed to the village in similar fashion.

A community information center grows up around the computer system. It includes a small library of printed materials, including technical manuals and printouts of information received via the satellite. It is staffed by a young person from the capital city, probably a high school graduate who has had specific training to use computer telecommunications. Part of his job is to teach promising local youths the basics of the computer, including how to tune in and pick up the satellite signal as it approaches and how to send and receive files when he is unavailable. Some of these youngsters may have the opportunity to go to the city for more advanced computer training.

The information center expands, through its own earnings and donations from urban firms with growing business interests in this rural area. It acquires a few multimedia computers, a generator to power them, and a library of CD-ROM software, including games and interactive references and books. In a place with so few amusements, the community information center becomes a popular place, especially for the young, and use of the CD-ROMs can be another source of revenue. The CD-ROMs prove far more durable than paper in the local climate.

The circuit rider teacher now carries a laptop computer and can pick up computer files from the information center or remotely with a radio modem. Receiving messages requires only a hand-held device, less power than is needed for sending to a satellite. The Ministry of Education of Country A takes advantage of the growing opportunity to improve the effectiveness of its educational TV and radio broadcasts by sending e-mail messages to the teacher with suggestions for follow-up activities for the students who have seen the broadcast. The teacher also receives e-mail from other teachers in other villages facing similar problems. The excitement of receiving mail motivates village teachers to return to the information center regularly.

This scenario is actually unfolding in several countries. The circuit rider concept is built on the success of a program in Nicaragua, where someone with a laptop makes site visits, returning to the center to send messages and reports. (Williams)

> In a remote part of the Malagasy Republic, a nascent tourist industry is growing up around an information/visitors center whose low-orbit satellite connection enables tour groups to make required reservation confirmations for their airline travel home from the distant capital. Endangered lemurs, a major draw for tourists, are less likely to become extinct now that local people have incentives to preserve their habitat. Income from sales of handicrafts to tourists enables villagers to buy fuel instead of cutting firewood in the lemurs' habitat. (Norman and Epstein)

Such models offer hope to the poorest countries, especially to the rural areas of places like Haiti and Mali.

Country B

In Country B, there are few phone lines and the ones that exist are unreliable, but schools have electricity and some businesses now need workers who are comfortable with computers. Here, there is more potential for using computers in primary schools and the few secondary

schools. In addition, there is a business opportunity for entrepreneurs ready to invest in starting private information centers with upgraded telephone connections, possibly the systems developed in India for use in rural areas.

> In 1980, 97% of India's villages had no telephones at all. By 1987, a three-year effort by many of India's great young engineers had produced a series of telephone switches, manufactured in India to international standards, and adapted to village use. The 128-line rural exchange was housed in a metal container, cost about $8,000, required no air conditioning, could be installed in a protected space in the village, and would switch phone calls more or less indefinitely in heat, dust, and monsoon. (Pitroda, 1993)

Once lines are installed, they can be used for e-mail and other data transfers as well as for voice. They supply a need worth paying for.

> In rural Sweden, Nordic Telecottages equipped with 2-5 computers, 1-2 printers, modems, and fax provide isolated village communities with access to information resources, distance working, distance education, and other capabilities. (VITA 1995)

Similar lifelong learning opportunities and computer training are provided in the U.S. by FreeNets, Big Sky Telegraph in Montana, La Plaza Telecommunity in New Mexico, and others. In a developing country where the center may have the first and only phone line within miles for voice or data, the prospects for becoming self-supporting and even profitable may be better than in the U.S.

With these models in mind, building an information/learning system in Country B, as in Country A, begins with a needs assessment of the area's community problems and a resource assessment of the area's assets and community capabilities. The assessment stage might follow the model used in England, where funding went to areas with high unemployment rates and was used to train community members to assess and map needs and resources. Similarly, in the U.S.A., a group called Public Allies received funding from nonprofit organizations to pay young people to go door to door asking people what they most want and then mapping patterns of needs and resources in education, business, health care, and government services.

The approach to building information centers in Country B follows a business development model, BOT, for Build-Operate-Transfer. The community or higher-level government leverages support from the private sector, providing incentives for private investment in what will become public infrastructure, information center(s) as public utilities. The initial investor pulls out after recouping the investment and a profit. The centers' commercial services to businesses offset the cost of public services, such as providing health information or educational materials. A center might be located in a school building if the bias against dual use (a profitable business in a public school building??!) can be overcome. Imagine a business similar to Kinko's or Copycat in a school building. It begins as just a copy machine with a service person and gradually grow into a complete multimedia center with computers, printers, FAX, desktop video, e-mail and other Internet services. The school benefits from the convenience of using the services and also from the opportunity for students to help run a business and to understand contemporary real-world needs. Downloading text from the Ministry of Education that is up-to-date and printing out only what is needed by a class can be cheaper

than textbook production and revision.

The advantage of such a shared-use system is that it brings in private resources to complement the hard-pressed public sector. A continuing challenge would be the risk of corruption, possibly even involvement of organized crime. The BOT model maintains controls by building performance standards into the initial negotiations or licensing. Having ownership remain public, with all records publicly available, also tends to discourage criminal elements.

In Country B's technology plan for schools, learning to use productivity tools such as word processors and spreadsheets further opens job opportunities for students and for adults who come to the center for training. In Country B, there are tensions regarding the role of women as viewed by the traditional culture and by the secular culture growing in urban centers. A breakthrough in attitudes toward technology occurs when people realize that women with computer skills are able to earn good money without defying cultural taboos. Female office workers sit at computers in their own separate room, but their output travels instantly to their male supervisors through a LAN connection. The lure of this respectable new kind of job increases enrollment in girls' secondary schools equipped with computers. Raising the education level of females tends to delay marriage and reduce the birthrate and mortality rates for women and babies, so this is especially welcome news in a country where abortion and other methods of birth control violate religious dogma and social norms.

In boys' and girls' secondary schools in Country B, students learn to use authoring tools to create multimedia educational software for children in lower grades. Some of the work is modeled on software from other countries that the secondary students adapt to local needs by translating text into their native language and creating their own illustrations depicting local people and settings. Other programs are original, requiring research on content. Teachers of core content subjects, accustomed to a traditional pedagogy emphasizing rote memorization, initially resist using computers themselves. But the professional-looking reports and multimedia software emerging from the computer lab are impressive, and the other teachers begin to collaborate with the computer teacher to ensure that the required concepts and content in their disciplines are reinforced by the computer project assignments.

At the primary/elementary level, schools have fewer computers. They are less likely to receive donations from businesses because the payoff in raising the skills level of new workers takes longer than the same investment in secondary education. Primary and elementary teachers tend to have less time for planning or conferring with colleagues than secondary school teachers, but they are less likely to be departmentalized or to have a rigid schedule of short class periods. They have more time to observe and get to know all their students. The primary school in which teachers stay with the same students nearly all day permits longer class periods for in-depth group projects. That flexibility also makes it easier for students to take turns using a computer. It is no accident that use of e-mail and integration of computers and curriculum happen most readily in the more student-centered environment of a primary or elementary school than in high schools.

Teachers at the primary level are unlikely to have time to create software, but they like to

be able to make adjustments to an off-the-shelf program, such as setting the level of difficulty or entering a different set of facts to be drilled. Although drill-and-practice software is frowned upon by those most wedded to the learner-centered ideal, it will probably remain popular at elementary levels as long as teachers and students are evaluated by tests that reward quick right answers. Elementary teachers also gravitate toward programs that hold children's attention, freeing the teacher to work directly with a smaller group. Easy-to-use word processing and illustrating programs and simple publishing (layout tools) also lend themselves to typical activities in an elementary classroom, including making a student-produced newspaper. In a developing country, the ease of producing an attractive newspaper this way has far-reaching implications for democratizing society.

Since Country B's resources are limited, its technology plan calls for introducing computers in just a few schools at first. Demonstration of success to parents, who seem in any country to be proud that their child uses a computer and to be impressed by his attractive work, often brings donations of money, equipment, and expertise. This is already happening in many developing countries today. Putting computers first into schools whose enrollments include children of leading politicians and other important decision makers may seem unfair, but it is also an excellent way to win support for educational reform at the top of the government.

Improving telecommunications connectivity is coming more slowly. Like most developing countries, B has abandoned its failed attempts at central planning in favor of a market-driven economy. But the desire for control dies hard in all governments. Many protective tariffs remain, and the PTT (post, telephone, and telegraph) system remains a national utility, a state monopoly with limited connectivity to other countries. Until that changes, schools will be denied the enormous benefit of being able to access the latest information all over the world through the Internet. Frustrating as this is in the short term, it is bound to yield eventually to external and internal pressures.

Domestic businesses in a market economy need to make decisions quickly and to make frequent course corrections to compete successfully. That means many times more communication than is necessary or likely in a command economy where ministries make decisions and hand down plans no more than once a year. The demand of Country B's businesses for improved internal communications -- voice and data -- and for connections to businesses in other countries will become irresistible economically and politically. The push for access from abroad of foreign telecommunications companies seeking worldwide expansion will provide increasingly attractive incentives for joint ventures or for opening the domestic market to foreign competition, incentives such as rapid increase in the number of connection channels, hard currency investment in Country B's telecommunications infrastructure, and the potential for increased tax revenues. (Wellenius)

The telecom monopoly will fall sooner or later, and education can then begin to benefit. Pushing the foreign suitors to provide donations to schools as part of the price of admission to the telecom market may work if other costs (including taxes) to those investors are not too high compared with likely profits.

Country C

Country C, formerly under highly centralized state control, has already decided to privatize telecommunications. It is giving non-exclusive licenses to foreign telecommunications companies in hopes that competition among them will keep rates down. Country C has other advantages: a high average level of education, a low and stable birthrate, a large supply of scientists and technicians, and telephones (however dated in capacity and unreliable) in almost every home. But most people are poor, there is high unemployment even among the skilled and well educated, and the disparity between average income and that of the rising class of capitalists is immense.

Country C's schools have no shortage of knowledgeable parents who volunteer their time to assist in maintaining computers and helping teachers and students learn to use them. This country's educational technology plan could include computer-based telecommunications as well as computer labs in public schools. In such a plan, schools would not only do what Country B is doing (building marketable skills in using common applications software, such as word processors and spreadsheets, and encouraging students to create instructive software for younger children), they would also have access to the worldwide Internet.

At the least this would open the possibility of exchanging electronic mail with peers and experts around the globe. A school or teacher might choose to enroll in a collaborative curriculum-based project on a network for schools (like I*Earn, Global SchoolNet, or National Geographic Kids Network). If a local Internet host computer at a university or private company provides affordable FTP (File Transfer Protocol) service, students and teachers could send search requests to remote libraries of information all over the world and receive the results of automated searches for particular items of information.

So far, using the World Wide Web to view digitized photos and art and video clips while connected to distant computers is not feasible in Country C's schools because they do not have access to modems or phone lines that support data transfer speeds faster than 2400 bps. (Most people accessing the Web in the U.S. do so at 14,400 or 28,800 bps.) In fact, modems in Country C often drop down to 300 bps or lose connection entirely because of line noise and overtaxed host computers. But as their obsolete infrastructure is replaced by wireless and/or fiber optic cable for the sake of the business community, schools may be able to use the Web to communicate visually with distant peers who speak another language and have limited proficiency in English, which is so far the lingua franca of the Internet. They may want to create their own Web page telling -- and showing -- important aspects of their school. Making Web pages is also becoming a marketable skill in the advertising and promotion sector of the world economy.

Introducing all these computer technologies is not without challenges even in Country C, which is making a rocky transition from heavy state intervention to a market economy. As everywhere, it isn't easy to find money to buy equipment for schools, and the local and national governments in C have none at all to spare for that purpose. Parents and the newly rich entrepreneurs are good sources of donations, as are businesses (foreign and domestic) that want

to build a positive friendly image in a society long taught to equate profit with crime and corruption. Using the school's computer lab during evenings and weekends to provide training for adults could be a source of income for the school, the BOT "Kinko's" model described for Country B. But fear of theft, disapproval of charging for use of public buildings, and the rigid rules of the electrical power utility have thus far kept that from happening. All electricity in the school buildings is cut off automatically from 6 p.m. to 7 a.m. weekdays and all weekend. Problems like this may be solved when concerned parents and educators direct their attention to it.

The public education establishment must change curriculum to get rid of the propaganda of the old regime, but educators struggle with how to change with minimal resources. Education leaders are justly proud of past educational accomplishments and do not want to risk a decline in measurable achievement levels. Elective courses and clubs on school grounds as well as any computer labs are the places where learner-centered approaches fit best at this stage. Another common obstacle is a reluctance to give something to one school or to one student without giving it to all the others. Resentment of elitism is another social value that gives way to practicality only slowly and reluctantly.

Lifelong learning is taking place in Country C, often hidden from public view. Fear of crime and taxes drives a lot of people to keep their entrepreneurial efforts quiet and low profile, but many people are using computers in their homes to do contract work and to assist them in communicating with clients. They use the Internet to keep up-to-date about the latest computer models. Some make money illegally by smuggling in computers and avoiding both customs duties and an exorbitant sales tax when they resell them. The result of all this activity is that despite the outward shabbiness of most of its buildings and streets and the backwardness of much of its rural countryside, the Information Age is dawning in Country C. Unless the old bureaucratic instincts succeed in stifling initiative again through heavy-handed controls and in discouraging foreign investment by levying confiscatory taxes and making unpredictable changes in laws of ownership and protection of private property, Country C will continue to rise on wings of information from the ash heap of its massive crumbling factories and the poisonous environmental legacy of its forced industrialization period.

Amid the discouraging problems of Country C, it is comforting to see the way so many people place children first in their priorities. Schools are possibly the most stable institution in that society and one of few sources of cohesion. For the sake of sheltering the children from the ugliness of political and economic uncertainty, teachers and parents and community leaders make extraordinary sacrifices of time and effort. In a country where volunteerism was effectively suppressed for years, the unpaid and underpaid labor in schools is remarkable. And learning computer skills is clearly valued by educators and parents and business leaders. For them it is perhaps more obvious than in the more prosperous West that human capacity development is the best investment for economic survival.

Country C could be Poland or Russia or another European country emerging from the Soviet empire period. With some important differences, it could be the Republic of South Africa, which also has a wealth of natural resources, a highly educated work force, a history of

oppression and isolation from the rest of the world, and a major challenge to maintain national unity and political stability. One of the big differences is that the historically Black and so-called Coloured schools were hotbeds of unrest and still suffer from serious vandalism as well as from their long deprivation of books and other teaching materials. The first step in helping the schools in the Black Townships must be to increase their security -- Plexiglas windows with bars, metal doors -- so that new equipment or supplies will stay in the buildings.

> Black women who are community activists and volunteers in the Langa Township of Cape Town told me in August 1995 that what they needed most is to provide something in the school buildings that will hold the interest of adolescents not only during school hours but after school and on weekends. Now, the teenagers tend to hang out at video games parlors where they get involved with drugs and alcohol. Computers in a secured school environment could be equipped with entertainment programs for use after school as well as programs for mastering academic subjects and productivity applications. (Bradsher)

South Africans of all races seem to feel a sense of urgency in addressing educational inequity as an essential step in maintaining peace and unity. White schools now have sizable enrollments of black and brown children, and historically brown schools now include large numbers of blacks. But these efforts at integration are plagued by the legacy of Apartheid: the black children usually must travel long distance by bus, and their parents are unlikely to have any communication with the school. Teachers can't call the parents, most of whom can't afford a home telephone. Technology may address this problem. In gaining permission to offer cellular phone service in Cape Town, a private telecommunications company agreed to provide cellular service in the townships and areas of "informal settlement" (squatters' huts). It is possible to run a voice mail system in a school at very reasonable cost with a computer (preferably 486 level with large hard drive capacity), a data/Fax/voice mail modem (about $250 in the U.S.), and appropriate voice mail software (that included with the modem or a more expensive "automated attendant" package). With such a system in place, a parent could go to the cellular service van in the township and at minimal cost place a call to the number for his/her child's class. The teacher's recorded message could give announcements, including homework assignments, praise for good work. As with e-mail, this kind of asynchronous communication builds a sense of community across distance and cultural barriers.

Collaborative research projects that include a number of schools within an urban area may provide the kind of curriculum that can further the process of reconciliation among the racial groups that were forcibly separated for so long. In South Africa and many other Country C's (including many American cities), e-mail projects allow people to celebrate local achievements and distinctions while feeling pride in a larger unified whole.

IV. Policy Assessment

The scenarios emphasize local action with little involvement of national ministries. Ideally, an intervention to improve basic education would include support at the national level, as well as grassroots initiative and involvement.
A host government seeking help in beginning to use information technologies would be well advised to re-examine and consider changing certain policies that tend to thwart efforts to make effective use of technology in basic education, health, and other public sectors of an economy.

Since the information technologies provide benefits in many sectors, funding is likely to come from several sources. Cross-sectoral or inter-ministerial cooperation is important and virtually unprecedented. Typical policy barriers to anticipate include:

- acquisition rules that don't relate to current circumstances, especially when services, assets, and technologies cut across ministries;

- budgeting funds without "ownership," or allocation without full control. For example, ministries that contribute funds to a project but have no control are unlikely to exert leadership and may withdraw support completely;

- unwillingness to share or collaborate on the part of the dominant ministry. For example, the Ministry of Education is usually at the bottom of the hierarchy. The Ministry of Commerce (or Technology), charged with building the infrastructure or for reasons related to local manufacturing, is likely to impose the technology for education on the Ministry of Education without considering educational goals or objectives;

- content control may be a serious issue, especially in countries where freedom of the press has been limited or curtailed. It is almost impossible to censor domestic e-mail, much less the traffic on the worldwide Internet. Fear of freedom of expression may slow official approval to open channels of computer communication;

- opposition or stalling by the Ministry of Communications (The PTT (Post, Telephone, and Telegraph ministry) may have an especially hard time adjusting to or allowing a competitive market for telecommunications services because traditionally that ministry operates under a tariff model, in which some services are prohibited because no one ever did it before, or no price has been established. Data communications are not allowed in many places because officials don't know who to charge or how. Early on, it's important to find the person in telecommunications who can offer experimental licensing. Hidden rules are often encountered too late in the process);

- suspicion of external motives. Part of the resentment and obstacles come from the perception that this is yet another subtle way the developed countries will further their domination and keep developing countries in check by making them pay royalties and

keeping them totally dependent on expertise, know-how, and implementation. An appreciation is needed of a country's capacity and desire to develop its own expertise, such as wanting a local industry to assemble the technology; and,

- lack of experience with schools at the PTT. The new communications infrastructure will require a change in the way the PTT or private telecommunications companies do business with schools. Instead of talking about a high speed line (normal approach), discussion should be at a different level to explain the importance to learning of getting the line and of building the school system's internal data networks.

Two strategies are offered to help overcome such barriers:

- If no cross-sectoral agency or inter-ministerial planning department exists, such an entity should be formed, choosing people who command respect or can provide inspiration across bureaucratic lines. When people understand the value of the technology, through training or receiving new kinds of information, they will find solutions; and,

> In Israel, the chief scientist's office is the chief catalyst, perhaps equivalent to a chief technology person, who sometimes cuts across all these agencies. This office was instrumental in making the Harari commission work because it made the participating agencies talk to each other. (Kahn)
>
> National Councils for Science and Technology are involved in Chile and Peru, where we have seen the highest growth rate in Internet connections because the Ministry of Science and Technology has really pushed for that. In Mexico, they played a role, but more limited now since the work is now done. (Hernandez)
>
> Apple Computer is working on a health project in India in the rural areas, involving the Newton personal digital assistant, not traditional computers. The project's goal is to improve the data collection system for health workers. Each health worker serves 500 families each and has been working with an archaic system to collect data on paper, transfer data into journals, send the journals to regional centers, and finally get the data to the Ministry of Health. This paper-based system does not allow feedback to health workers to inform action steps to address needs. The Newton project involves collaboration among the Ministries of Health, Electronics, and Telecommunications to use different types of technology that are better suited to improve this flow of data. With the Newton, data are collected electronically, and within days the data are processed and fed back to the field. This is an example of what can be done when ministries collaborate. When the respective ministries understood the value of the technology, they began driving the process. (Hernandez)

- If part of the plan for using technology for basic education is to encourage microenterprise, such as the semi-private information centers in the scenarios for Countries A, B, and C, a necessary element will be financial assistance. Outside of the U.S., the cost of money is high, especially in developing countries. The entrepreneurial educator will need the collateral to get started. The solution lies with a ministry other than Education that can provide loans or other funds.

> "Offset Programs" are usually attached to large international defense sales/transactions, in which the foreign seller is required to provide other services. For example, if a country

commits to buy jets from France or a U.S. company, an offset requirement might be negotiated to provide other services. It's possible at the national level to bring in forms of finance useful in terms of importing technology. Banks seeking charters will be asked to set up types of low-end leasing programs. Ministries of Finance or Defense need to collaborate with education, in order to benefit that sector. In the organizational change process, a cadre of thought leaders or change agents could assume responsibility. The "best and brightest" sometimes take control; and if they shift to a new position, no one below is there to take over. You need participatory processes to sustain the activity and avoid a top-down control structure. Perhaps at the policy level, USAID could work with the Ministries of Education to help them understand different forms of finance models so that they could then seek inter ministerial cooperation. (Kelley)

V. Designing for Best Results

Designing an intervention for a real country, as in the scenarios for imaginary countries described earlier, begins with assessing needs and resources. Starting to use information technologies isn't really about buying computers; it's about helping people extend their abilities to communicate and solve problems. Since styles of communicating and problem solving are wedded to culture, the design of any learning system must be customized, not imported. In looking at the strengths of the local situation and culture, which institutions, individuals, and organizations should be considered?

A. Finding Potential Allies and Leaders of Change

USAID's work in education should not be restricted to or by ministries of education. Selecting and training the assessment team to map needs and resources may involve also NGOs, outreach centers, religious groups, rural extension services, health systems, local government structures, or some combination of those human resources. Of course teachers, school administrators, and parents must be included in making any plan that will affect them directly. Unless they are involved in decision making, damaging backlash reactions may defeat the goals of the project. The students themselves, even young children, are stakeholders, not just consumers. Their active involvement in some of the planning can help assure success. At the school level, teachers to participate in the planning and implementation should include subject area specialists and English teachers, as well as the technology expert on the faculty.

Universities might be overlooked in a project for basic education. University faculty often play a key role as change agents because they have a broader view of the world and often are the first to use computers. The first and only Internet access point in many countries is probably the universities.

The Peace Corps and foreign students studying abroad could be a useful resource. Part of their program might be as an intern with a USAID field mission to bring in their knowledge of Internet and add the human element to a training program in Internet use. Through various exchange organizations, young people gain experience and could be a great resource. By tying into school-to-work programs, such students could have valuable work experiences, not just serving as au pairs or doing other domestic chores. In many parts of the U.S., even very young students are proving to be effective trainers of both peers and teachers.

As a link to the private sector, the equivalent of the Small Business Administration might be useful, as well as the U.S. Chamber of Commerce international division, the AACLA in Latin America, and equivalent organizations in Asia and Africa, along with their local affiliates or counterparts in target countries. Cooperative organizations, such as CLUSA (Cooperative League of the USA) might have a marketing stake to be considered. Rotary International and the Sister Cities program mobilize volunteers in the U.S. as well as partner nations. Local chapters of the

YMCA and YWCA may also prove helpful, as may professional associations, such as the IEEE (International Electrical and Electronics Engineers), which have large global memberships and relevant skills.

Commercial American telecommunications companies -- MCI, AT&T International, Sprint, RBOCs (Regional Bell Operating Companies such as Bell Atlantic and NYNEX which now have subsidiary operations abroad) -- will be natural allies. They deal directly with telecommunications officials. Enlisting their support can provide effective leverage; they may be able to offer something in the process. However, working with commercial firms carries the risk that the whole intervention may appear to be exploitative.

Specific ministries may have developed their own EMIS (educational management information systems) mainly for internal training purposes, but these are rarely centers for innovation. The staff may have excellent computer skills, but they often are isolated from the decision makers, and their focus is on the machines more than on education. Still, among them may be allies with influence.

B. Promoting the Vision as Part of the Design

The actual project design, based on the assessment of needs and resources, should include steps for building awareness by establishing models and using them to show others how technology can help. It is vital to identify and appeal to the self-interest of potential leaders and users. Promoting the vision should be part of the project design and built into the budget.

> Start with awareness activities, videotapes, opportunities for entry-level awareness experience, how to get on-line for the first time, a newsletter component of successful uses, a scalable model, storytelling, Include self-directed on-line free lessons. CD-ROMs can show people what an off-line reader looks like, how to go to a World Wide Web site. Through demonstrations of delivered on diskettes, people can see an example of telecommunications with an off-line reader and quickly get the idea. (Odasz)

> Rather than telling them what they might want to do, I have a firm belief in raising awareness of potential possibilities. Then they will think of their own applications and buy into it:. We deliver technology, but they decide how to use it. (Hill)

For sustainability, the design needs to include a revenue-generating component. If the entrepreneurship model is followed, it may require training and supervision to avoid corruption. Ideally, the revenue-generation should be inclusive, allowing for multiple partners, and should be minimal cost and volunteer-based. In this way, it's possible to build communities within communities.

C. Cost/Benefit Considerations

Setting up small projects as models of success can build a shared vision within an area. Then, managing growth of a regional or national project becomes the big challenge. It is not

easy to predict the rate of growth of computer communications systems. Time and again in the U.S., planners in both the public and private sectors have been caught unprepared for sudden huge spurts in the number of people gaining access to a network or to the Internet. Even with help from people who have been through this process, the growth of infrastructure is likely to be uneven. At each stage of growth, there will be many choices and a large need for technical assistance in laying out the options: Which hardware configurations can do what for us? Without constantly revisiting the goals of the community, it's all too easy to spend out of all proportion to benefits.

Just as it would be unkind to give a very poor man a car that guzzles more gas than he can afford, building a sustainable network to support basic education means keeping the ongoing costs low. It has become common to subsidize use of an innovative technology to give consumers a taste of it, and then to start charging what the market will bear. This was the history of Bitnet, a service to universities around the world that was free of charge only for the first two years. Similarly, the practice of letting schools piggyback on the flat-rate institutional subscriptions of universities is now giving way, as the institutional rates rise, to passing on a share of that cost to the schools. In California, Pacific Bell is offering free installation of high speed wide band (ISDN) lines to schools and free use of the lines for a year or more. But what will be charged after the year? Designing a system to be self-supporting from the beginning is far more fair. In developing countries, this probably means ignoring the latest developments, such as some of the razzle dazzle under development for the World Wide Web, in favor of older-fashioned dial-up e-mail.

All of these considerations argue for a modular approach with some flexibility and opportunities for course correction built in. The investments with the most long-tenn benefits are in training people, who continue to grow once launched on a path that promotes self-education. Hardware, which seems especially prone to obsolescence. Training can include a range from informal demonstration centers to accredited courses for technicians. Perhaps most cost-effective is training for those who would otherwise be most likely to resist change, namely, powerful people and their children. Such training programs should be as open as possible across sectors. Quibbling about which ministry is funding or being funded is self-defeating when one of the biggest goals is to promote cross-sectoral cooperation.

Leveraging local support is also a good strategy; the more people buy in, literally, the greater their stake in the outcome and the less likely they are to waste money on nonessentials. Partners to match or partly match USAID funds could include local NGOs, international service groups like Rotary, commercial companies or subsidiaries of foreign companies that can be persuaded to kick in seed money. The partners' investment may well be in-kind contributions, a form of barter, rather than in cash. Small grants to small NGOs often produce tremendous results relative to the cost because they inspire so much volunteer labor and sweat equity and allow little waste.

D. Change Takes Time

The transformation of any group, dispersed or concentrated, into a computer-using community is likely to take several years. Everyone who has studied the phenomenon is familiar with the "early adopters" and the "laggards." The former are self-starters who require little training themselves and become evangelists almost immediately. The laggards will resist every blandishment until there is no escape. The majority of teachers, regardless of nationality, will take gradual steps (2 to 5 years) from being a tentative user of the technology as a supplement to someone who has integrated it and is moving toward a new way of teaching. This progression requires a lot of guidance and structured experiences on on-line systems. Much of that guidance and experience can be delivered through self-paced instructional materials -- on video, on diskette, on audio-cassette, on-line -- but some human contact, in person or an on-line buddy or mentor, is an essential ingredient to keeping motivation high enough to weather frustration and foster persistence. One on-line mentor can support many neophytes -- once they get on-line. That first connection is the hardest and most intimidating part, a kind of initiation ritual that seems for most people a confirmation that they have indeed passed into a new world and that they are capable of learning all about it.

> A recent effort in Australia identified those steps as follows: at first people are observers, then downloaders, then users, then take the first steps of introducing themselves and their own ideas. By the end of the second year, they are ready to participate fully. It takes another three years to become a real leader and creator. (Gragert)

Small-scale pilot projects, even if not sustainable on their own, can make a big impression if they are very successful and the right people, such as national leaders, are watching. Through trainer-of-trainers pyramids, networks can grow rapidly. If the pilots are self-scaling, growing sustainably on their own, the critical mass to trigger widespread change may be quite small. In Spain, 5-20 satellite schools were involved, drawing in parents and others in the surrounding communities. The impact was phenomenal despite the rudimentary hardware.

> Recall that in Chile, only 3 schools were targeted in the first year; 10 in the second, and now there are 150 schools on the network. This project expanded effectively outside the center and now is self-sustaining. (Hernandez)

> You need to start with a minimum buddy system for support to the community. Starting with 5 to 20 teachers, which grows by planning scale properly, and including key people, it can grow from a few hundred to thousands of teachers over three years. The key group needs to be plugged into other networks. If you have a leverage model with a finance capacity, you have an engine with potential to perpetuate itself. (Kahn)

E. Evaluation of Results

Evaluation should be an integral and ongoing part of project design and should be tied to the stated goals of the project. Deciding on those goals becomes critically important. In formal education, it is common to use standardized tests or exams based on national standards as the framework for setting goals and performing evaluation. This may not be wise for the basic

education and new delivery systems discussed in this report. Students' test scores as compared with a control group may not necessarily show marked improvement. Such tests often measure mastery of selected trivia that can be learned just as thoroughly without technology. Raising scores on tests that measure a small element of human capacity would not be an appropriate goal for a project like this one. It is also difficult to design tests free of cultural or national bias. Often, the most significant changes in areas like teaching style are hard to quantify.

> Lessons learned are an important piece in the evaluation plan. These might present benchmarks, some of which are stories rather than numbers. It's important to clarify what is being measured against what. The practice and goals of education may be different than what we do in the U.S. (Fulton)

> Evaluation has been a big part of BIG SKY TELEGRAPH: how many people log on, the length of messages, etc., but you cannot measure the degree of collaboration and information sharing. Networking alone is an elusive success; you need anecdotal evidence. Ask the local people to develop new assessment methodologies and measurements. At the outset, can ask community members (what would constitute success in meeting their expressed need). (Odasz)

Nevertheless, there are many quantitative indicators that can be built into an evaluation plan, depending on the goals of the project:

- If one of the goals is to build a mechanism for self-supporting continuation of the project, there will be financial indicators of degrees of success, such as income from the sale of services or use of equipment. These indicators will help answer crucial questions: Will a significant number of people value the service enough to pay for it? How long is it likely to take to pay back an equivalent investment to duplicate the pilot project in a different location? Is the enterprise earning enough income to pay for its own long-term maintenance?

- If democracy building is a project goal, numbers of participants are important indicators. How many people participated in planning meetings, answered surveys in person or by mail? How many people have requested or received information, sent messages, attended training sessions, come to an information center to use its library of printed materials or software?

- If increasing adult literacy is a goal, how many adults are taking advantage of the opportunity to learn to read? What is the drop-out rate? Has there been an increase in the number of students? What level or rate of progress do they report about themselves?

- Probably one goal is developing a cadre of people skilled in using computers for common business tasks or for finding and retrieving information. It is possible to track automatically the use of computers and telecommunications systems in great detail -- number of users, time spent by each, even the number and kind and speed of keystrokes. The number of people gaining employment with these skills and their level of compensation are also good quantitative indicators. People whose acquisition of computer skills led directly to a higher paying job are the best kind of advertisement for learning at an information center or school computer lab. The number of such people and

whether the number is rising helps predict sustainability.

- The cost-benefit ratio also deserves attention. How many people have benefited from the investment to date? After an initial large outlay for equipment, the ratio may look better and better over time. For the next implementation, in a different location, can that cost/benefit ratio be improved by a different choice of hardware, software, or training method?

Review of the qualitative and quantitative results should be ongoing, designed to inform course corrections for the next implementation or decisions about when or whether to phase out support from USAID. Comparison of results of grants given to different groups or NGOs and comparisons of USAID's results with other donors also indicate success or need for improvement. If a project is modeled on an earlier effort, matching or exceeding its most salient success may provide a precise goal.

> At a program level, it takes experience to develop a deeper understanding of what an indicator of success means -- of notions of process improvement. In the field missions, there is a lot of intellectual capital based on experience, involving views of success over time. Through connectivity, the missions might start the equivalent of a virtual "quality circle," that is, gather notions of success among people from different countries and negotiate what the common elements of success are. In areas of consensus, focus dialogue around a matrix and indicators. This process will help guide program designs. (Kelley)

F. Best Uses of USAID's Strengths

USAID's greatest inherent strength is its field missions in so many countries. The agency could perform a great service by creating a clearinghouse of information about the experiences of various countries in designing and implementing technological interventions in support of basic education. What has worked? What has not? What factors were most critical? The more case studies of actual experience available, the more likely someone perusing such records could avoid re-inventing wheels or making common, avoidable mistakes.

What's more, people embarked on this transformation to the Information Age society seem to feel a great need to share their stories, whether of success or of frustration. (The frustrations are as instructive as the successes and so should not be called failures. Today's seeming failure may be just a very slow-moving success!)

Providing on-line access to the clearinghouse data base and other information resources would be an appropriate way to build awareness and to promote the vision as well as to disseminate the data. USAID also might consider funding the development of training and awareness-building materials in various languages and media, including print materials and manuals, videos, software, and sets of such materials available on-line.

The training effort needs to begin with USAID staff in Washington and in the field, many of whom have not had the essential hands-on experience they will need in designing programs using technology.

VI. Summary

Many countries in the developing world are eager for a second chance in the world economy. They never quite caught up with the leaders in the Industrial Age, and their problems grow more urgent every day. Jumping directly into the global information infrastructure offers hope, an end to isolation and a chance to try new tools that may actually bring improvement in the standard of life or at least stop a downward slide into intractable poverty, misery, and violence.

As exciting as the new technologies are, there is no one-size-fits-all solution or formula for success. Project design must reflect local needs, strengths, and self-interest and, from the beginning, endeavor to put the tools in the hands of the local people and empower them to build a self-sustaining system. This is the essence of human capacity development, more an issue of training and awareness than of hardware or software. The HCDC has already made important discoveries about how to encourage positive social change in developing countries through its earlier social marketing programs, there are principles that can be applied to this new area of improving basic education through computer-based information systems. The HCDC Weekly On-line now offers different program descriptions and raises points for discourse and dialogue, starting to create a reservoir of on-line information and a vehicle for building a stronger sense of community among missions and across sectors within USAID. This reservoir could be the beginning of a unique clearinghouse for specialists in aid to developing countries.

Mark Twain once remarked, "I love progress! It's *change* that I hate." Don't we all? Change is painful, especially changing one's own habits. For officials in most developing countries, changing from the long-established top-down, centralized, imperial style of governing to a more democratic one, influenced by community leaders and private commercial initiative will seem dangerous and destabilizing, especially since that kind of change inevitably will limit their own prestige and personal privilege. A shift in the direction of empowering people to educate themselves and thus earn their own keep seems the best hope of survival for many countries.

USAID can draw on experience in many countries and, thus, is in a position to evolve multilateral approaches, to broker agreements among countries, to help governments make hard choices, and, especially in countries whose governments can't bring themselves to make those choices, quietly to encourage NGOs, teachers, and others who want to develop their own potential with the help of technology. By addressing the dilemmas of cross-sectoral budgeting, administrative responsibility, and managerial control within USAID itself, the agency is developing as a pioneer able to advise foreign governments faced with the same new issues presented by the information technologies.

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