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The Roles of Information, Communication, Technology, and Education in Achieving the Millennium Development Goals: Toward an African Knowledge Network

A Research Report in Support of the Millennium Villages Project and the People of Sauri, Kenya

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The Roles of Information, Communication, Technology, and Education in Achieving the Millennium Development Goals:

Toward an African Knowledge Network

Executive Summary for the People of Sauri

"Information is Power." This is the succinct yet resonant slogan of Joseph Sekiku's Family Alliance for Development and Cooperation (FADECO) Community Telecenter in Karagwe, a rural village in northwestern Tanzania. Information and power, as much as money, distinguish the developed from the developing world. The Western World has much of all of these; Africa has little of any of them. Yet in the face of this hardship and financial scarcity, the FADECO slogan recognizes that it is information and the knowledge to use it that will empower Africans to lift themselves out of poverty. As the head of a rural village in Senegal asserted, "Our most basic need is information, knowledge" (Mchombu, 2004; p. 31). When considering alternatives, an elder in a neighboring village proclaimed, "If you give me a choice between money and information, I will choose information" (Mchombu, 2004; p. 31-32).

These are among the stories that farmers in rural East Africa told me of how information contributed directly to their economic and social improvement:

- A Ugandan farmer on the northern shore of Lake Victoria used to produce ten 100 kg sacks of maize per acre on his farm. When he learned how to use manure as fertilizer, he increased the productivity of his farm to twenty sacks per acre.

- Another Ugandan maize farmer used to broadcast his seeds in the spring planting. When he learned to plant in straight lines and space his seeds, his productivity went from two bags per acre to ten bags or more.

- In a rural market in northern Tanzania, a buyer offered a maize farmer TzSh 2,800 per 100 kg sack. Because he knew the going market price, the farmer refused the offer and was able to get TzSh 3,200 per sack. With the 14% difference he was able to purchase sheet metal for a roof on his house.

- Another Tanzanian farmer was offered TzSch 2,500 per 20 kg basket of her chick peas. Because she knew the market price she was able to negotiate TzSh 4,000 per basket. With the 60% difference, she was able to pay her daughters' high school fees.

Each of these villagers was a user of a community telecenter, one of seven I visited in East Africa. Computers were available in all these centers. But bicycles, books, cell phones, radios, video tapes, and the internet were among the technologies that villagers were using to acquire information and improve their lives.

In this report, I examine the role of information, communication, technology, and education to empower African communities to pull themselves out of poverty and launch sustained development. I consider the information, communication, and education needs of African villages and identify the most appropriate and least expensive technologies that can meet these needs. The primary audience of my report are you, the people of Sauri, who are working with the MVP on action plans to pull themselves out of poverty, including the development of a community learning resource center.

My findings and recommendations are based on interviews with the people of Sauri and discussions with teachers at the Bar Sauri Primary School. Also, I met with policymakers, NGO staff, and the managers of various ICT projects and programs, in Kenya, Uganda, and Tanzania. And I interviewed managers, staff and users at seven community telecenters and one school-based ICT center around Lake Victoria in Uganda and Tanzania.

Given the significant financial and technical constraints in Sauri, I propose a development trajectory for the learning resource center that will meet some of the community's most important informational needs with minimal cost, yet grow with the community's emerging experience, developing skill base, and increasing resources, as the MVP scales up. I approach this architecture from both technological and social perspectives.

Technological Trajectory

Step 1: Library and museum. When I was in Sauri, the Education Committee had recently received a set of books from the government, as an initial response to their proposal for a community learning resource center. The books, some in English and some in Kiswahili, were on topics that ranged from malaria and microfinance to livestock breeding and mathematics for adults. This is a highly appropriate way to start the community learning resource center. I recommend that the Committee think of the center in its early phase as a library and museum—a location for collecting and sharing information and cultural artifacts that are valued by the village. This approach to the early implementation of the center requires little or no electricity and only a limited

investment—a facility to store, share, and use informational materials and cultural resources.

Step 2: Audio-visual center. As the community learning resource center becomes established, electrical power becomes available, and the text collection grows, the emphasis can gradually shift to include a broader range of technologies and resources. The addition of a copier would allow people to take away the specific pages or sections of print material that are most useful to them. A radio receiver and/or audio tape player can be particularly useful to non-literate villagers. A video tape player can make it easier to learn about processes and procedures related to farm practices, health, nutrition, water harvesting, or other everyday applications of knowledge that benefit from visual information forms. These technologies also have the advantage of being modestly inexpensive, requiring little technical skill to operate, and needing electricity only as they are used. As the resources and skills of the community increase, the center can purchase video recording equipment. This would allow the emerging community experts to create video productions to teach and preserve the local culture.

Step 3: Community radio station. The establishment of a community radio station would be a significant leap in building the capacity of the center. Initially, the station can be launched with a less-expensive, low-wattage transmitter. But as the MVP scales and the village becomes a information and communication hub for the area, the wattage and coverage can be increased. A special committee can be formed of radio "supporters" that can solicit programming ideas and on-air volunteers from the community and review the quality of the programs. Volunteers broadcasters can be drawn from the center's special interest groups and the volunteers can, in turn, draw on the center's growing information resource base in the production of their programs.

Step 4: Remote mini-centers. As the center grows in size and the MVP scales up, there will likely be an interest within these villages to see the center expand its service area to remote sites in outlining areas and ultimately become the information and communication hub for the growing network of Millennium Villages nearby. This will be most easily done through the community radio station. But as the center at Sauri gets computers and, ultimately, Internet access, it can share these resources with the remote sites by printing out the results of remote user custom-ordered web searches or by eventually using a wireless transmitter to distribute Internet access to the sites.

Step 5: Computer Center. As the center generates more income, the Committee may chose to purchase multimedia computers. The cost of these can be minimized by the purchase refurbished equipment and the cost of new computers will continue to come down over the coming years. Having even one computer provides the community with access to a significant new source of information. CD-ROM reference and educational

works can hold much more information that on a book and at a much cheaper price. And the use of application packages, such as a word processor and spreadsheet, can come to support the improvement of farm productivity and the development of small businesses.

Step 6: Internet knowledge center. Internet access, particularly access at a relatively high speed, is one of the most expensive additions the center can acquire. But over the next few years, Internet access will become increasingly affordable and available in rural areas. The expense may be further minimized by sharing bandwidth and its associated cost with nearby organizations. Its impact can be maximized by distributing access to a growing set of remote sites throughout the area, as the MVP scales up. The deployment of this technology can significantly extend the information resources of the center, much more so than any other acquisition. Internet access makes the World Wide Web and its vast informational resources on millions of topics available to the community. The community's increasingly sophisticated users can use the Web and the Internet to search for information, share files, send email, and join discussion groups. As the users' technological sophistication grows, the center can establish a website for the community by which the community can share its ideas, products, and culture with other communities and the outside world.

Social Structure

Step 1: Creating a social space. In its initial phase, the community resource center should be structured not only as a place to collect and disseminate information and cultural artifacts but as a place where people can congregate for lectures, formal meetings, and casual gatherings are held. It can serve as the community's social as well as an informational hub where the collection, creation, and person-to-person sharing of knowledge take place. It can be the locus of the community's cultural events and demonstrations of traditional practices. The Education Committee can work with other Millennium Village committees to form focus groups of "information enthusiasts" with special interests (e.g., farming, handicrafts, starting small businesses, etc.) similar circumstances (e.g., women, out-of-school youth, adult learners). These groups can meet at the center, help the Committee identify informational needs, locate and collect informational resources, and support each other's learning. The Committee can solicit volunteer "readers" within the community, who can make the center's text information available to non-literates and improve their literacy skills.

Step 2: Hiring a manager. In its early days, the center can be launched and initially run without a formal staff, with community volunteers operating the facility. However, in order for the center to grow and reach its potential, a manager will need to be hired. I recommend that Sauri look for a person with strong technological skills but also a

commitment to rural development and a vision of the center not as a technological resource as much as it is a facility that serves the informational needs of the community. To make the position attractive with few available funds, the Committee should work with candidates to investigate additional arrangements that supplement the manager's income. The manager's salary can also be complemented by other benefits, such as meals supplied by community volunteers or free housing. As the Committee plans for the construction of a permanent facility for the center, they should consider including an apartment for the Manager.

Step 3: Building an organization. The chief goals of the manager will be to build the informational and technological resources of the center, as well as its organizational structure. With a constrained staffing budget, as was the case in all of the centers that I visited, the manager of the center had to augment the paid staff with volunteers. Initially, all the staff may be volunteer help. The manager should build on the Millennium Village committees and their interests to create a more formal schedule of operations, with volunteers helping at certain days and times to collect, catalog, organize, and distribute resources and help users. The manager will also need to build the technological resources of the center, following the trajectory above, as modified by opportunity and constraints. As the center establishes a radio station, acquires computers, and connects to the Internet, training will become a very important activity. Initially, the training will focus on volunteer staff and their operation of the increasingly complex technology. Subsequently, the volunteer staff can provide training, either in organized classes or on-the-spot, to other users. As the resources and the budget of the center grow, volunteer staff may be supplemented by one or two paid staff, such as assistants, janitors, or guards.

Step 4: Producing and sharing local knowledge. As experience and resources grow, the people of Sauri will increasingly move from information consumers to knowledge producers. As Millennium Village committees implement their plans, they will learn from the results. The center can be a place where this local knowledge can be shared, initially with others in the village and the neighboring Millennium Village cluster, ultimately with the clusters of MVP villages in other regions and countries. This will probably first occur with the programming for the community radio station. With additional resources and skill, the community can produce video tapes to share what they have learned and preserve the local culture. As the center acquires computers and Internet access, these resources can be employed for the production and sharing of local knowledge. As the MVP scales up and other centers develop their technological capacity, Sauri can share what they learn with other communities and benefit from their best practices.

Step 5: Making it sustainable. The growth and ultimate sustainability of the center will be directly associated its ability to bring in resources, particularly money. This will mean that marketing will be an important role of the Manager. There are three types of markets: individual users, organizational users, and organizational donors. Clearly it is difficult for a poor community to pay for all of its information, communication, technology, and education needs on its own but the manager's goal should be to maximize the local income by maximizing the value of the center's services to local individual and organizational users. Income can also be generated from organizational users, such as local NGOs, businesses, hospitals, or schools by giving their staff or students access, sometimes priority access, to the equipment or other resources of the center. In other cases, organizations can be charged a set fee for a special service, such as training. Managers also reduced their cash outlay by sharing the cost of resources with local organizations, such as sharing Internet bandwidth and the monthly tariff with a local organization or business.

Finally, the organizational and marketing practices of the telecenters at Nabweru, Nakaseke, and Karagwe are models for the Sauri Education Committee and the future Manager of their community center. I recommend that a subgroup from the Committee visit these centers to learn from these practices first hand and to establish ongoing relationships for mutual support.

Conclusion

In his remarks to the World Summit on the Information Society, UN Secretary General Kofi Annan (2005) called for the application of information and communications technologies that benefit the economies and societies of poor countries and transform the lives of poor people. He called for an information society in which human capacity is expanded, built up, nourished and liberated, by giving all people access to the tools and technologies they need, and with the education and training to use them effectively. The development of a community learning resource center in the sub-location of Sauri, Kenya can serve as a model for how information, communication, education, and technology can develop human capacity so that rural citizens in Africa can increase agricultural productivity, improve the health and nutrition of their families, create a sustainable environment, and generate business opportunities. The development of an African Knowledge Network can expand this capacity to all of rural Africa and help these communities lift themselves out of poverty. By supporting these developments, the Millennium Villages Project, the Millennium Center, and national government policies in Sub-Saharan Africa can make major inroads to achieving the Millennium Development Goals and the goals of Education for All.

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Toward an African Knowledge Network

Executive Summary for the Staff of the Millennium Villages Project

Economists attribute much of the dramatic growth in the world's economy over the past several decades to the role that information and technological innovation have played in driving economic productivity. In the developed world, the production, distribution, and use of new information and technological innovations have been major contributors to increased productivity, the upgrade of physical capital, and the creation of new, high-value-added jobs. These increases in human, institutional, and technological capabilities are, in turn, major sources of new knowledge and innovation which then feed economic growth. Thus investments in information, communication, technology, and education have created new knowledge that has spawned a virtuous cycle of economic and social development. But can information, communication, technology, and education play this same role in supporting development in Africa, a continent where 300 million people subsist on less than a $1 a day?

In this report, I examine the role of information, communication, technology, and education to empower African communities to pull themselves out of poverty and launch sustained development. I consider the information, communication, and education needs of African villages and identify the most appropriate and least expensive technologies that can meet these needs. The primary audience of my report are the people of Sauri, Kenya, who are working with the MVP on action plans to pull themselves out of poverty, including the development of a community learning resource center. I make recommendations for information architectures that will support the development goals of the people of Sauri, as well as recommendations to the staff of the Millennium Villages Project, and to national and multinational policy makers.

My findings and recommendations are based on interviews with the people of Sauri and discussions with teachers at the Bar Sauri Primary School. Also, I met with policymakers, NGO staff, and the managers of various ICT projects and programs, in Kenya, Uganda, and Tanzania. And I interviewed managers, staff and users at seven community telecenters and one school-based ICT center around Lake Victoria in Uganda and Tanzania. Computers were available in all these centers. But bicycles, books, cell phones, radios, video tapes, and the internet were among the technologies that villagers were using to acquire information and improve their lives.

Based on my research, I recommend a development trajectory for an information architecture that would move the community learning resource center in Sauri from a library and museum, to audiovisual center, to community radio station, to computer center, and finally to Internet knowledge center. And I make recommendations for the development of a supporting social structure that would take the community from information enthusiasts to knowledge producers and turn the center into an information and communication hub of the growing cluster of Millennium Villages in the Sauri area.

I also recommend an information architecture for the Millennium Villages Project and the Millennium Center. Scaling-up is the 900 pound gorilla of the MVP. ICT can help, as the Project works to move from the two initial villages, to a total of twelve research villages, and then to clusters of villages around these that eventually total tens of thousands of villages with a population of a half billion people. There are two overlapping ways that the MVP can use ICT to advance its goals: 1) work with villages, governments, and agencies to build an African Knowledge Network that supports economic and social development and 2) create an international research network in support of its own operations.

Building an African Knowledge Network

If hundreds of millions of people are ultimately going to be helped by the MVP, it will be because Africans themselves are mobilized in the cause of their own development. This, of course, is the goal of the Project. ICT can serve as the glue that integrates all of the goals in Sauri and other Millennium Villages related to poverty, hunger, health, environmental sustainability, and education and connects the villages to the project, to each other, and to the world. As such, the development of ICT resources within the MVP villages should be given the highest priority for it is through information, communication, and technology that all of the other goals will be accomplished. The development of ICT capacity in the villages can be advanced significantly if the MVP creates an African Knowledge Network. This Network would have three components:

1. Priority support for the development of community centers within each of the 12 research villages.
2. Creation of an African Knowledge Network Portal.
3. Work with national governments to create pro-poor telecommunications policies and infrastructure programs.

Creating an International Research Network

Research is an important function of the Millennium Villages Project. The interventions that you propose for adoption by villages are posed as research hypotheses. A significant activity of the Project is to collect and analyze data that will establish the effectiveness of these interventions, an activity that is distributed between Columbia University, the Millennium Center in Nairobi, regional MVP research offices in various countries, and the rural villages. This is a significant challenge for the Project, particularly as it scales up. ICT can help here, as well. The Project can start its ICT work by establishing an international research network among its various offices and at the same time lay the ground work for the African Knowledge Network. The infrastructure that connects the Earth Institute and the Millennium Center with the regional field offices can be the same infrastructure that ultimately connects the headquarters with the villages and the villages with each other and the world. This network can also house a second, password-restricted portal that serves to coordinate the discussions and activities of research teams through the distribution of instruments, the monitoring of progress and quality, the collection of data, and the dissemination of findings. Furthermore, the findings of the project could also feed into the African Knowledge Network Portal.

Conclusion

In his remarks to the World Summit on the Information Society, UN Secretary General Kofi Annan (2005) called for the application of information and communications technologies that benefit the economies and societies of poor countries and transform the lives of poor people. He called for an information society in which human capacity is expanded, built up, nourished and liberated, by giving all people access to the tools and technologies they need, and with the education and training to use them effectively. The development of a community learning resource center in the sub-location of Sauri, Kenya can serve as a model for how information, communication, education, and technology can develop human capacity so that rural citizens in Africa can increase agricultural productivity, improve the health and nutrition of their families, create a sustainable environment, and generate business opportunities. The development of an African Knowledge Network can expand this capacity to all of rural Africa and help these communities lift themselves out of poverty. By supporting these developments, the Millennium Villages Project, the Millennium Center, and national government policies in Sub-Saharan Africa can make major inroads to achieving the Millennium Development Goals and the goals of Education for All.

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Executive Summary for National Policymakers

Economists attribute much of the dramatic growth in the world's economy over the past several decades to the role that information and technological innovation have played in driving economic productivity. In the developed world, the production, distribution, and use of new information and technological innovations have been major contributors to increased productivity, the upgrade of physical capital, and the creation of new, high-value-added jobs. These increases in human, institutional, and technological capabilities are, in turn, major sources of new knowledge and innovation which then feed economic growth. Thus investments in information, communication, technology, and education have created new knowledge that has spawned a virtuous cycle of economic and social development. But can information, communication, technology, and education play this same role in supporting development in Africa, a continent where 300 million people subsist on less than a $1 a day?

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My findings and recommendations are based on interviews with the people of Sauri and discussions with teachers at the Bar Sauri Primary School. Also, I met with policymakers, NGO staff, and the managers of various ICT projects and programs, in Kenya, Uganda, and Tanzania. And I interviewed managers, staff and users at seven community telecenters and one school-based ICT center around Lake Victoria in Uganda and Tanzania. Computers were available in all these centers. But bicycles, books, cell phones, radios, video tapes, and the internet were among the technologies that villagers were using to acquire information and improve their lives.

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I also make recommendations to national government for policies that can support local rural development that, in turn, contributes to national economic and social development goals. Improvement at village-level is predicated on national and multinational policies and programs that provide the enabling environment for these developments—policies related to economic development, food security, water safety, health, education, and environmental sustainability. I provide suggestions for national telecommunications and education policies and programs that can support local development. I concentrate on two areas most relevant to my research.

Telecommunications Policies and Programs

As documented in this report, information is vitally important to rural villages in Africa for the improvement of their food production, health, education, and environmental sustainability. Community telecenters can be a significant way of communicating this information to rural villages and generating and sharing local knowledge about best practices. Policies that would enable the use of information, communication, and technology to support rural development include those that:

- Promote the development of local content and encourage the use of local languages in content development, particularly as a way of preserving the knowledge and culture of traditional communities.
- Provide for community broadcasters whose programming addresses grassroots issues, such as development, education, health, environment, and local culture.
- Allow V-SAT service providers to offer broadband access to rural and underserved areas and give special consideration to those that provide public services, including tele-education and libraries.
- Open up frequencies for public use of wireless services, such as Wi-MAX.
- Integrate information technology into the teaching curriculum at all levels of education.
- Provide assistance for the disadvantaged, women, and youth to acquire ICT skills.

Programs that support the implementation of these policies include those that:

- Provide funding for the establishment of community telecenters in rural areas that can serve as local information hubs—libraries, post offices, radio stations, computer centers, and internet access points.
- Dramatically reduce or eliminate licensing fees for community radio stations.
- Provide funding for the development of broadcast and digital content in the national and local languages that is most needed by rural communities to support their development, content related to farm practice, health, water safety and sanitation, and small business development.

Education Reform Policies and Programs

The future of Africa will depend on the development of its human capacity—the ability for citizens to take up and apply new ideas and technologies. Through education people can acquire the skills they need to provide for themselves, contribute to the health and welfare of their families and communities, solve local problems, and grow the local and national economy. Yet in many African countries fewer than 70% of school-age children reach 5th grade, in some countries it is fewer than 60% (World Bank, 2005). In most African countries fewer than 30% of appropriate-age youth are enrolled in secondary school. The figures for girls' enrollment are even lower. Furthermore, education in many countries is too often merely an exercise that may prepare students for more education but does little to prepare them for the real world. Increased enrollment is important. But universal primary education will not contribute to solving Africa's problems if students leave school without the skills they need to contribute to their community and country.

National education policies can contribute to economic and social development include those that:

- Change the curriculum to emphasize the deep understanding of subjects (rather than memorization) and the application of this knowledge to solve complex problems that students are likely to encounter in the real world.
- Encourage student-oriented teaching practices that introduce the concepts and principles of a subject in the context of real-world situations and that engage students in the application of knowledge in the real world.
- Change assessment tasks to reflect real-world situations and use these tasks both in the classroom to provide students with feedback on their progress and on examinations to measure student achievement and instructional effectiveness.

The implementation of these recommendations requires a fine balance between classroom sizes that are large enough to achieve enrollment targets but small enough to allow for student engagement and interaction in the classroom.

Again, ICT can support the implementation of these policy goals. Given the growing importance of ICT in out-of-school situations, the introduction of ICT skills into the curriculum is a goal in itself. But ICT can also play a role in education reform. Technology can be used to support the deep understanding of school subjects and the application of these in real-world like situations. It can support the use of complex assessment tasks as for student feedback and examinations. And it can connect students and teachers to those in other schools and other countries and to vast informational resources on a variety of school topics. Used in these ways, ICT can both support education reform and connect it to economic and social development goals.

Conclusion

In his remarks to the World Summit on the Information Society, UN Secretary General Kofi Annan (2005) called for the application of information and communications technologies that benefit the economies and societies of poor countries and transform the lives of poor people. He called for an information society in which human capacity is expanded, built up, nourished and liberated, by giving all people access to the tools and technologies they need, and with the education and training to use them effectively. The development of a community learning resource center in the sub-location of Sauri, Kenya can serve as a model for how information, communication, education, and technology can develop human capacity so that rural citizens in Africa can increase agricultural productivity, improve the health and nutrition of their families, create a sustainable environment, and generate business opportunities. The development of an African Knowledge Network can expand this capacity to all of rural Africa and help these communities lift themselves out of poverty. By supporting these developments, the Millennium Villages Project, the Millennium Center, and national government policies in Sub-Saharan Africa can make major inroads to achieving the Millennium Development Goals and the goals of Education for All.

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Introduction

"Information is Power." This is the succinct yet resonant slogan of Joseph Sekiku's Family Alliance for Development and Cooperation (FADECO) Community Telecenter in Karagwe, a rural village in northwestern Tanzania. Information and power, as much as money, distinguish the developed from the developing world. The Western World has much of all of these; Africa has little of any of them. Approximately 70% of people in Sub-Saharan Africa are poor (Sacks, 2005). More than 300 million live in extreme poverty; they barely subsist on less than $1 a day. Another 200 million live on between $1 per day and $2 per day. Life expectancy is only 47 years and each year more than a million children die of malaria.

Yet in the face of this hardship and financial scarcity, the FADECO slogan recognizes that it is information and the knowledge to use it that will empower Africans to lift themselves out of poverty. As the head of a rural village in Senegal asserted, "Our most basic need is information, knowledge" (Mchombu, 2004; p. 31). When considering alternatives, an elder in a neighboring village proclaimed, "If you give me a choice between money and information, I will choose information" (Mchombu, 2004; p. 31-32).

Economists attribute much of the dramatic growth in the world's economy over the past several decades to the role that information and technological innovation have played in driving economic productivity (Romer, 1993; Stiglitz, 1999; UNIDO, 2003; World Bank, 2003; OECD, 2004, Sachs, 2005). Information—unlike commodities—can be used multiple times and by more than one person without losing value, and in the developed world it has marginal distribution costs. These facts open the possibility of a productivity factor with compounding rather than diminishing returns. In the developed world, the production, distribution, and use of new information and technological innovations have been major contributors to increased productivity, the

upgrade of physical capital, and the creation of new, high-value-added jobs. These increases in human, institutional, and technological capabilities are, in turn, major sources of new knowledge and innovation which then feed economic growth. Thus investments in information, communication, technology, and education have created new knowledge that has spawned a virtuous cycle of economic and social development. But can information, communication, technology, and education play this same role in supporting development in Africa?

These are among the stories that farmers in rural East Africa told me of how information contributed directly to their economic and social improvement:

- A Ugandan farmer on the northern shore of Lake Victoria used to produce ten 100 kg sacks of maize per acre on his farm. When he learned how to use manure as fertilizer, he increased the productivity of his farm to twenty sacks per acre.

- Another Ugandan maize farmer used to broadcast his seeds in the spring planting. When he learned to plant in straight lines and space his seeds, his productivity went from two bags per acre to ten bags or more.

- In a rural market in northern Tanzania, a buyer offered a maize farmer TzSh 2,800 per 100 kg sack. Because he knew the going market price, the farmer refused the offer and was able to get TzSh 3,200 per sack. With the 14% difference he was able to purchase sheet metal for a roof on his house.

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Each of these villagers was a user of a community telecenter, one of seven I visited in East Africa. Computers were available in all these centers. But bicycles, books, cell phones, radios, video tapes, and the internet were among the technologies that villagers were using to acquire information and improve their lives.

Food production is the livelihood of most Africans and export crops provide many African countries with their main source of foreign exchange (World Bank, 2005). If information on farm practice can increase by five-fold or even double farm production, the impact on the economy of African countries can be enormous. If increased production can be compounded by increased income of 60 or even 14 percent, the impact on personal standard of living can be dramatic. Information on improved farm

inputs, nutrition, water safety, energy efficient stoves, and health practices can improve livelihoods and extend lives.

In this report, I examine the role of information, communication, technology, and education to empower African communities to pull themselves out of poverty and launch sustained development. I consider the information, communication, and education needs of African villages and identify the most appropriate and least expensive technologies that can meet these needs. Based on this analysis, I make recommendations for information architectures that will support the development goals of the people of Sauri, the Millennium Villages Project, and national policy makers.

Context

This research is inspired by the work of Professor Jeffrey Sachs and the Earth Institute at Columbia University. My wife, Sharon (Shari) Malone, and I read *The End of Poverty* (Sachs, 2005) and we realized that for the first time in history the world has the financial and technological resources to bring an end to extreme poverty. After reading this compelling book we volunteered our efforts in support of the Millennium Villages Project and the communities it serves. After more than thirty-five years in education—as a primary school teacher, university professor, research scientist, and international consultant in the area of educational technology—I felt that I might be able to contribute my knowledge and experience to improving the condition of poor communities in Africa through this project. Shari was a successful business woman for thirty years, during which time she started, managed, and sold several retail and service enterprises. She wanted to contribute her experience to support rural women in their development of small businesses, including their access to capital, market information, and training in business skills. (Shari's report is submitted separately.) The Millennium Villages Project was an excellent opportunity for our contributions to be added to those of others in support of ending poverty in Africa.

The Millennium Villages Project

The Millennium Villages Project (MVP) is a United Nations sanctioned project located at the Earth Institute, Columbia University. The MVP is a sister project to the Millennium Project, co-managed by Columbia's Earth Institute and the United Nations Development Program (UNDP). The Millennium Project produced 13 task force reports and recommendations on topics that ranged from trade and health to education and technology. Both projects are designed to advance the United Nations Millennium Development Goals (MDGs) of reducing extreme poverty, achieving universal primary education, promoting gender equality, reducing child mortality, preventing diseases, and ensuring environmental sustainability. While the Millennium Project addresses these goals at international and national levels, the Millennium Villages Project

addresses them at a local level. The MVP combines local capacity development with a recommended investment of US$110 per person per year over the next ten years in key interventions that will empower rural African communities to pull themselves out of poverty. The Project started in 2004 with two research villages: Sauri, Kenya and Koraro, Ethiopia. In the second half of 2005, the project added ten more villages in various agro-ecological zones in Ghana, Kenya, Malawi, Mali, Nigeria, Rwanda, Senegal, Tanzania, and Uganda. Over the next five years the project will scale up by using the 12 research villages as local hubs for expanding networks of villages that will ultimately serve 500 million people. The Millennium Center, located in Nairobi, Kenya, is charged with coordinating the work of the MVP across villages and countries and connecting the efforts of this project with national and multinational policies, programs, and resources dedicated to the Millennium Project and the Millennium Development Goals.

Sauri, Kenya

Shari and I volunteered to work with the MVP in part because it was an organized way to fight poverty and in part because in focused on specific villages. The people-to-people aspect of this project appealed to us very much. In this regard, we see the people of Sauri as our primary clients for our reports.

Sauri is a sublocation of 11 small villages covering 8 square kilometers in Western Kenya near Lake Victoria and between Kisumu and Busea, which is at the Ugandan border. According to Project data, the population of the sublocation is 5,500 people with 99% of the population from the Luo ethnic group. The main languages spoken in the sublocation are Dholuo, Kiswahili, and English. Sauri is a hunger hotspot. As in much of Africa, agriculture is the primary livelihood in the area. The land area for farming is usually less than 0.5 ha per household—insufficient to produce food for a family of five at current production levels. This area is a maize-based farming system but other crops include beans, sweet potatoes, bananas, cassava, and some vegetables—kale, tomatoes, and onions. Sixty to 70% of the people in this district live below the Kenyan poverty line of $1 per day. Over 20% of the children younger than 5 years old are underweight. There is a high incidence of malaria in Sauri. HIV prevalence is in excess of 10% and perhaps as high as 30%. The sublocation is not currently electrified and the primary sources of energy for cooking are kerosene, firewood, and charcoal. The estimated illiteracy rate is over 30%. There are three primary schools in the sublocation and most people have finished primary school. But it is estimated that only 10% finish secondary school.

A key feature of the MVP is community empowerment and local capacity development to enable villages can pull themselves out of poverty. In Sauri, MVP staff worked with

villagers to create a set of committees that include an Executive Committee and committees on agriculture, environment, health, water, energy, roads and communication, business, and education. Each village in the sublocation elected 3 members to each committee who, in turn, elected a chair. The committees were then charged with designing community action plans in their area of specialization. The committees most relevant to my research interests are the Executive Committee, the Education Committee, and the Roads and Communication Committee. I meet with each of these committees and discussed their development plans.

One of the candidate interventions that the MVP proposes to villages is the planning of a village community center. The Sauri Education Committee took up this suggestion and developed a plan for the construction of a community learning resource center. At the time I had met with the committee in early October they had already written a proposal for such a center and sent it to the Department of Adult Education of the Ministry of Gender, Sports, Culture, and Social Services. Discussions of their plan served as an organizing device for my research in service both to the committee and to the MVP.

Research Approach

Research questions

I began my investigations by drawing up a set of research questions related to the role of ICT and education in development. They were quite general:

- What types of information do poor villages need to assist them in their moving out of poverty?
- How can this information be accessed and communicated?
- What role does education play in supporting development?
- How can technology support these processes?

When I met with the Education Committee, they described their plans for a community learning resource center and I shared my plans to visit established centers in other villages. The committee gave me additional questions that they wanted me to pose to others who I interviewed. Their questions were quite practical, the answers to which would help them plan their resource center:

- How were these centers started?
- What needs were they designed to meet?
- How did they get their resources?
- What services do they provide?
- What have been the responses of villagers to these centers?
- What benefits do the communities draw from the centers?

- How do they address needs of the full range of citizens in their communities, including illiterates?
- What is the structure of their management teams?
- How are these centers being made sustainable?

These questions organized my visits to centers in other communities in Uganda and Tanzania.

Resources

My findings and recommendations are based on interviews with managers of seven community resource centers and one school-based center around Lake Victoria: Nabweru Community Telecenter, Nakaseke Community Telecenter, Buwema Community Telecenter, and St. Henry's Secondary School Computer Center in Uganda and the Sengerema Community Telecenter, the Mwanza Community Telecenter, the Cromabu Telecenter in Magu, and the FADECO Community Telecenter of Karagwe, all in Tanzania. I also interviewed staff and users. In addition, I met with the directors of the Ugabytes, SchoolNet, and CurriculumNet programs in Uganda; and the director of the PrideAfrica DrumNet program in Nairobi. I interviewed Dr. Johnson Nkuuhe, Member of Parliament, Republic of Uganda and Dr. Kelimi Mwania, Assistant Minister of Education and Member of Parliament, Republic of Kenya. I met with staff members of organizations that have supported many of the community resource centers that I visited: the International Development Research Center of Canada (IDRC) and UNESCO, Nairobi. The organizations in this list are described in Appendix A. I met with the Executive Committee, the Education Committee, and the Roads and Communication Committee in Sauri, as well as visited Bar Sauri Primary School and interviewed the Assistant Head and a teacher. I also met with the MVP community developer for Sauri, Jared Oule, the Director of the MVP office in Kisumu, Dr. Patrick Mutuo, and his assistant, Pamela Ati.

Limitations and qualifications

This volunteer, self-funded research project was limited in a number of ways. There were limited funds and time for data collection. The primary data collection described above occurred between October 5 and October 27, 2005. The time spent at each center was limited, typically to a half day each. Center users were selected based on the convenience of their availability that day. Because the data collection at each center was not extensive, I drew on evaluation reports and print and web-based materials provided by the centers' managers. These are supplemented by other evaluation reports, research articles, and policy documents. I also draw on my 30+ years of experience and research in ICT and education, including several international research projects and consultations with agencies on the topic in Singapore, Norway, Thailand, Chile, and Egypt.

The research is also limited to the context of the East Africa. The MVP has targeted villages in ten African countries altogether, including Kenya, Uganda, and Tanzania. While I believe that the questions I address and recommendations that I make are of general concern to poor villages throughout Sub Saharan Africa, my findings and analyses are most relevant to the three countries in East Africa and, more specifically, to the villagers of Sauri.

Components of the Information System

Information, communication, and technology each play a unique role in development that is often lost with they are rolled up into the common acronym "ICT". ICT is often thought of only as technology, and too often narrowly conceived as computers; the roles of information and communication are overlooked. Yet information and its communication are critical to ending poverty. *Information* is the raw intellectual material that supports development. *Communication* is the social, interpersonal process by which information is transferred, exchanged, and disseminated. *Technology* is the means to extend human capability and support these processes. *Education* is the process by which people are capacitated to take up information, communication, and technology and apply them to improve their lives.

Information alone will not change conditions in Africa; nor will technology by itself—whether computers, improved fallows, or malaria bed nets. Change will come when information, often technology-based information, is communicated in a usable form to the people that need it, at a time and in a form that is needed, and when people have the knowledge to apply this information. These factors, along with land, labor, capital, and physical, social, and institutional infrastructures are those needed for sustained and sustainable economic and social development. All of these factors are essential. Development can not happen in the absence of information, communication, technology, or education any more than an otherwise operational automobile can function without fuel or a transmission. They must be viewed as a system in which the components work together—or not—to support development.

Information

Of the community telecenters that I visited, the most active were those most responsive to the informational needs of their community. For example, the Nakaseke Community Telecenter did a formal survey of community informational needs. Staff members of the Nabweru Community Telecenter regularly attend community meetings and they have a user's committee that helps them assess the community's informational needs. Several centers have user support groups that regularly assess the needs of particular clientele

(women, out-of-school youth, farmers, and others in the case of Cromabu) or topics (environment, health, farming practice, and so on, in the case of FADECO).

Many of these informational needs related to farm practice and productivity: information on seeds, planting, fertilizing, weeding, and harvesting, as well as animal breeding, feeding, and treatment of diseases. Current information on market prices was also highly valued. But there were needs beyond farming, related to water harvesting, energy efficiency, health, nutrition, culture, local news, and national sports.

In my interview with members of the Education Committee of Sauri they too were very aware of the kinds of information that they want from their community learning resource center. First, they want the center to meet the needs of all the people of the community: young and old, literate and illiterate, out-of-school youths and adults, those of the majority tribe and others. They want it to help them raise their standard of living and to provide them with information on nutrition and health, including traditional medicine. They want it to meet the basic education needs of the community. They want to learn about human relations and communication skills, leadership and group management skills, and problem solving skills. They want new ways of thinking about gender roles, community empowerment, and service delivery. They want technical training in agriculture, household energy use, water and sanitation, community health and infrastructure development.

In addition to acquiring current information and new skills, the people of Sauri want to preserve their culture and history, which they feel is in danger of being lost. They want the resource center to be a museum and a cultural center for both villagers and visitors. They want the center to contain objects and artifacts handed down from their grand fathers. They want their young people to be aware of both the modern culture and the traditional culture of the village. They want the youth to learn indigenous knowledge: customary laws, traditional medicine and food, and traditional music, instruments, dance, and handicrafts. They want the center to host an education day when the elders of the village would share their traditional knowledge and practices with others in the village.

The informational needs of Sauri villagers are similar to those in other rural villages in developing countries. A survey of informational needs of radio audiences in 40 African countries, conducted by the World Association of Community Radio Broadcasters (AMARC, n.d.), listed 17 categories of information needed by rural communities. This list was narrowed down to the top five priorities, including nutrition, post-harvest management, seed production, water collection and management, and agricultural marketing (see Box 1). Ozowa (1995) lists the needs of Nigerian small scale farmers as those related to farm inputs (fertilizers, improved seeds, feeds, plant protection

chemicals, and water), productivity technology (labor saving practices related to cultivation, fertilization, pest control, weeding, and harvesting), agricultural credit to finance production activities, and market information (current prices, sales timing, group marketing, and so on). A study by Agwaru, Matsiko, and Delve (2004) collected data on informational needs from focus groups of farmers in three villages in Uganda. The most frequently mentioned need was related to pest and disease control, followed by information related to inputs, markets, soil improvement, and feeding livestock. In another empirical study in Uganda (Ikoja-Odong, 2001), farmers mentioned that they needed information on markets, farm inputs, and advice on farm practices.

Box 1
AMARC Study Ranking of Informational needs of Rural African Communities (Top five in bold.)

1	**Nutrition**
2	**Post-harvest management**
	Seed production
4	**Water collection and management**
	Agricultural marketing
6	Gender and development
	Animal production and health
8	Special Program for Food Security
9	Forestry
10	Agro-meteorology
	Genetic bio-diversity and resources
	Biotechnology and nutrition
	Food security
14	Early warning system
15	World Agricultural Information Center
16	Fisheries
17	Information mapping system on food insecurity and vulnerability

It can be useful for analytic purposes to collect and organize informational needs by broad categories that might be common across communities and countries. But these categories need to be inclusive enough for a broad range of needs, not only those focused on economic productivity. For example, none of the research reports listed the health and nutrition concerns of the Sauri villagers or the cultural information that they cited as important to their community.

For planning purposes, information categories must be specific enough to capture the unique needs of particular villages or even individuals. While information needed by maize farmers in Kenya may be similar to that needed by maize farmers in Tanzania and Uganda, the informational needs of maize farmers in Kenya will differ from that of pastoralists in Kenya. And to some extent, informational needs will vary from person to person within a village.

Also, the information needed within a community will vary over time, so information analysis must be a continuous process. The information needed by Kenyan maize farmers during planting season will differ from that needed during harvesting. Informational needs will change as conditions change within a village: as new pests are introduced, new seed varieties become available, soils deplete, and so on. Informational

needs will also change as a village develops: as the community moves from an emphasis on subsistence crops to cash crops; as it moves from inaccessible to accessible markets; as it moves from low literacy to high literacy.

Communication

Before needed information can make a difference in the lives of rural Africans it must first get to the people who need it. Some of the information needed is indigenous to Africa and is located in the village itself. Certainly this is the case for cultural, historical, and traditional knowledge. But most of the world's information lies outside of Sauri and East Africa. While much of this information is irrelevant to the immediate needs of Africans, some of it is vitally important. Unfortunately, it is often not available to Africans and when it is, it is in a form that reduces its usefulness or usability—it requires literacy skills that people do not have or it is in the wrong language. The challenge to the people of Sauri and the Millennium Villages Program is to create an information infrastructure in which the people who need specific information are able to get it at a time and in a form that is most useful to them.

The channels of communication in Sauri are currently quite limited. The Education Committee reported that the information is typically passed along in the village by word of mouth from person to person, from parents and grandparents to their children. These interactions may be result from casual encounters or intentional episodes of information seeking or delivery.

As in Sauri, oral communication is the most common form of information exchange in rural African villages. The Ugandan farmers in the Ikoja-Odong study (2001) also said that they relied most often on word of mouth for their information, followed by print media, radio, and occasionally television. A typical spoken exchange has the advantage of being in native language and local dialect and it does not require specific literacy skills. A feature of this discourse is the asking of questions that support understanding and clarify ambiguities in speech. The discourse is also supported by the physical context within which it occurs; things can be pointed at, processes can be demonstrated, and gestures and facial expressions can be used to coordinate understanding between parties (Clark, 1996).

However, the farmers in Uganda also reported difficulties related to word-of-mouth communication (Ikoja-Odong, 2001). Among them was the unreliability of oral information, due to informational drift as it passes through the community, misunderstanding of the original message, or intentional misinformation in service of competitive edge on the part of the delivering party. The converse of contextual support is that oral communications are often narrowly bounded by time and place, if not by

chance encounter. Other problems associated with word-of-mouth communication are the challenge of knowing which person has the needed information and the difficulty of getting to that person, given the poor transportation infrastructure. While group meetings can deliver information to relatively large numbers of people, the more typical, serial person-to-person nature word-of-mouth communication makes it a very slow and ultimately unreliable as a means of disseminating important information to large numbers. Finally, a problem that affects both large groups and small is the general disconnection of all members of the community from important information in the outside world. If the information does not already exist in the community, no one will have access to it. As Joseph Sekiku put it when describing the motivation for starting the FADECO Telecenter, "We were in an information blackout" with no access to newspapers, radio, or other information sources. All these limitations argue against the use of word of mouth as the foundation of the community's information architecture.

The community resource center can serve as the information conduit and communication hub of the community by collecting, organizing, storing, retrieving, and disseminating needed information. It can be the place where people go to get the information they need. As libraries, as well as telecenters, FADECO, Nakaseke, and Nabweru see themselves as centers of both information and communication. Other centers, for example the telecenters at Buwema and Mwanza, are only places of access to technological resources. But FADECO, for example, has 6,000 books in English and Kiswahili on development, agriculture, renewable energy, crop protection, natural resource management, and indigenous knowledge. It also has over 100 CD-ROM titles on agriculture, environment, water, health, sanitation, HIV-AIDS, malaria, tuberculosis, and other topics. Nakaseke has books in English, Kiswahili, and Bugandan on banana growing, coffee management, animal diseases, among many others; audio tapes that range from rice growing to fish pond management, and video tapes on pig production, heifer management, and tick control in cattle. Nabweru has CD-ROMs on agriculture, fishing, organic farming, environment, and bee keeping.

Nakaseke, Nabweru, and Sengerema are community radio stations and they use this medium to distribute needed information to large numbers of people. For example, Nakaseke broadcasts 18 hours a day, 7 days a week and has programs on local news, agriculture, market prices and updates, health, sports, education, family affairs, women's concerns, religion, and world events. Nakaseke and Nabweru have the capability for listeners to call in to the radio program while others hear their questions. This capability makes the radio programming immediately responsive to listener needs and both callers and other listeners can learn from the answers to their questions. In the case of Nakaseke, this capability is supported by 16 "mini-telecenters" in the community where social centers, pubs, and other local businesses have radio receivers and cell phones that they make available to their patrons for listening and call in.

While some of these telecenters have fairly sophisticated technology that includes copy machines, video cameras and tape decks, computers, and even internet access. In some cases, communication was accomplished with very simple technology. The primary function of the Cromabu Telecenter is to gather price information on various crops from neighboring markets, organize this information, and distribute it to farmers in the community. This is done with a small fleet of bicycles that are made available to community volunteers. The volunteers go to assigned markets, collect price information on a range of crops, reconnoiter on Saturday mornings to collate information from various markets, and then use the bicycles again to distribute the information to their neighbors. The key is collecting, organizing, and distributing information to the people that need it in a usable form and at a time that it is needed.

Of the informational needs of Sauri, those related to nutrition, health, farming practices, energy efficiency, water, and sanitation are needed by a large number of people in the villages. However, there may be individuals that want additional or specialized information related to a particular farming practice, health need, and so on. Some information may be more relevant to particular groups, such a women, out-of-school youths, and adult illiterates. Some of this information, such as that related to traditional customs and medicines, may lie within the community. In these cases, the communication task is to identify local sources and transfer information to others that need it. However, much of the information needed by the community is exogenous; it must be brought into the community and distributed to the people that need it. The telecenters I visited are models of how information can be obtained and communicated. The people of Sauri can look to these centers for ideas and guidance as they develop their own community learning resource center. These centers can also serve as models for the MVP as it considers recommended interventions and advises other villages on their development plans.

Technology

There is a broad range of technologies that will help change the conditions in Africa, including drugs that improve health, seed varieties and fertilizers that improve agricultural productivity, energy efficient stoves, and water harvesting techniques. But in this section I focus on the use of technology to communicate information related to these and other technologies, information that is essential to improving the condition of rural African villages. I analyze the range of technologies that I encountered when visiting telecenters in Uganda and Tanzania and discuss their capabilities, costs, advantages, and disadvantages in addressing the information and communication needs of rural villages.

Table 1. Technologies that Support Village Development

Technology	Characteristics				
	Form of Information	Communication Pattern	Skill Requirement	Infrastructure Requirement	Costs
Bicycle	Supports word-of-mouth oral communication or distribution of printed information.	One-to-one; one-to-a-few.	Minimal skill required to operate a bicycle.	Minimal requirements for paths or roads.	Modest start-up costs; minimal recurring costs associated with maintenance.
Book	Text, photos, diagrams.	One-to-one.	Significant skill needed in literacy, at least in the national language; literacy in English provides access to much more information.	Little infrastructure needed to obtain and store books and make them available to users.	Per-unit initial cost is fairly high; minimal recurring costs.
Telephone	Word-of-mouth oral communication; text with SMS.	Timely one-to-one communication; there is limited availability of multicasting of text messaging that would extend this capability to one-to-many.	Little special skill needed to operate phone; additional skill needed for advanced features, such as text messaging, which requires basic literacy skills; multicasting of text messaging requires specialized skills	Land lines have traditionally been the infrastructure needed for telephones but these are in poor repair in many African countries, especially in rural areas; cell phone towers are becoming widely available even in many rural communities; specialized equipment is needed for SMS multi-casting. On the user end, power is needed for recharging batteries.	Modest start-up costs, especially if shared by a number of users; modest recurring costs associated with per-use voice charges, very low for SMS.
Copier	Allows for the reproduction of text, photos, diagrams.	One-to-one, one-to-a-few.	Little special skill needed to operate copier.	Power is needed.	Initial cost is high; per use cost for power, paper, and toner are minimal but high enough to preclude mass printing and one-to-many use.
Audio and video tape	Word-of-mouth oral communication, in the case of audiotape, puls motion, limited text, photos, and diagrams, in the case of videotape.	One-to-one, one-to-a-few.	Little skill needed to operate an audio or video playback unit.	Power is needed.	Modest initial equipment cost and per-unit cost of videos; minimal recurring costs associated with power and maintenance and repair over time.
Radio reception & broadcast	Word-of-mouth oral communication.	Radio reception allows one to receive information from many channels; radio broadcast allows one-to-many, call in over radio extends this to include audience input.	Little skill needed to operate a radio receiver; significant skill needed to operate a radio station.	Batteries are sufficient for radio receivers; power is needed for radio transmission.	Modest cost for a radio receiver and low recurring cost associated with battery replacement; high start up costs for radio broadcasting and modest recurring costs minimal associated with power and maintenance and repair over time.
Computer	Multimedia computers combine audio, motion, text, photos, and diagrams.	One-to-one; the addition of a printer allows for one-to-a-few copies of text, photos, and diagrams.	In addition to literacy in English, or at least the national language, significant skill is needed to operate computer and various software applications.	Power is needed.	High initial equipment cost and per-unit cost for operating system and software; minimal recurring costs associated with power and maintenance and repair over time.
Internet access	Text, photos, and diagrams; high-speed service provides access to motion and audio.	One-to-one; email and discussion groups allow for many-to-many communication.	Modest additional skill is needed to search for information.	Power is needed; internet access is needed, either through dial up, cell phone, Wi-Fi , WiMAX wireless, or satellite.	No initial cost for dialup access and modest recurring costs; modest initial costs and recurring costs for cell phone access; high set-up and recurring costs for satellite service

Technologies can be distinguished by the forms of information and the communications patterns they support. They also vary in their skill requirements, their infrastructure requirements, and their costs. Table 1 displays the range communication technologies that I encountered and their different characteristics along these dimensions. All of these characteristics are relevant when mapping information and communication needs onto the technology that can fill these needs. However, the information form and communication patterns of a technology are particularly important in the impact that information can have on development. Related to the form, market information can be conveyed with simple text messages on a cell phone. But the information needed to understand how to appropriately use mosquito bed nets can not be adequately conveyed with simple text or perhaps even the spoken word alone. A demonstration, presented in person or via video, can make the difference between getting malaria and not. Word of mouth, one person at a time, is the dominant pattern of communication in rural Africa. But if technological information is to have a significant impact on rural development in Africa other patterns are needed—those that efficiently reach many more people.

As a communication technology, ***bicycles*** extend the practical reach that a person has when looking for or delivering information. The communication pattern supported by this technology is limited to one person connecting with another or, at best, several other people, as was done at the Cromabu Telecenter in Magu, Tanzania. However, the skill needed to "operate" this technology is minimal and it relies on a minimal infrastructure of roads, or at least paths, for its use. Its start-up costs are minimal-to-modest[1] and recurring costs are limited to occasional maintenance. So this is a technology that is good for supplementing others that support a pattern of broader communication.

Books, magazines, and other printed material can be an important source of outside expert information, as presented in text and supplemented by pictures and diagrams. The Nakaseke, Nabweru, and FADECO telecenters all had libraries. These print materials require little infrastructure, typically no more than a place to store them and make them available to users. They are particularly useful if they are written in the local or at least national African language. Unfortunately, few are so. This technology has several other shortcomings. Its use requires a very high level of skill which takes years

[1] The costs presented here are primarily for comparison purposes. "Minimal" costs refer to those less than $50; "modest" costs are between $50 and $500; "high" costs are above $500. Specific prices or fees are given in US dollars, again for comparison purposes. Prices vary from company to company and those given are not necessarily the lowest available (or the highest). Prices also vary from country to country and change over time. Shipping costs, import duties, and other taxes are not included and are often substantial. Consequently, prices should be obtained locally and those mentioned here should not be used for budgetary purposes.

to learn; 30% or more of the people of Sauri do not have these skills. Typically a book is on one topic only and only one person can use it at a time. It is a durable medium so it can be passed along to others, but its information may become dated over time. While the costs of magazines are minimal, the costs of books can be modestly high. The recurring costs are limited to addressing problems of ware and tear.

Telephones are an increasingly important technology in rural Africa, but not because of traditional landlines. The incumbent telephone company in Kenya, Telkom Kenya, charges $60 to install a landline and a minimum $7 monthly tariff, along with local, trunk, and long distances charges, per use. However, the infrastructure is unreliable, particularly in rural areas. Rather the huge increase in rural telephone use is due to mobile phone service, in large part resulting from the recent liberalization of this segment the telecommunications market in Kenya. The popularity of phone communication is also due to the fact that communication is in the local language and very little skill is needed to use this technology. Cell phones are minimally expensive; a handset can cost as low as $14. This cost can be further ameliorated by distributing it over a number of people through phone sharing or renting, as was done at several of the telecenters that I visited. Per-use costs are fairly low, although high by US standards. Safaricom tariffs are at the low end $.22 per minute for local calls and $.65 for regional calls. These per-use costs are even lower when text messaging (SMS) is used, which for Safaricom is .07 a minute to send and free to receive. The DrumNet Program of PrideAfrica uses SMS to "multi-cast" market quotes to farmers who subscribe to its service. Using specialized equipment, SMS information can also be uploaded to a database, for example from an information source at the market to a database of market quotes, which is in turn made available to subscribers. However, in addition to limitations of the form of information a phone can support, the basic problem of this technology is that it is a one-to-one means of disseminating information. Phones will work in many situations where the needed information is verbal and when one knows who has the information and the source's contact information. But it is not a very satisfactory solution when media-rich information is needed by a large number of people.

Copiers and printers were available all of the telecenters that I visited. In conjunction with a library, these technologies are relatively inexpensive means of on-demand reproduction of print, photographic, and diagrammatic information found in books, magazines, computers files, and on the internet. Power is needed to run a copier but only when it is used and it takes relatively little skill to operate. The initial cost of copiers is very modest, around $100 or less. And the per-use costs of paper, toner, and power are minimal, although high enough to make mass distribution of printed text quite expensive. For example, the FADECO Telecenter used its printer/copier to publish a monthly newsletter until they had to discontinue publication because of the costs.

I found ***audio and video tape*** playback units at three of the centers (Nakaseke, Nabweru, and FADECO). Audiotapes are a useful way of making verbal information available on demand, information that might otherwise be available only fleetingly on the radio. Several telecenters that were also community radio stations taped their broadcasts for later use, as needed. Video tape has the added advantage of providing visual information that is particularly helpful in understanding practices and procedures related to farming, health, nutrition, and craft making, as well as cultural practices, such a dancing, the playing of musical instruments, and rituals. The cost of an audio tape player can be minimal, $10-$20, and the cost of a combination television and video tape player can be quite modest, $120-$150. The per-unit cost for titles is usually minimal. These technologies require little power; most audio tape players run on batteries. These technologies have the added advantage of requiring little skill to operate and little literacy skill to use the information. However, because there are few commercial titles in national languages and almost none in local languages, two of the telecenters made their own videotapes, using video cameras. This technology has now become modestly inexpensive with some camcorders running as low as $200 or less. This equipment requires more skill to operate but no additional infrastructure other available power, as most audio and video recorders run on batteries. All of these factors make these technologies very powerful communication resources for rural villages. The only downside is that they address the informational needs of only a small number of people at one time.

Radio receivers provide access to a fairly large number of information channels, even in rural areas, although most commercial stations broadcast popular music and other entertainment that has little developmental value to these communities. Three of the telecenters on my itinerary were community radio stations: Nakaseke, Nabweru, and Sengerema. These are low-power operations with transmitters rated as low as 30 watts. Nonetheless, these transmitters still have enough power to service a large number of people within the immediate community, 10-15 km from the telecenter. Their programming is often in the local language and ranges from topics on agricultural practices and market prices to health, education, and women's concerns. As such, they meet a crucial set of informational needs within the community. Radio receivers require very little skill to operate and they are very inexpensive to acquire, as low as $10 or less. Their operating costs are limited to the price of batteries. Even here, a somewhat more expensive crank radio (around $40) operates at no cost, without batteries. At the higher end, WorldSpace (http://worldspace.com/) is a proprietary subscription-based digital satellite radio service that covers all of Africa, including rural areas. For a radio receiver and satellite antenna at $150, a $10 activation fee, and $10 monthly tariff, subscribers can receive a range of cultural, educational, news, and sports programming in English as

well as other European and African languages. Two of the telecenters that I visited used WorldSpace radios.

While radio receivers are relatively cheap, radio stations are very expensive both to start and to operate. The three radio stations that I visited were near-professional studios that cost tens of thousand of dollars to start, funded by UNESCO, IDRC (International Development Research Center), and ITU (International Telecommunications Union). But there are less expensive ways to start a low-power radio station. While FADECO currently does not operate a radio station, they sent a proposal to UNESCO that would fund the purchase of a "suitcase transmitter". Available from Wantok Enterprises in Canada (http://www.wantokent.com/), this package includes a stereo transmitter ($4,000 for a 30 watt transmitter package and $5,000 for a 100 watt package), antenna, cords, power supply, and microphone. This equipment, plus a mast, enables live broadcasts within a short range. Other desirable equipment is an audio mixer, earphones, a CD player, an audio cassette recorder-player, and an audio input/output board with telephone connection. This added equipment allows additional audio information from tapes and CDs to be broadcast, as well as call-in questions and comments. A sound-proof studio would also be advantageous. Radio stations do require a fairly significant amount of power. But power is not the most expensive recurring cost. National governments control the radio spectrum within their boundaries and they charge fees for the use of a particular frequency. These annual fees can be quite high and there is often no distinction between commercial stations and low-power community stations. As of April 2005, the annual fee for all stations in Kenya was more than $1,700 (Inter Press Service News Agency). Consequently, as of April, there was only one community radio station in Kenya, compared to eight in neighboring Uganda where the licensing has been adjusted to encourage community radio stations. The governments of Mali, South Africa, Senegal, and Mozambique have also passed enabling policies that have resulted in the establishment of 150, 100, 36, and 25 such stations, respectively. Given the reach that community radio stations have in their area and their ability to mediate national and international information for their local audiences, this technology can have a huge impact on rural communities and any policy or program that reduces costs or facilitates their establishment can further development goals.

All of the telecenters that I visited had ***computers***. For two (Buwema and Mwanza), access to computers was nearly the only service they provided, beyond copiers. The biggest advantage of multimedia computers (those with CD-ROMs, of which nearly all in these centers were), is their access to the full range of informational forms—audio, motion, text, photos, and diagrams. Many educational and reference CD-ROM titles combine text with video demonstrations, animations, and even interactive simulations that support understanding and learning. This range and combination of forms supports a large variety of informational needs within the community. However, the

technology can be used by only one person, or at the most two or three, at a time. A high level of literacy is needed to use text material on the computer, particularly since much of the material available exists only in major languages. In addition, the use of the hardware and software requires significant additional literacy skills, sometimes referred to as "computer literacy". The price of computers has come down significantly over the years, although the cost of new computers is still quite high by African standards. Both desktop computer bundles (i.e., computer with CD-ROM, monitor, keyboard, and mouse) and laptop computers can be purchased for as little at $700 or less. These prices will continue to drop. For example, researchers at MIT are working on a laptop specifically designed for the needs of developing countries that would cost only $100. Currently, there are several organizations (for example, Computer Aid [http://www.computeraid.org/] and Computers for Africa [http://www.computers4africa.org/]) that provide refurbished computers to schools and organizations "at cost". Costs typically includes shipping, handling, and sometimes set up fees that can run as low as $100 per computer. However, the cost of equipment is only the beginning. The computer will need an operating system (such as Microsoft Windows or Linux), applications (such as a word processor, spreadsheet, etc.), as well as content (educational or reference CD-ROMs on various topics). Separately, each of these titles has between a minimum to modest cost but a library of titles can be very expensive. Often, the operating system will come with a new computer but not so with a refurbished computer. The cost of software can be cut significantly by using "free and open source software" (FOSS), based on the Linux operating system. Two of the centers that I visited, Karagwe and St. Henry's, were using Linux. However, more skill is required to use Linux, particularly if one takes advantage of its more powerful features (i.e., customize the language used) and currently there is significantly less application software available for this operating system. Electrical infrastructure is required, although the power demand of laptops is minimal.

In summary, the capabilities of the computer are significant but so are the costs. This technology can be an important part of a community's information architecture but it must be used strategically and justified in terms of the importance of the information that it can uniquely provide.

The ***Internet*** significantly extends the amount of information available to a center. The amount of information available on the Internet is immense and it is increasingly available in national languages (although still almost nothing exists in local or minority languages). The range of available informational forms is also significant, particularly if the access is broadband. Indeed, the amount and kind of information available on the Web is so enormous that it requires yet another set of skills, those needed to search for, organize, analyze, and use the desired information, sometimes referred to as "information literacy skills".

Seven of the telecenters that I visited had access to the Internet. All of the centers were connected to the Internet by satellite (or VSAT) connections. Connectivity is a huge and expensive problem in Africa. Because of the poor quality and the limited coverage of landlines, dialup service has not become widespread as a way of accessing the Internet, particularly in rural areas. In Kenya, dialup Internet service at 56 Kbps costs between $40 and $95 a month through Africa Online, along with a $12 one-time setup fee and normal local and trunk charges for each call. Higher bandwidth land-based connections, such as ISDN and ADSL are even more limited in availability and can be more expensive. Telkom Kenya ISDN service, running at 64 Kbps, costs $62 for a deposit, $95 for installation, and $19 for monthly access, on top of normal calling charges for each use. In addition to a $38 installation fee, Telkom Kenya ADSL service costs $170 per month for 256 Kbps downlink and 64 Kbps uplink, to $387 for 512 Kbps uplink and 128 Kbps downlink, on up. However, there are no per-use charges and it is "always on". With the recent liberalization of telecommunications in Kenya, wireless Internet solutions have begun to appear in the market and they are particularly appealing to rural areas, since the availability of land-based high speed services is limited to the cities. For example, mobile phone service providers are beginning to offer digital Internet service. A cellular modem can be purchased for less than $200 that inserts into a PCMCIA slot. With this, the user can subscribe to wireless Internet access through Safaricom at a modest rate of 40 kbps for $7 a month plus per use calling charges. Other wireless solutions, such as Wi-Fi and WiMAX, offer very high speeds; Wi-Fi at a throughput rate of between 2 Mpbs and 54 Mpbs and a range of 200 yards and WiMAX at a throughput rate of 70 Mpbs and a range of 10 miles. However, as of October 2005, Angola was the only Sub-Saharan country that had WiMAX Internet access available commercially. While neither of these technologies can yet be used by Internet service providers in Kenya, they can be used privately to extend service from a particular access point to other locations within their range. This leaves VSAT as the only source of universal Internet coverage in rural Africa. As of April 2005, there were only two companies in Kenya that were licensed to provided commercial Internet service using VSAT: Telkom Kenya and Afsat. Speeds are a rather modest 64 Kbps and both startup costs and tariffs are high. Telkom Kenya initial costs are $2,000 for a satellite dish, necessary additional equipment, and their installation and their monthly tariffs are $385 for shared bandwidth and $1,325 for dedicated bandwidth.

All of this is to say that for the time being, Internet access in rural Kenya is both problematic and expensive. In planning a community resource center, the significant power of a computer and the Internet must be traded off with their very high costs. Consequently, their use should be highly strategic.

The Problem of Infrastructure

Roads. The roads in East Africa, particularly rural areas, are in very bad shape. Using the Nairobi-Kampala highway, the principal road in the region, it took us 6 hours to travel from Kisumu, Kenya to Kampala, Uganda (a distance of only 250 km) because of the condition of the road. Rural roads are even worse. Sauri is near the Nairobi-to-Kampala highway. But there is only one graded dirt road the sublocation; the rest are rutted and, in the rainy season, impassable by auto or even bike. This condition has significant implications for the flow of information, as well as access of villages to agricultural and other markets. The remoteness of villages and the condition of roads means that any information requiring the movement of people, such as a visit from an extension agent or health worker, can be time consuming and problematic to the point of prohibitive. In many cases, these resources can be provided remotely, if the telecommunication infrastructure is in place. The costs of investing in the telecommunication infrastructure are significantly lower than the costs of investing in the road infrastructure and they can be implemented more quickly. So, relatively low-cost investments can have huge informational returns, although investments in road infrastructure are still justified by market needs.

Electrical power. Most of the technologies above require electrical power. However, electricity in East Africa, particularly in rural areas, is often very unreliable or not available at all. The sublocation of Sauri does not currently have access to the electrical grid. Even when the grid is available in rural Africa, the frequent surges and outages (that can last from several hours to days) increase the costs of operation. Several of the centers that I visited had generators for back up. These can cost several hundred dollars to purchase and much more to operate over time. To cover short-term outages, all of the centers had uninterrupted power supply (UPS) and surge protection devices that added $100 or more to the cost of a computer. At the telecenter in Nakaseke, Uganda, a power spike was so strong that it destroyed several computers despite surge projection. Subsequently, they installed solar panels and took themselves off the grid, with the support of a grant from IDRC. The solar panels, batteries, and inverter needed to generate 50 watts of power can cost up to $6,000 to purchase, prohibitively high for most operations.

Education

One of the eight Millennium Development Goals set by the UN is to achieve universal primary school attendance by the year 2015. In addition, among the UN Education for All goals for 2015 are: to enhance education quality, to achieve gender equity in education, promote the acquisition of life-skill by adolescents, and to expand adult literacy by 50 percent. All of these goals are based on the assumption that increased

school attendance is correlated with economic development, social integration, and personal well-being.

Yet dramatic increases in school enrollment without additional policies, programs, and resources will only degrade the quality of education and not lead to economic and social development. For example, over the last several years the number of students in Bar Sauri Primary School has increase from between 250-300 to over 500 students, due to the government's elimination of school fees and to the school's introduction of free lunches. This increase is clearly a successful move toward accomplishing the educational MDG. But while the population of the school has nearly doubled, the number of textbooks, classrooms, and teachers in the school has not changed. There are now two or three students sharing a textbook in Sauri classrooms. And there are more than 70 students in some classes. The diversity of the student body has also increased significantly. As out-of-school youth enroll in school, students as old as 9 are in Class 1 and as old as 14 in Class 2, where the ages would otherwise be closer to 5 and 6, respectively. Increased teacher workload has not been accompanied by increased pay. Rather, larger and more diverse classes have made it more difficult for teachers to mark assignments and give students feedback or individual attention during class. These conditions promote lecturing, memorization, and a lock-step approach to teaching and learning.

These conditions are not peculiar to Sauri, as a recent study of Kenyan classrooms documents (Pontefract & Hardman, 2005). These researchers observed 27 Kenyan primary school teachers conducting lessons in English, mathematics and science and they surveyed another 359 teachers about their teaching practices. The findings revealed the prevalence of teacher-led recitation in which rote and repetition dominate the classroom discourse in Kenya, with little attention paid to securing pupil understanding. The authors this study and others (Kellaghan & Greaney, 2003) argue that these classroom practices are driven by the end-of-primary examination. Taken in English at the end of Class 8, the exam uses multiple-choice format requiring a selection of correct answers from a number of discrete facts. They generally do not require understanding or application of basic principles. Yet the exam serves two significant functions: it assesses the performance of teachers and head teachers and it determines which students will go on to secondary education. In the first instance, the exam shapes the behavior of teachers toward emphasizing the kind of factual information that will appear on tests and toward using recall as an instructional device. In the second instance, it prepares students for further school learning rather than for life in the world outside of school. Unfortunately, 90% of the students of Sauri and other rural schools will not go on to secondary education. Primary school is "preparing" them for a future they will not likely experience at the expense of a future that they will.

The memorization tasks found in language, mathematics, and science classrooms are peculiar to schools and do not correspond to tasks outside of the class, which involve the application of knowledge to everyday activities, such as parenting, farming, buying, and selling. Furthermore, the one-way discourse pattern peculiar to classrooms does not follow the more interactive, give-and-take communication pattern found outside the class. The disconnection between school practices and the real world is increased by differences in the language used in each—English in the classroom, the local language in the real world. As a result of all this, the knowledge learned in the classroom is inert, confined to school, and unlikely to be applied in real life. Language, mathematics, and science, and other knowledge learned in school is not used to increase crop production, improve the breading of farm animals, negotiate better market prices, improve a family's health and nutrition, increase household energy efficiency, advance the quality of water and sanitation, or resolve disputes in the community or persuade neighbors about a particular point or to use a particular practice. Yet it is this knowledge and these skills that will improve the conditions of the village.

The utility of teaching for understanding and application is illustrated in the CurriculumNet project that I visited in Uganda. In this project, computers are used to change the curriculum and the way it is taught in the classroom. In one example, students are asked to collect, examine, and compare the organisms in several local ponds or wetlands. The objectives are for them to engage in inquiry based science, assess the major factors that affect different organisms, and connect learning out doors with classroom learning, and use technology to analyze and present their findings. Another task has them interviewing community members about their use of traditional versus modern medicines, and compare the advantages and disadvantages. Although these activities are designed for secondary students, they illustrate the combination of a curriculum based on advanced skills and understanding, student-centered learning strategies, and the connection between school learning and real-world applications of school knowledge that is also needed by primary students who may never attend secondary school.

The principle function of a primary education is to teach literacy skills. The ability to read and write in one's own language and, in East Africa, the national language and English is fundamental to the subsequent use of a wide range of information resources that are vital to development in Africa. But increasingly, there are other literacy skills—those related to the use of ICT to access, analyze, evaluate, communicate, and use information to solve problems and create new knowledge —that are vital to economic and social development (Quellmalz & Kozma, 2003; Wagner & Kozma, 2005). These skills, along with deep understanding of school subjects, their application to solve real world problem, and the ability to create new knowledge, are those that will lead to increased economic productivity and sustainable development (Kozma, 2005).

African schools have the potential to provide valuable educational services to the community, including access to information and communications technologies. But often this does not happen. ICT resources are most often targeted at secondary schools in Africa, through programs such as SchoolNet Uganda and the NEPAD e-Schools program. These resources and the corresponding teacher training can make a significant contribution to educational reform and to bridging the digital divide in Africa (Kozma, et al., 2004; Gaible, 2005). However, secondary schools, particularly private ones, are often residential facilities that draw on students from a wide geographical area. Consequently, they are often disconnected from the concerns of and interactions with the immediate community. In addition, they have their own concerns about having outside adults on campus—concerns that range from equipment misuse to drug trafficking—and these often result in school policies that limit the use of facilities and programs to school staff and students (Gaible, 2005). I visited St. Henry's Secondary School in Kitovu, Uganda. They had 65 computers in their computer center and a total of 120 computers throughout the campus, many of them with access to the Internet via VSAT connection. Yet the school had no program to make these resources available to the surrounding community.

Until Kenyan schools are able to focus on the needs of local communities and students' understanding of school subjects and their application to real world problems, the community learning resource center remains a village's best source of knowledge for development. As such, it can and should be designed so as to address the information, communication, and out-of-school educational needs of all the community members. In the remaining sections, I provide some recommendations to the village of Sauri, the Millennium Villages Project, and to national policy makers for how that can be done and how education can be reformed to support a country's economic and social development goals.

An Information Architecture for Sauri

Based on my research in East Africa, I emphatically support the goal of the Education Committee to launch a community learning resource center in Sauri. The challenge becomes how to design and implement this program in the face of constrained resources that range from the lack of electrical power to the MVP's budget limitation of $110 per person per year for all interventions. Consequently, I propose a developmental trajectory for the learning resource center that will meet some of the community's most important informational needs with minimal cost, yet grow with the community's emerging experience, developing skill base, and increasing resources, as the MVP scales up. I approach this architecture from both technological and social perspectives. Throughout, I suggest ways that the center can become sustainable. While I organize

these trajectories in "steps", the process will likely not be so linear. The steps will overlap and their sequence will and should be subject to opportunity and constraints.

Technological Trajectory

Step 1: Library and museum. When I was in Sauri, the Education Committee had recently received a set of books from the government, as an initial response to their proposal for a community learning resource center. The books, some in English and some in Kiswahili, were on topics that ranged from malaria and microfinance to livestock breeding and mathematics for adults. This is a highly appropriate way to start the community learning resource center. I recommend that the Committee think of the center in its early phase as a library and museum—a location for collecting and sharing information and cultural artifacts that are valued by the village. This approach to the early implementation of the center requires only a limited investment—a facility to store, share, and use informational materials and cultural resources. For this purpose, there is little need for electricity at first. The Committee should continue to gather books, magazines, posters, newspapers, and community notices and announcements on topics selected by the villagers. The center could also make paper, pencils, and art supplies available for the local production of print materials. The cost of individual materials can be minimal to modest and purchases can be based on informational priorities and scaled to the available budget. Inexpensive or free materials can be obtained from various government agencies, NGOs, and development organizations. Historically and culturally important objects and materials can be donated by community members.

Step 2: Audio-visual center. As the community learning resource center becomes established, electrical power becomes available, and the text collection grows, the emphasis can gradually shift to include a broader range of technologies and resources. The addition of a copier would allow people to take away the specific pages or sections of print material that are most useful to them. A radio receiver and/or audio tape player can be particularly useful to non-literate villagers. A video tape player can serve the needs of these people as well as any others who are interested in learning about processes and procedures related to farm practices, health, nutrition, water harvesting, or other everyday applications of knowledge that benefit from visual information forms. These technologies also have the advantage of being modestly inexpensive, requiring little technical skill to operate, and needing electricity only as they are used. As the resources and skills of the community increase, the center can purchase video recording equipment. This would allow the emerging community experts to create video productions to teach and preserve the local culture.

Step 3: Community radio station. The establishment of a community radio station would be a significant leap in building the capacity of the center. This would be the first purchase of high-cost equipment but with it the center leaps from the mere dissemination of information to its production. Initially, the station can be launched with a less-expensive, low-wattage transmitter. But as the MVP scales and the village becomes an information and communication hub for the area, the wattage and coverage can be increased. Quite likely, the community would need some help from the government or a donor to set up a station. But by this point in its development, the center should have firmly established itself as an important resource for the community. The experience base of the users will have grown and the size of this group and their level of interest should be such that the center's manager can draw on them as volunteers to locally produce much of the station's programming. The broadcast day can be rather short to start and extended as the volunteer base grows. The volunteers can be drawn from the center's special interest groups and the volunteers can, in turn, draw on the center's growing information resource base in the production of their programs. A special committee can be formed of radio "supporters", as was done in Nakaseke where 285 members of the "listeners' club" paid a monthly fee and pledged themselves to raise more funds in support of the center. This committee can solicit programming ideas and on-air volunteers from the community and review the quality of the programs.

Step 4: Remote mini-centers. As the center grows in size and the MVP scales up to service nearby communities, there will likely be an interest within these villages to see the center expand its service area to outlining areas and become the information and communication hub for the network of Millennium Villages. Several telecenters that I visited can serve as models for this expansion. For example, the FADECO telecenter had a remote site 45 km away that serviced people in this less-accessible rural area. This remote site was not electrified but contracted with the national postal agency to provide postal service to this area. The small facility also had a cell phone and a library drop box which the villagers could use to call in book requests to the main center and pick up and drop off materials. The Nakaseke center had 16 "mini-centers", establishments with a radio receiver and cell phone that listeners could use to call into the community radio station with their questions and comments. As the center at Sauri gets computers and, ultimately, Internet access, it can share these resources with the remote sites by printing out the results of remote user custom-ordered web searches or by eventually using a WiMAX wireless transmitter to distribute Internet access to the sites.

Step 5: Computer Center. As the center generates more income, the Committee may chose to purchase multimedia computers. The cost of these can be minimized by the purchase refurbished equipment and the cost of new computers will continue to come down over the coming years. The center does not have to purchase a lot of them to start.

Indeed, having just one computer provides the community with access to a significant new source of information. CD-ROM reference and educational works can hold much more information that on a book and at a much cheaper price. And the use of application packages, such as a word processor and spreadsheet, can come to support the improvement of farm productivity and the development of small businesses. This computer and CD-ROM reference material can be an important resource for the radio station's on-air volunteers, as they plan their programs. It can also be used to develop a pool of computer literate people in the community who can, in turn, justify and support the purchase of additional computers.

Step 6: Internet knowledge center. Internet access, particularly access at a relatively high speed, is one of the most expensive additions the center can acquire. But over the next few years, Internet access will become increasingly affordable and available in rural areas, as the undersea cable to East Africa is completed in 2007 and as the region's telecommunications industry continues to develop. The expense may be further minimized by sharing bandwidth and its associated cost with nearby organizations. Its impact can be maximized by distributing access to a growing set of remote sites throughout the area, as the MVP scales up. The deployment of this technology can significantly extend the information resources of the center, much more so than any other acquisition. Internet access makes the World Wide Web and its vast informational resources on millions of topics available to the community. The community's increasingly sophisticated users can use the Web and the Internet to search for information, share files, send email, and join discussion groups. As the users' technological sophistication grows, the center can establish a website for the community by which the community can share its ideas, products, and culture with other communities and the outside world.

Social Structure

Step 1: Creating a social space. In its initial phase, the community resource center should be structured not only as a place to collect and disseminate information and cultural artifacts but as a place where people can congregate for lectures, formal meetings, and casual gatherings are held. It can serve as the community's social as well as an informational hub where the collection, creation, and person-to-person sharing of knowledge take place. It can be the locus of the community's cultural events and demonstrations of traditional practices. As a social space, the facility should be made attractive, comfortable, and inviting. The center can be decorated with colorful and informative posters, locally made or obtained from development organizations. With few resource materials to start, they can be openly displayed, rather than shelved, so as to make them easily accessible and minimize storage requirements. An announcement board can be used to keep the community posted on scheduled events and current

matters. The Education Committee can work with other Millennium Village committees to form focus groups of "information enthusiasts" with special interests (e.g., farming, handicrafts, starting small businesses, etc.) similar circumstances (e.g., women, out-of-school youth, adult learners). These groups can meet at the center, help the Committee identify informational needs, locate and collect informational resources, and support each other's learning. The Committee can solicit volunteer "readers" within the community, who can make the center's text information available to non-literates and improve their literacy skills.

Step 2: Hiring a manager. In its early days, the center can be launched and initially run without a formal staff, with community volunteers operating the facility. This can even have the effect of creating a stronger sense of ownership among the villagers—it is *their* center, not that of some technocrat. However, in order for the center to grow and reach its potential, a manager will need to be hired. The most active of the telecenters I visited were lead by dedicated, skilled, and visionary managers. Based on my observations in these centers, I recommend that Sauri look for a person with strong technological skills but also a commitment to rural development and a vision of the center not as a technological resource as much as it is a facility that serves the informational needs of the community. The pay was not high at the centers that I visited, although there was some effort to make them competitive with the market. Consequently, the managers that I interviewed were often just out of the university or very early in their career. Often the managers I met grew up in rural regions, and found the hospitality and affordability of rural living to be attractive. Occasionally the manager supplemented his or her salary with outside ventures, to start. The Committee should work with candidates to investigate such opportunities. Often the manager's small salary was complemented by other benefits, such as meals supplied by community volunteers or free housing. As the Committee plans for the construction of a permanent facility for the center, they should consider including an apartment for the Manager.

Step 3: Building an organization. The chief goals of the manager will be to build the informational and technological resources of the center, as well as its organizational structure. With a constrained staffing budget, as was the case in all of the centers that I visited, the manager of the center had to augment the paid staff with volunteers. Initially, all the staff may be volunteer help. The manager should build on the Millennium Village committees and their interests to create a more formal schedule of operations, with volunteers helping at certain days and times to collect, catalog, organize, and distribute resources and help users. The manager will also need to build the technological resources of the center, following the trajectory above, as modified by opportunity and constraints. If the Committee chooses to establish a community radio station the staffing needs will increase significantly. The community radio stations that I visited were on the air for 18 hours a day, seven days a week. Most of the programming

was locally produced, with a small portion rebroadcast from other sources. Fortunately, all of the locally produced programming was done with volunteer help. The Nakaseke telecenter had a volunteer staff of 25 people from the village to do on-air broadcast; Nabweru had 20 on-air volunteers. As the center establishes a radio station, acquires computers, and connects to the Internet, training will become a very important activity. Initially, the training will focus on volunteer staff and their operation of the increasingly complex technology. Subsequently, the volunteer staff can provide training, either in organized classes or on-the-spot, to other users. As the resources and the budget of the center grow, volunteer staff may be supplemented by paid staff. This growth should be managed carefully and, of course, should be subject to a sufficient cash flow and a stable budget. The staffs were usually quite small in the telecenters that I visited, often one or two, rarely more, in addition to the manager. The functions of the staff varied, some were receptionist/assistants, librarians, janitors, or guards. Recall, however, that all these centers were supported by outside donations. As these donations terminated, the staffs shrank to the manager and volunteers supplemented by one or two other part time paid helpers.

Step 4: Producing and sharing local knowledge. As experience and resources grow, the people of Sauri will increasingly move from information consumers to knowledge producers. As Millennium Village committees implement their plans, they will learn from the results. The center can be a place where this local knowledge can be shared, initially with others in the village and the neighboring Millennium Village cluster, ultimately with the clusters of MVP villages in other regions and countries. This will probably first occur with the programming for the community radio station. With additional resources and skill, the community can produce video tapes to share what they have learned and preserve the local culture. As the center acquires computers and Internet access, these resources can be employed for the production and sharing of local knowledge. As the MVP scales up and other centers develop their technological capacity, Sauri can share what they learn with other communities and benefit from their best practices.

Step 5: Making it sustainable. The growth and ultimate sustainability of the center will be directly associated its ability to bring in resources, particularly money. This will mean that marketing will be an important role of the Manager. There are three types of markets: individual users, organizational users, and organizational donors. Clearly it is difficult for a poor community to pay for all of its information, communication, technology, and education needs on its own. All of the centers that I visited relied on donor money at least to fund the startup of the center and often it operation for the first several years. Quite likely, Sauri and other poor rural communities that participate in the MVP will also need startup support from the Project, the government, and/or national or international donors to get started. This startup support can easily be

justified as an investment in community development that will see significant local and national returns. However, the manager's goal should be to maximize the local income by maximizing the value of the center's services to local individual and organizational users. If the community members and organizations participated in designing the center's services from its start, it will most likely meet the community's needs. But increasingly over time, these needed services will have to be matched with cash income. Most of the centers that I visited charged some amount for their services. Often there was a per-use or per-minute fee for using the copier, the computer, or the Internet. It was more difficult to structure fees for some services, such as reading books, viewing video tapes, or listening to the community radio station. Several centers had a "members club" of people who paid a modest monthly fee. Alternatively, membership could be honorary, conferred on those people who met a certain level of fund raising for the center. Those not in the club might have to pay more per use for some services than did members. Some managers I met brought in cash from organizational users that often offset the need to for individual users to pay as much or pay at all. These organizational users might be local NGOs, businesses, hospitals, or schools. In some cases, these organizations were charged a monthly that gave their staff or students access, sometimes priority access, to the equipment or other resources of the center. In other cases, organizations paid a set fee for a special service, such as training. This approach was particularly useful for community radio stations, where NGOs paid for programming spots in which they could disseminate information to the community audience who were their clients. Several of the centers used volunteers to recruit organizational clients with the promise that they would receive a percentage of the income. Managers also reduced their cash outlay by sharing the cost of resources with local organizations. For example, the Nabweru telecenter has a plan to use a wireless transmitter to share its bandwidth and the cost of the monthly tariff with the nearby hospital.

The organizational and marketing practices of the telecenters at Nabweru, Nakaseke, and Karagwe are models for the Sauri Education Committee and the future Manager of their community center. I recommend that a subgroup from the Committee visit these centers to learn from these practices first hand and to establish ongoing relationships for mutual support.

An Information Architecture for the Millennium Villages Project

Scaling-up is the 900 pound gorilla of the Millennium Villages Project. On paper, scale-up plans involve working with governments, donors, and multinational agencies over a five year period to move from the two initial villages, to a total of twelve research villages, and then to clusters of villages around these that eventually total tens of thousands of villages with a population of a half billion people. While a goal of this

magnitude is required to address the enormity of the poverty problem in Africa, there are huge substantive and logistical problems that must be addressed if it is to be reached. ICT can and must be part of this solution. There are two overlapping ways that the MVP can use ICT to advance its goals: work with villages, governments, and agencies to build an African Knowledge Network that supports economic and social development and create an international research network in support of its own operations.

Building an African Knowledge Network

If hundreds of millions of people are ultimately going to be helped by the MVP, it will be because Africans themselves are mobilized in the cause of development. This, of course, is the explicit goal of the Project. ICT can play a crucial role in this mobilization. Given the importance of information, communication, and technology in the villages I visited, I recommend that the MVP view ICT as the glue that integrates all of the other goals, related to poverty, hunger, health, environmental sustainability, and education and connects the villages to the project, to each other, and to the world. As such, the development of ICT resources within the MVP villages should be given the highest priority for it is through information, communication, and technology that all of the other goals will be accomplished.

In an earlier section, I offered a development trajectory for an information architecture that would meet the needs of the people of Sauri. This same architecture could benefit all of the other villages in the Project, although in its implementation the character of the community information centers would reflect the uniqueness of each village. The development trajectory of this architecture in individual villages could be advanced significantly if the MVP saw as a primary goal the creation of an African Knowledge Network. This Network would have three components:

4. Priority support for the development of community centers within each of the 12 research villages.
5. Creation of an African Knowledge Network Portal.
6. Work with national governments to create pro-poor telecommunications policies and infrastructure programs.

Community development centers. The development of a community center is already a candidate intervention in the MVP and it is this intervention that is supporting the plans of the Education Committee in Sauri to develop a community learning resource center. This center has the potential of supporting and integrating all of the other MVP interventions and the work of all of the other village committees. As the Project scales to nearby villages, these community centers could serve as information hubs for other

communities and eventually entire districts. Given the importance of community telecenters, as established in this report, and the costs of building both the community's resources and its skill base, the MVP and the Millennium Center could further promote this intervention it two ways:

1. The Millennium Center can add a technical and informational support staff that could work with villages to recommend and facilitate the purchase of equipment, train villagers in the use of equipment, and, most importantly, advise villages on the collection, generation, aggregation, and sharing of information, particularly that in local languages, that would meet the needs of villagers and support the work of its various MVP committees.
2. The Center can leverage the high profile of the MVP and the Millennium Project to work with donors, NGOs, and the private sector to develop coordinated, low-cost, grassroots ICT solutions that are specifically tailored to the needs of African villages and the constraints of the African context.

There are several organizations with considerable technical expertise and on-the-ground experience in Africa that could support the work of the Project and the Millennium Center in this area. Many of these organizations are those that supported the establishment of the community telecenters that I visited. These include: the Communication and Information Division of UNESCO, the International Telecommunications Union, Canada's International Development Research Center (IDRC), and the International Institute for Communication and Development (IICD) of The Netherlands. These organizations and relevant contact information are listed in Appendix B.

African Knowledge Network Portal. The Project could support the development of community centers by not only facilitating the acquisition of equipment and providing technical training to villagers but by creating a Web portal through which information is collected and disseminated to all of the participating villages. The portal could be a database of digital information in a number of colonial and national languages that could be organized in support of the various MVP committees around key development themes. As the technical resources and knowledge production skills of communities increase, communities themselves can become a major source of African knowledge in this database. Using audio, video, and computer technologies and using local national and local languages, communities can capture knowledge and best practices that they have acquired while participating in the project, preserve their cultures, and make these resources available to other communities in Africa.

Promote pro-poor ICT and education policies. I make recommendations for national and multinational policies and programs that support the information, communication,

technology, and education needs of the poor in the next section. The Center can facilitate the formulation and implementation of these policies and programs by supporting the work of national legislatures and ministries and by mobilizing other agencies, such as UNESCO, ITU, and the World Bank in service of their work. I recommend that the Millennium Center hire an ICT policy expert, preferably with experience in Africa, who can consult with national ministries, develop partnerships, supervise the work of the Center's technical and informational support staff, and coordinate the MVP's ICT effort with other development efforts within and outside of the Project. I also recommend the hiring of an educational expert who could consult with ministries on various aspects of educational reform—pedagogy, curriculum, educational ICT, teacher training, and assessment—and on how changes in these could improve the quality of education and connect it to other policies and programs that promote economic growth and social development.

Creating an International Research Network

Research is an important function of the Millennium Villages Project. The interventions that they propose for adoption by villages (including the development of community centers) are posed as research hypotheses. A significant activity of the Project is to collect and analyze data that will establish the effectiveness of these interventions. This research activity is distributed between Columbia University, the Millennium Center in Nairobi, regional MVP research offices in various countries, and the rural villages. ICT can help here, as well. The Project can start its ICT work by establishing an international research network among its various offices and at the same time lay the ground work for the African Knowledge Network. The infrastructure that connects the Earth Institute and the Millennium Center with the regional field offices can be the same infrastructure that ultimately connects the headquarters with the villages and the villages with each other and the world. This network can also house a second, restricted portal that services the research activities of the Project. In my experience as director of a three-year, international project involving research teams in 27 countries and six continents, I can attest that the use of such a portal was invaluable in coordinating the activities of research teams living across 16 time zones through the distribution of instruments, the monitoring of progress and quality, the collection of data, and the dissemination of findings (Kozma, 2003). A similar portal could be invaluable in supporting the research of the MVP. Furthermore, the findings of the project could also feed into the African Knowledge Network Portal.

Implications for Policies and Programs

The village-level development that is the goal of the MVP is predicated on national and multinational policies and programs that provide the enabling environment for these developments—policies related to economic development, food security, water safety,

health, education, and environmental sustainability. This is the domain of the Millennium Project which has issued a series of reports from a number of high-level, multi-national task forces that make recommendations for national and multinational policies in support of the MDGs. However, in this section I concentrate on recommendations from the grass-roots perspective, suggestions for how policies and programs of national government agencies can support local development. I concentrate on two areas most relevant to my research: telecommunications and education.

Let me begin by acknowledging policy changes in Kenya, particularly those that are most relevant to the development goals in Sauri. While Kenya is not on track to meet the MDGs by 2015 and the Government has experienced some significant political set-backs in recent weeks, the Government has issued some important policy documents that have the potential for fostering rural economic and social development. Among these are the Kenya Economic Recovery Strategy (Ministry for Planning and Development, 2003), which lays a foundation of macroeconomic reform and promotes the development of micro and small enterprises in rural areas; the Policy Framework for Education, Training, and Research, which commits the Government to increased enrollment and improved quality of primary and secondary schools and the integration of ICT into the school curriculum (Ministry of Education, Science, and Technology, 2004, 2005); and a draft National Information and Communication Technology Policy which, if enacted, would further liberalize the telecommunications industry and commit to providing widespread access to the Internet in schools and rural communities (Ministry of Information and Communications, 2004). Together and in coordination, the policies in these documents if adequately implemented can provide a foundation for grassroots-level development of the sort envisioned in this report for Sauri. Here I comment in more detail on the policies and programs that are needed to support this development.

Telecommunications Policies and Programs

As documented in this report, information is vitally important to rural villages in Africa for the improvement of their food production, health, education, and environmental sustainability. Community telecenters can be a significant way of communicating this information to rural villages and generating and sharing local knowledge about best practices. There are very few of these telecenters in Kenya but a growing number of them in Uganda and Tanzania, due in part to favorable telecommunication policies, programs, and regulations. The draft ICT policy statement articulates a number of goals, including using the power of information technology to alleviate poverty and to address gaps related to gender, youth, rural and urban disadvantaged groups. In the document, the Ministry of Information and Communication spells out many new

policies that would enable the use of information, communication, and technology to support rural development. Among them are those that:

- Promote the development of local content and encourage the use of local languages in content development, particularly as a way of preserving the knowledge and culture of traditional communities.
- Provide for community broadcasters whose programming addresses grassroots issues, such as development, education, health, environment, and local culture.
- Allow V-SAT service providers to offer broadband access to rural and underserved areas and give special consideration to those that provide public services, including tele-education and libraries.
- Open up frequencies for public use of wireless services, such as Wi-MAX.
- Integrate information technology into the teaching curriculum at all levels of education.
- Provide assistance for the disadvantaged, women, and youth to acquire ICT skills.

The findings from this study support the enactment of these draft policies. I also recommend that programs be instituted to implement these policies. Specifically, I recommend that programs:

- Provide funding for the establishment of community telecenters in rural areas that can serve as local information hubs—libraries, post offices, radio stations, computer centers, and internet access points.
- Dramatically reduce or eliminate licensing fees for community radio stations.
- Provide funding for the development of broadcast and digital content in the national and local languages that is most needed by rural communities to support their development, content related to farm practice, health, water safety and sanitation, and small business development.

Education Reform Policies and Programs

The future of Africa will depend on the development of its human capacity—the ability for citizens to take up and apply new ideas and technologies. Through education people can acquire the skills they need to provide for themselves, contribute to the health and welfare of their families and communities, solve local problems, and grow the local and national economy. Yet in many African countries fewer than 70% of school-age children reach 5th grade, in some countries it is fewer than 60% (World Bank, 2005). In most African countries fewer than 30% of appropriate-age youth are enrolled in secondary school. The figures for girls' enrollment are even lower. Furthermore, education in

many countries is too often merely an exercise that may prepare students for more education but does little to prepare them for the real world. Increased enrollment is important. But universal primary education will not contribute to solving Africa's problems if students leave school without the skills they need to contribute to their community and country.

Recently, policies have been enacted in Kenya that address these problems. Both the Kenya Economic Recovery Strategy (Ministry for Planning and Development, 2003) and education reform plans (Ministry of Education, Science, and Technology, 2004, 2005) cite as goals universal primary enrollment, increased secondary enrollment, and improved education quality and relevancy. Specifically, the policies call for improved teacher training, support for adult education and literacy, the use of ICT in schools, and linkage between universities and communities.

National education policies can contribute to economic and social development in Kenya and elsewhere in Africa when they:

- Change the curriculum to emphasize the deep understanding of subjects (rather than memorization) and the application of this knowledge to solve complex problems that students are likely to encounter in the real world.
- Encourage student-oriented teaching practices that introduce the concepts and principles of a subject in the context of real-world situations and that engage students in the application of knowledge in the real world.
- Change assessment tasks to reflect real-world situations and use these tasks both in the classroom to provide students with feedback on their progress and on examinations to measure student achievement and instructional effectiveness.

The implementation of these recommendations requires a fine balance between classroom sizes that are large enough to achieve enrollment targets but small enough to allow for student engagement and interaction in the classroom.

Again, ICT can support the implementation of these policy goals. Given the growing importance of ICT in out-of-school situations, the introduction of ICT skills into the curriculum is a goal in itself. But ICT can also play a role in education reform. Technology can be used to support the deep understanding of school subjects and the application of these in real-world like situations. It can support the use of complex assessment tasks as for student feedback and examinations. And it can connect students and teachers to those in other schools and other countries and to vast informational resources on a variety of school topics. Used in these ways, ICT can both support education reform and connect it to economic and social development goals (Kozma, 2005).

Conclusion

In his remarks to the World Summit on the Information Society, UN Secretary General Kofi Annan (2005) called for the application of information and communications technologies that benefit the economies and societies of poor countries and transform the lives of poor people. He called for an information society in which human capacity is expanded, built up, nourished and liberated, by giving all people access to the tools and technologies they need, and with the education and training to use them effectively. The development of a community learning resource center in the sub-location of Sauri, Kenya can serve as a model for how information, communication, education, and technology can develop human capacity so that rural citizens in Africa can increase agricultural productivity, improve the health and nutrition of their families, create a sustainable environment, and generate business opportunities. The development of an African Knowledge Network can expand this capacity to all of rural Africa and help these communities lift themselves out of poverty. By supporting these developments, the Millennium Villages Project, the Millennium Center, and national government policies in Sub-Saharan Africa can make major inroads to achieving the Millennium Development Goals and the goals of Education for All.

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Appendices

A. Telecenters, Projects, and Organizations Included in the Study

Buwama Multipurpose Community Telecentre. Buwama, Uganda is a rural sub-county of 350,000 people located in the Mpigi District, 64 km west of Kampala. The Buwema Community Telecenter was started in 1999 with funding from IDRC and UNESCO. Currently, the telecenter provides computers and secretarial services to community members. At one time the telecenter had also had satellite access to the Internet but they were not able to continue to pay the monthly fees. They also had a radio station but the mast broke and they do not have the funds to fix it. The telecenter has a manager but lost their other employees. They do not have a social support structure. Nor do they have a website. (See also Munyua & Asingwire, 2004; Etta & Parvyn-Wamahiu, 2003)

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Cromabu Telecenter. The Cromabu Telecenter is located in Magu, Tanzania, a city with a population of nearly 18,000 east of Mwanza on Lake Victoria. The telecenter was established in 2002 with funding from IICD and it serves 3 wards with a total population of 44,000. The objective of the telecenter is to improve the livelihoods of

the community by increasing self help capacity with information on agricultural production, market prices, marketing, transportation, and packaging. The telecenter provides computers with Internet access, secretarial services, and computer training. It has an extensive base of community volunteers and supporters.

Website:
http://www.cromabul.com/
Contact:
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CurriculumNet. Funded by IDRC, the Uganda National Curriculum Development Centre (NCDC) is converting several primary and elementary school courses into the local language and redesigning them on IT platforms to be used on CD-ROM and eventually on the Internet. The CurriculumNet program aims at empowering students, educators and educational administrators to develop appropriate competencies to use ICTs effectively in teaching and learning. Equipped with adequate computer skills and curriculum integration techniques, teachers will be able to enhance their instructional delivery skills and gain access to inexhaustible reference materials from the Internet. Further, the project will enable teachers to collaborate with their colleagues in other parts of the world.

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FADECO Community Telecentre. FADECO telecentre is based on the belief that information is a powerful instrument in catalyzing the development process. So this ICT project was conceived: to introduce information and communication technologies and library / information resource services to the rural areas of Karagwe, Tanzania, and to demonstrate that ICT catalyses the development process and results in improvement in the quality of life of the people. The resource centre started as a small bookshelf by the Director of FADECO in 1992 as what was termed at that time as a rural library. Gradually, as FADECO became established in development work, the collection expanded until it was decided to start a small library. It currently provides computers, Internet access, computer training, and secretarial services to the community. It has an extensive network of volunteers and supporters.

Website:
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Mwanza Community Telecentre. Funded initially by IICD, the Mwanza Community Telecentre is located in the city of Mwanza, Tanzania, a city of approximately 1.5 million people on the shores of Lake Victoria. The telecentre provides the community with access to computers, the Internet, and secretarial services. (See also Nielinger, 2003).

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Nabweru Multipurpose Community Telecentre. Nabweru is a peri-urban Sub-county of about 100,000 people in Wakiso District, north of Kampala, Uganda. Its major economic activities are composed of trading and farming. The Nabweru Multipurpose Community Telecentre was established in 1999 with funding from IDRC, ITU, and UNESCO. It currently provides library services, computers, Internet access, computer training, secretarial services, and a community radio station. It has an extensive volunteer and community support network. (See also Munyua & Asingwire, 2004).

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Nakaseke Multipurpose Community Telecentre. Nakaseke Telecenter is located in rural Nakaseke Sub-County about 50 miles north of Kampala. It is a network of villages that have a population of 31,000, about 1,000 of whom live in the proximity of the Nakaseke trading center. The telecenter was established in 1996 with funding from IDRC, ITU, UNESCO, and the Danish aid agency. The telecenter provides extensive services to the community that include a radio station, library, audio-visual resources, computers with Internet access (although they were temporarily off-line when I visited them), secretarial services, and computer training. They have an extensive network of community volunteers and supporters and service a set of 16 mini-centers in the neighboring area. (See also Mayanja, 2003).

Website:
http://www.nakaseke.or.ug/
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PrideAfrica DrumNet. Over the past 18 years, Pride Africa has delivered microfinance services to the informal sector in six African countries and has embedded its group-based model within existing traditional African cultural structures. The DrumNet

project is structured as a membership driven information and financial IT platform facilitating a network of interactions and transactions among rural smallholder farmers, commercial banks, large-scale buyers of farm products, produce transporters, field agents, and retailers of farm inputs. The purpose of the platform is to facilitate relationships, provide rules, keep records, and allow for the secure flow of funds and information among network participants.

Website:
http://prideafrica.com
Contact:
Jonathan Champaigne, jfc@prideafrica.com ; President

St. Henry's College, Computer Center. St. Henry's is a private, boy's residential secondary school located in Kituvo, Uganda, near the city of Masaka. The school has a history of participating in ICT projects, starting with the World Links for Development project in the late 1990's. The computer center has approximately 65 computers, many of them connected to the Internet. The school has a total of approximately 120 computers, altogether, many of them purchased by parents and alumni. There is little connection between the school and the surrounding community.

Website:
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SchoolNet Uganda. SchoolNet Uganda is a national network of professional educators and schools whose vision is to transform the Uganda educational system from an Industrial model (learning by assimilation) to a knowledge-based model to prepare the youth of Uganda to effectively enter a Global Economy based on Knowledge, Information and Technology. SchoolNet Uganda supports Uganda educators by providing pedagogical and technical expertise and advice, infrastructure and human resources, coordination, training and capacity building and developing SMART local and international partnerships in the areas of: Internet connectivity and appropriate technology, content and curriculum development, and human resources development and capacity building.

Website:
http://www.schoolnet.sc.ug/homepage.php?option=aboutus
Contact:

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Sengerema Multipurpose Community Telecentre. Sengerema is a rural area of nearly 50,000 people located west of Mwanza, Tanzania near Lake Victoria. Funded by IDRC, UNESCO, and ITU, the Sengerema Telecentre was started in 2001. Services of the Telecentre include a community radio station, computer training, Internet access, conference facility and meeting, secretarial and consultancy services. They have a paid staff of 6 with an additional 12 volunteer workers from the community (See also Nielinger, 2003.)

Website:
http://www.sengerema.or.tz/Default.htm
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Ugabytes. UgaBYTES initiative is Not-for-profit organization with a vision of promoting the integration of ICT in the development plans of East Africa. As a catalytic non-profit making organization, the UgaBYTES Initiative is particularly skewed towards disadvantaged community groups as well as rural and remote areas. Ugabytes plays an advocacy role and promotes awareness of the potential of ICTs among the general public and decision makers at all levels, promotes information sharing among stakeholders, and develops local capacity to manage, package and utilize information in multi-purpose telecenters.

Website:
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B. Potential Partners

Ending poverty in Africa is a major challenge that can not be met by one organization, project, to group working on its own. The recommendations made in this report require the efforts of donors, NGOs, and transnational corporations, as well as national governments, universities, and local companies. A variety of expertise, experiences, and resources are needed to create an African Knowledge Network that will enable Africans to pull themselves out of poverty, as well as create new markets. These include organizations that can provide:

- Specialized software and information in digital form and in local languages on Computers and peripherals

- Operating systems and general applications
- farm production, health, education etc.
- Multimedia equipment
- Satellite internet access
- Internet service
- LAN and Wi-Fi networking
- Technical training for network administrators, teachers, and community users
- Monitoring and evaluation
- Systems aggregation and integration
- Policy consultation
- Funding

Below are a number of organizations that have the technical expertise and the international experience relevant to the recommendations in this report. Many of these organizations have had experience in Africa, often in isolation from the efforts of other programs of other organizations. Each could contribute to the use of ICT and/or the improvement of education at local and national levels to empower Africans to pull themselves out of poverty. MVP could create huge synergies by acting as a neutral party to create a common set of goals and a framework to organize a coordinated set of actions among organizations with complementary expertise, resources, and skills. I recommend that the MVP strategically explore the interest of these organizations in working collaboratively to set up an African Knowledge Network and use ICT to improve education and the capacity of communities to develop their economic and social condition.

Academy for Educational Development (AED). AED is an independent, nonprofit organization committed to solving critical social problems and building the capacity of individuals, communities, and institutions to become more self-sufficient. AED works in all the major areas of human development, with a focus on improving education, health, and economic opportunities for the least advantaged in the United States and developing countries throughout the world. They have extensive experience in the use of ICT to promote development, particularly in Africa. They are a prime contractor under the USAID-funded dot-EDU program to promote digital opportunities for developing countries to improve their learning systems in innovative ways.

Website:
http://www.aed.org/TechnologyApplications/
Contact:
Dennis Foote, dfoote@aed.org ; Vice President and Director, Center for Applied Technology

Alcatel. Alcatel provides communications solutions to telecommunication carriers, Internet service providers and enterprises for delivery of voice, data and video applications. Alcatel has a strong presence in 38 countries of the African continent and is considered a long-term telecommunication solution supplier having been in Africa since 1950. Alcatel is committed to leverage its leading position in fixed and mobile broadband networks, applications and services to bring value to its African customers in the framework of a broadband world. Alcatel is also dedicated to the sustainable development of these countries and plays a major role in helping them to bridge the digital divide.

Website:
http://www.alcatel.com/lead/itu04.html
http://www.alcatel.com/sustainable/DigitalBridge/index.htm

Bill and Malinda Gates Foundation. The Bill & Melinda Gates Foundation is committed to promoting greater equity in global health, education, and public libraries. The goal of the Foundation's International Library Initiatives is to make sure that all people can access knowledge tools through no-cost access to information technology in public libraries.

Website:
http://www.gatesfoundation.org/Libraries/InternationalLibraryInitiatives/default.htm

Bridges.Org. The mission of Bridges.Org is to promote the effective use of ICT in developing countries to improve people's lives. They work at the policy level—by promoting policies and laws that foster widespread ICT use—and at the grassroots level—to help people understand ICT and its practical utility. Specifically, they: (1) provide information and resources related to the digital divide and technology use in developing countries; (2) advise decision-makers and the general public on key issues; and (3) support grassroots projects, local businesses and e-government efforts. Bridges.Org is a non-profit corporation in the United States and South Africa. Their work is supported by donations and grants from individual contributors, private foundations, international development agencies, governmental programs, and companies.

Website:
http://www.bridges.org/index.html
Contact:
Teresa Peters, tmpeters@bridges.org ; Executive Director.

Canada International Development Agency (CIDA). CIDA is Canada's agency for foreign aid. Africa is at the centre of Canada's cooperation agenda. Through the $500-million Canada Fund for Africa, Canada has taken a leadership role in responding to the first made-in-Africa vision for development, the New Partnership for Africa's Development (NEPAD), and the corresponding priorities of the G8 Africa Action Plan. Canada was the first G8 country to establish a fund specifically designed for these purposes. The Canada Fund for Africa ($15 million) is funding the International Development Research Centre's (IDRC) Connectivity Africa Program. This program will build on Canada's experience in connectivity projects in Africa and adapt Canadian expertise to the needs of African countries, especially in education, health, economic and community development. The intended result is increased connectivity and local content.

Website:
http://www.acdi-cida.gc.ca/cida_ind.nsf/0/CF4F96B1D73F9AF685256D18004AFC56?OpenDocument

Carnegie Foundation. Carnegie Corporation of New York is a general-purpose, grantmaking foundation established for the advancement and diffusion of knowledge and understanding. Overseas grants are currently concentrated in Commonwealth Africa. The Foundation's International Development Program (IDP) was established in 1999 for the express purpose of carrying out Carnegie Corporation activities in sub-Saharan Africa. Focused primarily on higher education in Africa, the Program aims to improve access to, and utilization of, information and communication technology; train institutional leaders and managers; and promote gender equity.

Website:
http://www.carnegie.org/sub/program/intl_development.html
Contact:
Narciso Matos, nma@carnegie.org ; Program Chair

Commonwealth of Learning (COL). COL is an intergovernmental organization created by Commonwealth Heads of Government to encourage the development of open learning and distance education, through the fostering and sharing of knowledge, resources and technologies. Headquartered in Vancouver, Canada, COL is the world's only intergovernmental organization dedicated solely to promoting and delivering distance education and open learning. COL is committed to assisting Commonwealth member governments to take full advantage of open, distance and technology-mediated learning strategies to provide increased and equitable access to education and training for all their citizens.

Website:
http://www.col.org/about/whatis/

Cisco Systems. Cisco is a leading provider of network equipment and solutions. Within Cisco, the Cisco Networking Academy Program is working to achieve digital equity in underserved areas to benefit low-income individuals, certain ethnic groups, people in disadvantaged communities and those with disabilities. The Academy provides skills students need to work in IT fields. The program offers Web-based content, online assessment, hand-on labs, instructor training, and preparation for industry certifications. The Least Developed Countries (LDC) Initiative was introduced in July, 2000, as a program to provide opportunities for IT training in an effort to bridge the digital divide in the LDCs of the world. Currently, 33 least developing countries are participating in the initiative; most of them are in Africa.

Websites:
http://www.cisco.com/en/US/hmpgs/index.html
http://www.cisco.com/web/learning/netacad/index.html
http://www.cisco.com/web/learning/netacad/digital_divide/ldc/index.html

Department for International Co-operation, France. The Department for International Co-operation is the agency for foreign aid in France. France has wholeheartedly committed itself alongside its African partners in order to ensure that the benefits associated with the information society are shared out fairly. In addition to the number of initiatives that France has launched with a view to narrowing the digital divide, France also supported the setting up of the Digital Solidarity Fund from the outset.

Website:
http://www.diplomatie.gouv.fr/en/france-priorities_1/internet-multimedia_2347/smsi-tunis-2005_2483/the-digital-divide_2554.html

Department for International Development (DFID), United Kingdom. DFID is the agency for foreign aid in the UK. Imfundo: Partnership for IT in Education is an initiative in DFID which considers ways in which Information and Communication Technology can be used to support Education in Sub Saharan Africa. The aim of Imfundo is to create partnerships to contribute to the delivery of universal primary education and gender equality in Africa, through the use of ICT.

Website:
http://www.dfid.gov.uk/research/imfundo.asp

Education Development Center, Inc. (EDC). EDC is a non-profit research institute that manages 335 projects in 50 countries, including 13 in Sub-Saharan Africa. Their projects span the areas of early child development, K-12 education, health promotion, workforce preparation, community development, learning technologies, basic and adult education, institutional reform, medical ethics, and social justice. EDC's Global Learning Group's Center for Innovative Technologies focuses on the application of ICT to support development goals in the fields of information technology strategy, distance training and education, e-commerce, e-governance, and expanding ICT access.

Website:
http://www2.edc.org/GLG/#INFO
Contact:
Janice Brodman, jbrodman@edc.org ; Center Director

Ford Foundation. The Ford Foundation is a resource for innovative people and institutions worldwide. Their goals are to: strengthen democratic values, reduce poverty and injustice, promote international cooperation and advance human achievement. Their Knowledge, Creativity, and Freedom funding program recognizes that knowledge and creativity are central to the richness of people's lives and the progress of communities. They have three regional offices in Sub-Saharan Africa. Among the goals of their Nairobi office are to support communities, the poor, and the disenfranchised in their efforts to secure access to justice as well as to the information, skills and assets they need to take control of their lives and gain the confidence and capacity to build a better future.

Websites:
http://www.fordfound.org/global/office/index.cfm?office=Nairobi
http://www.fordfound.org/global/office/programs.cfm?office=Nairobi&language=english
Contact:
Tade Aina, ford-nairobi@fordfound.org; Foundation Representative

Free Software and Open Source Foundation for Africa (FOSSFA). The Foundation provides grants to institutions and individuals seeking to improve the lives of poor people. FOSSFA works with all stakeholders to ensure that Open Source is available as a platform to engineer solutions that meet the needs of Africans at affordable prices. FOSSFA also strives to work closely with the NEPAD ICT component, UN

Agencies and other development partners in spearheading ICT development in Africa. FOSSFA's vision is to create awareness of Open Source software, build capacity in Open Source software, develop a knowledge warehouse of expertise in the African countries/continent, develop national and regional Open Source portals. FOSSFA intends to achieve this by urging key government organs to support open source development in Africa, leveraging various free and open source capacities and resources in Africa, urging donor governments and other institutions to consider funding open source software in their developmental activities, and urging governments to adopt free and open source software.

Website:
http://www.fossfa.net/tiki-index.php?page=FOSSFA

Global e-Schools and Communities Initiative (GeSCI). GeSCI was established by the United Nations ICT Task Force to raise global standards of education for communities in the developing world and make the U.N. Millennium Development Goals a reality. GeSCI works at the local, national, and international level to support, to create, and to implement strategies to harness ICTs for education and community growth. Using a multi-stakeholder approach, GeSCI focuses on delivery, offering project development and management, strategic support, facilities and resource mobilization, and implementation. They currently work in Ghana, Namibia, India, Bolivia, and countries in Central America and the Caribbean.

Website:
http://www.gesci.org/gesci/publisher/index.jsp
Contact:
Stephen Nolan, stephen.nolan@gesci.org ; Executive Director.

Global Knowledge Partnership (GKP). The GKP is a leading international multi-stakeholder network committed to harnessing the potential of ICT for sustainable and equitable development. The GKP's activities focus on: Convening knowledge sharing events, brokering multi-stakeholder partnerships for knowledge sharing and increasing effectiveness of ICT for development initiatives, promoting innovation in the use and appropriation of ICT for development initiatives and knowledge sharing, facilitating mobilization of investments in ICT for development at local, national, and global levels, and influencing policy, regulatory frameworks and public opinion
Website:
http://www.globalknowledge.org/gkps_portal/index.cfm

Hewlett Foundation. The Foundation concentrates its resources on activities in education, environment, global development, performing arts, and population. Within the Education Program, the Foundation supports efforts to increase student achievement by developing, demonstrating, evaluating, and disseminating approaches to systematically improve classroom instruction in urban school systems and to improve access to exemplary postsecondary and K-12 educational content through a variety of approaches, including supporting institutions to make high-quality content freely available on the Web. The Foundation also has a Global Development Program that works with the Foundation's other programs to support efforts to improve the effectiveness of universal basic and secondary education in the developing world.

Website:
http://www.hewlett.org/Programs/Education/
http://www.hewlett.org/Programs/GlobalAffairs/

Hewlett Packard Corporation (HP). HP is a world leader in the sale of lap top computers, servers, pocket PCs, and printers. The company is committed to tacking some of the world's toughest challenges, including increasing access to technology and environmental sustainability, by aligning their business and global citizenship strategy and collaboration across the industry and with multinational organizations, governments, and NGOs. From 2000-2005, HP launched programs and projects under its e-inclusion initiative, which was designed to increase access to technology and accelerate economic development in underserved communities around the world. Together with key partners from the international development community, government and local communities, HP deployed technology to assist individuals and communities in areas including education and micro enterprise business development. HP's Digital Community Center project strategically deploys ICT to encourage the participation and inclusion of all appropriate parties in the economic and social development. These centers were created to help underserved communities in Europe, Middle-East and Africa to access education through information technologies.

Websites:
http://grants.hp.com/
http://www.hp.com/e-inclusion/en/index.html
http://www.hp.com/e-inclusion/en/project/project_dcc.html

Information for Development Program (*info*Dev): *info*Dev is an innovative global partnership of international development agencies focused on how ICT can help to combat poverty and promote opportunity, empowerment and economic growth in developing countries. This partnership is coordinated and served by an expert

Secretariat housed at the World Bank, one of *info*Dev's principal donors and founders. The Program's goals are to enable ICT access for all, mainstream ICT as tools for development and poverty reduction, and support innovation, entrepreneurship, and growth.

Website:
http://www.infodev.org/section/aboutus
Contact:
Mostafa Terrab, mterrab@worldbank.org ; Program Manager

Intel Corporation. Intel is the world's largest chip maker is also a leading manufacturer of computer, networking, and communications products. The Intel® Innovation in Education (IIE) initiative focuses on preparing teachers and students for tomorrow's demands. The goals of this initiative are: Improving science and math in primary and secondary education, increasing the effective use of technology in classroom teaching, broadening access to technology, and increasing the number of people, especially women and minorities, pursuing technical careers. IIE currently works in 25 countries around the world.

Websites:
http://www.intel.com/index.htm?iid=Corporate+Header_Intel_logo&
http://www97.intel.com/education/index.asp
Contacts:
Wendy Ramage Hawkins, wendy.hawkins@intel.com ; President, Intel Foundation
Paige Kuni, paige.kuni@intel.com ; World Wide K-12 Education Manager

International Development Research Institute (IDRC). IDRC is a Canadian Crown corporation that works in close collaboration with researchers from the developing world in their search for the means to build healthier, more equitable, and more prosperous societies. IDRC funds research activities that are designed to provide direct benefits to developing countries and their citizens. The Acacia Initiative is an international program to empower sub-Saharan communities with the ability to apply ICTs to their own social and economic development. This initiative is designed as an integrated program of research and development and demonstration projects Connectivity Africa, an initiative hosted by IDRC that is part of Canada's response to the G8 Africa Action Plan. Connectivity Africa's mission is to accelerate innovation, adoption, and development in ICTs in Africa to address issues of applications, technology, infrastructure, policy, and governance. IDRC funded several of the community telecenters reviewed in this report.

Websites:
http://www.idrc.ca/en/ev-1-201-1-DO_TOPIC.html
http://www.idrc.ca/en/ev-5895-201-1-DO_TOPIC.html
Contacts:
Richard Fuchs, rfuchs@idrc.ca ; Director, ICT for Development
Steve Song, ssong@idrc.ca ; Managing Director, Connectivity Africa
Edith Adrea, eadera@idrc.or.ke ; Senior Program Specialist, Kenya

International Institute for Communication and Development (IIDC). IICD is an independent non-profit foundation, established by the Netherlands Minister for Development Cooperation in 1997. Its sources of core funding are the Dutch Directorate-General for Development Cooperation (DGIS), the UK Department for International Development (DFID) and the Swiss Agency for Development Cooperation (SDC). IICD assists developing countries to realize locally owned sustainable development by harnessing the potential of ICTs. They work extensively in Africa. IICD works with its partner organizations in selected countries, helping local stakeholders to assess the potential uses of ICTs in development. They also strengthen the capacities of our local partners to formulate, implement and manage development policies and projects that make use of ICTs. IICD funded several of the community telecenters reviewed in this report.

Website:
http://www.iicd.org/
Contacts:
Saskia Harmsen, sharmsen@iicd.org ; Knowledge Sharing Officer

International Literacy Institute (ILI), University of Pennsylvania. ILI was officially established in 1994 by UNESCO and the University of Pennsylvania Graduate School of Education. The mission of the ILI is to provide leadership in research, development, and training in the broad field of international literacy and development, with an emphasis on developing countries. The ILI organizes regional and international conferences, disseminates the *ILI Newsletter, Literacy Innovations*, and is involved in a number of significant research, development, training, and networking activities around the world, particularly those related to the use of ICT to support literacy. *Literacy.org* is a gateway to electronic resources and tools for the national and international youth and adult literacy communities. The Bridges to the Future Initiative (BFI) addresses the Digital Divide of education and technology in emerging economies by improving literacy, basic education, and technological literacy, thereby assisting the world's poorest peoples to better determine their own social and economic future.

Website:
http://www.literacyonline.org/ili.html
http://www.literacyonline.org/index.html
http://literacy.org/bfi_ili/index.html
Contact:
Dan Wagner, wagner@literacy.upenn.edu ; Director

Japan International Cooperation Agency (JICA). JICA is the foreign aid agency in Japan. Through JICA, Japan provides support to developing countries around the world on issues related to poverty reduction, education, health, agriculture and rural development, environmental management, and ICT. JICA has identified five development goals in the ICT field: (1) the formulation of policies to improve the quality and quantity of ICT services and to give social consideration to users, (2) the development of a communications infrastructure, (3) human resources development in the area of ICT, (4) the promotion of ICT use in various sectors and (5) the improvement of aid quality and efficiency through the use of ICT.

Websites:
http://www.jica.go.jp/english/global/info/index.html
http://www.jica.go.jp/english/countries/af/index.html

Microsoft Corporation. Microsoft is the world's leading developer of operating systems, software products, and solutions for business, government, and education. The company is committed to helping countries improve their global competitiveness, promote local economic growth and development, and drive innovation. Microsoft also recognizes that for millions of people the promise of technology is still unrealized. They have made a comprehensive commitment to promote digital inclusion. Working with their partners around the world, by 2010 they plan to provide ICT training to a quarter billion people who were previously underserved by technology.

Websites:
http://www.microsoft.com/mscorp/default.mspx
http://www.microsoft.com/industry/publicsector/default.mspx

MIT Media Lab. The Media Lab provides a unique environment within MIT to explore basic research and applications of ICT, without regard to traditional divisions among disciplines. Research at the Media Lab comprises interconnected developments in an unusual range of disciplines, such as software agents; machine understanding; how children learn; human and machine vision; audition; speech interfaces; wearable computers; affective computing; advanced interface design; tangible

media; object-oriented video; interactive cinema; digital expression—from text, to graphics, to sound; and new approaches to spatial imaging, nanomedia, and nanoscale sensing. The MIT Media Lab has launched a new research initiative to develop a $100 laptop—a technology that could revolutionize how we educate the world's children. To achieve this goal, a new, non-profit association, One Laptop per Child (OLPC), has been created by the Lab.

Websites:
http://www.media.mit.edu/research/
http://laptop.media.mit.edu/

Motorola. Motorola is a global communications leader that provides mobility products and solutions across broadband, embedded systems and wireless networks. The company is comprised of four businesses: Connected Home Solutions, Government & Enterprise Mobility Solutions, Mobile Devices and Networks, including its Canopy Wi-Max platform. Through its corporate charity, Motorola supports education and community development around the world.

Websites:
http://motorola.canopywireless.com/
http://www.motorola.com/content/0,,5120-8165,00.html

New Partnership for Africa's Development (NEPAD). NEPAD is designed to address the current challenges facing the African continent. The goals of the organization are to eradicate poverty; place African countries, both individually and collectively, on a path of sustainable growth and development; halt the marginalization of Africa in the globalization process and enhance its full and beneficial integration into the global economy; accelerate the empowerment of women. Among NEPAD's priority areas is facilitating and supporting the development of Africa's ICT infrastructure. Related to this, NEPAD seeks to lower the cost and improve reliability of telecommunication service; to achieve e-readiness for all countries in Africa; to develop and produce a pool of ICT-proficient youth and students from which Africa can draw trainee ICT engineers, programmers and software developers; and to develop local-content software, based especially on Africa's cultural legacy.

Website:
http://www.nepad.org/2005/files/home.php

OneVillage Foundation. The goal of the OneVillage Foundation is to promote ecologically and socially responsible development in emerging markets through a comprehensive and synergistic set of programs called the OneVillage Foundation

Initiatives (OVI). Multipurpose Community and Unity Centers (MCCS) are the delivery vehicle for OVI. MCCs will be designed as physical convergence points for local community revitalization and improvement featuring the most relevant sustainable practices and technologies. Centers will enable field agents and local people to work together to develop local networks to effectively implement OVI development approaches. The Center plans to include a Connection Portal to enable external and globally linked field agent support network.

Website:
http://www.onevillagefoundation.org/ovf/index.html
Contact:
Joy Tang, joy@onevillage.biz; President

Open Knowledge Network (OKN). OKN grew out of the Digital Opportunity Task Force (DOTForce) set up by the G8 Heads of State to make a decisive contribution to bridging the digital divide. The G8 Genoa Plan of Action called for national and international effort to support local content and applications creation. OKN works in Sub-Sahran Africa, Southern Asia, and Latin America. OKN is a human network, which collects, shares and disseminates local knowledge and is supported by flexible technical solutions. Local content development is closely tied to human development, and the ultimate aim of OKN is the empowerment of local communities.

Website:
http://www.openknowledge.net/

Rockefeller Foundation. The Rockefeller Foundation is one of the world's major philanthropic foundations. The Foundation provides grants to institutions and individuals seeking to improve the lives of poor people with a focus on the issues and region where we work. The Foundation focuses on a set of critical issues that affect the lives of poor people: hunger and malnutrition, the burden of disease, employment, the availability and quality of housing and schools, and creativity and cultural expression. The Foundation's work in Eastern and Southern Africa focuses on agriculture, arts, education, health, and global inclusion. The Foundation sees technological innovation as a primary instrument of change.

Websites:
http://www.rockfound.org/
http://www.rockfound.org/iandr/EasternAndSouthernAfrica

SES-Global. SES-Global is a European-based company that provides a full range of satellite services that include: media broadcasting, enterprise solutions, mobile broadband solutions, government services, and global solutions. They supply satellite-based service to Sub-Saharan Africa through their Astra 4A and, in the future, Sirius 4 satellites. Through their Corporate Responsibility program, the company focuses on supporting educational initiatives, and aims to expand the basis for the development of a knowledge and communications-based society in every region of the world. They believe that this is a key element in the emergence of a model for sustainable development.

Websites:
http://www.ses-global.com/ses-global/homepage.php
http://www.ses-global.com/ses-global/siteSections/SES_The_Group/responsiblity/index.php

SRI International (SRI). SRI is an independent, nonprofit research institute conducting client-sponsored research and development for government agencies, commercial businesses, foundations, and other organizations. SRI is well known for its innovations in communications and networks, computing, economic development and science and technology policy, education, energy and the environment, and engineering systems, among other areas of research. They are internationally known for ICT-based systems development and integration. Its Center for Science, Technology and Economic Development (CSTED) helps regions, organizations, and businesses become more successful in today's economy through more effective science and technology, economic, and educational programs and policies. Its Center for Technology in Learning (CTL) develops and evaluates ICT-based solutions for education, including large-scale evaluations of ICT-based projects for the World Bank, the Gates Foundation, the U.S. Department of Education, and the International Association for the Advancement of Educational Achievement, among other clients.

Websites:
http://www.sri.com/rd/
http://www.sri.com/policy/
http://ctl.sri.com/
Contacts:
Matty Mathieson, john.mathieson@sri.com ; Director CSTED
Jeremy Roschelle, jeremy.roschelle@sri.com ; Director, CTL

Swedish International Development Agency (SIDA). SIDA is the primary agency for foreign aid in Sweden. SIDA's goal is to make it possible for poor people to improve their living conditions by reducing injustices and poverty throughout the world. Their aid focuses on poverty reduction, health, education, economic development, and sustainable environment. SIDA provides extensive aid to countries of Sub-Saharan Africa. SIDA's ICT for development (ICT4D) strategy aims to identify ways in which ICT can be used to reduce poverty and to promote democracy, human rights and social development in SIDA's partner countries. They believe that information and communication are prerequisites for the realization of the economic, social and cultural rights to which all individuals are entitled.

Websites:
http://www.sida.se/sida/jsp/sida.jsp?d=103&language=en_US
http://www.sida.se/sida/jsp/sida.jsp?d=707&language=en_US

United Nations Education, Scientific and Cultural Organization (UNESCO). UNESCO functions as a laboratory of ideas and a standard-setter to forge universal agreements on emerging ethical issues. The Organization also serves as a clearinghouse – for the dissemination and sharing of information and knowledge – while helping Member States to build their human and institutional capacities in education, science, culture, and the arts. UNESCO's Communication and Information Sector (CI) has the goals of promoting: the free flow of ideas and universal access to information, the expression of pluralism and cultural diversity in the media, and access for all to ICTs. In addition to it regular program, the CI Sector implements various inter-regional, regional and national projects with extra-budgetary funding mainly in Africa, the Arab States, Asia, the Pacific, Latin America and the Caribbean. An example of this regional approach is the ICT in Education Policy project of the UNESCO Bangkok office, with provides workshops, tools, and training to regional governments in the areas of policy, teacher training, teaching and learning, indicators and technologies.

Websites:
http://www.unescobkk.org/index.php?id=76
http://portal.unesco.org/ci/en/ev.php-URL_ID=1509&URL_DO=DO_TOPIC&URL_SECTION=201.html
Contacts:
Elizabeth Longworth, e.longworth@unesco.org ; Director, Information Society Division
Cedric Wachholz, c.wachholz@unescobkk.org ; Chief, ICT in Education Unit, Bangkok

United States Agency for International Development (USAID). USAID is the principal U.S. agency to extend assistance to countries recovering from disaster, trying to escape poverty, or engaging in democratic reforms. USAID supports long-term and equitable economic growth and advances U.S. foreign policy objectives by supporting economic growth, agriculture and trade, global health, democracy, conflict prevention, and humanitarian assistance. The Digital Opportunity through Technology and Communication (DOT-COM) program cuts cross all sectors, including education, economic growth, women in development, agriculture, trade, health, environment, and telecommunications/e-commerce policy. The three DOT-COM cooperative agreements provide expertise and services in policy (dot-GOV), access (DOT-COM), and learning systems (DOT-EDU).

Website:
http://www.usaid.gov/info_technology/dotcom/index.html
Contact:
Tony Meyer, ameyer@usaid.gov; Director, DOT-COM Project

World Links. World Links is a global learning network linking thousands of students and teachers around the world via the Internet for collaborative projects and integration of technology into learning. The core "value-added" of World Links is its training program, designed to help teachers and students learn to use information and communication technologies (particularly the Internet) to improve teaching and learning. They currently work in 35 countries, many of them in Africa.

Website:
http://www.world-links.org/index.php
Contact:
George Scharffenberger, george@world-links.org ; Executive Director

C. Additional Resources

Chapman, R., Slaymaker, T., & Young, J. (n.d.). *Livelihood approaches to information and communication in support of rural poverty elimination and food security*. London: Department of International Development. Accessed on the Web at: http://www.fao.org/rdd/livelihood_en.asp

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Global Knowledge Partnership (2003). *Youth, poverty, gender: ICT for development success stories.* Kuala Lumpur, Malaysia: Global Knowledge Partnership. Accessed on the Web at: http://www.globalknowledge.org/gkps_portal/index.cfm?menuid=201&parentid=179

Haqqani, A. (2003) *The role of information and communication technologies in global development*: *Analyses and policy recommendations.* New York: United Nations Information and Communications Technologies Task Force. Accessed on the Web at: http://www.unicttaskforce.org/perl/search.pl

Hughes, S., Eashwar, S., & Jennings, V. (2004). *How to get started and keep going: A guide to community multimedia centres*. Paris: UNESCO. Accessed on the Web at: http://portal.unesco.org/ci/en/ev.php-URL_ID=15665&URL_DO=DO_TOPIC&URL_SECTION=201.html

IDRC (2005). *Funding and implementing universal access: Innovation and experience from Uganda.* Ottawa, Canada: IDRC. Accessed on the Web at http://www.idrc.ca/openebooks/188-4/

Jensen, A. & Esterhuysen, M. (2001). *A community telecentre cookbook for Africa: Recipes for self-sustainability: How to establish a multi-purpose community telecentre in Africa.* Paris: UNESCO. Accessed on the Web at: http://unesdoc.unesco.org/images/0012/001230/123004e.pdf

Latchem, C. & Walker, D. (Eds.) (2001). Telecentres: Case studies and key issues. Vancouver, British Columbia: Commonwealth of Learning. Accessed on the Web at: http://www.col.org/telecentres/

Navas-Sabater, J., Dymond, A., Juntunen, N. (2002). *Telecommunications and information services for the poor: Toward a strategy for universal access*. Washington, D.C.: World Bank. Accessed on the Web at: http://www-wds.worldbank.org/servlet/WDS_IBank_Servlet?pcont=details&eid=000094946_02041804225061

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