HANDHELDS FOR HEALTH:

SATELLIFE'S Experiences in Africa and Asia

SATELLIFE

July 2005

This publication is dedicated to Dr. Bernard Lown, SATELLIFE founder and Chairman, whose vision, leadership, and wisdom gave launch to SATELLIFE and have sustained its flight.

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A Letter from the Executive Director

Dear Colleagues,

SATELLIFE's work over the past sixteen years has been to bridge the information and communication divide amongst the world's health providers and to support their efforts to share information and learn from each other. While we are sometimes mistaken for a technology organization – we have been on the cutting edge of some technologies by necessity – we are fundamentally a health information organization. Without the means to communicate ideas, we would be able to do little to improve the condition of the world's poor, so we have employed information and communications technologies (ICT) to carry the message of health and give voice to those working in challenging and resource-poor settings.

We embarked on our work before most people in the North were using email or the Internet. We have watched as the Web has grown to link most major cities in the world, including those in Africa and Asia. Over time, our technological support has changed to match the need. While we once used a low-earth-orbit satellite to carry some of the first email to Africa, health providers in major cities are now likely to have access to faster service through an Internet café. But these resources are still not reaching health providers where most live and work – in rural areas with no Internet Protocol (IP) addresses – some just miles outside the capitals.

We began thinking about using mobile computing technology to reach these providers several years ago and received our first funding for a handheld computer project from the Acumen Fund in 2001. We piloted the use of handheld computers for field surveys in Ghana during a measles immunization campaign with our partners from the American Red Cross (ARC). We also provided medical content to medical students in Kenya and to doctors in Uganda to see how they would use the small handheld devices. Bridges.org, a South African non-governmental organization (NGO), conducted the evaluation of our pilots that encouraged us to continue in this direction.

From the United Nations Millennium Action Plan

"Global health today is marked by a persistent divide in access to health services, paralleling the divide in information and communications. To attain health equity, relevant information – and the technologies to deliver it – must be widely available and effectively used. New technologies hold great potential for improving health care, primarily by increasing the quality, relevance and flow of information to health personnel. However, in many countries, we are far from having exploited this promise. This is due not only to financial, technological and infrastructure challenges as the term 'digital divide' suggests, but also because the real needs of the users – which vary greatly due to educational, social and cultural differences – are often overlooked.....Health information – relevant, timely and appropriate – must become unrestricted and affordable worldwide, so that all communities can benefit from this global public good." *(U.N. 2000)*

Pioneering the E-health Frontier

In 1989, when the Internet was just emerging into public awareness and the World Wide Web was still under development, a small non-profit organization in Cambridge, Massachusetts took the bold and unprecedented step of launching its own communications satellite. At a time when most Americans had yet to acquire their first PC, its goal was nothing short of revolutionary: to deliver email to remote sites in Africa. Though technologically innovative, this was no experiment in technology for technology's sake. The satellite was a means to a higher end: supporting information exchange and knowledge building among health professionals in the world's poorest countries. For communities where diseases of poverty claim thousands of lives every day, the breakthrough was not simply in delivering some of Africa's first email messages, but in identifying information poverty as a crisis demanding global attention.

SATELLIFE, which aptly derived its name from that groundbreaking satellite, has remained a catalyst in promoting knowledge building and knowledge sharing throughout the global health community. From its earliest store-and-forward email networks in Africa and Asia to its award-winning work with handheld computers and electronic information services, SATELLIFE has remained committed to finding cost-effective ICT solutions and building its partners' skills to use them.

Over the course of the last three years we have pushed handheld technology further, adding new devices and applications to respond to the needs of project partners in a dozen countries. We have learned a good deal in the course of this work, and that learning has not been limited to the handheld computer! There is as much to discover about people as there is about technology when you bring the two together for the first time – it is an exciting process. The fundamental lesson is that people who have never used an electronic device can easily and proficiently learn to use a handheld computer in a short period of time and can employ it effectively in their daily lives.

We have many favorite anecdotes: the doctor who was able to make a diagnosis that she otherwise might have missed by consulting the reference material on her handheld; the midwife who shares her unit with her neighbors so that they can read the national newspaper for the first time; the survey worker who can complete his work in half the time it used to take. But there have also been challenges. Each project has presented us with both complications and opportunities to try something new. And there have been projects where it just has not worked.

The following review of what we have learned to date does not dwell on technical or proprietary issues. We are not, for example, going to debate which platform is better – Palm OS, Pocket PC, or Linux – nor are we going to enter into a dispute about which forms development software is better. The bottom line is that one has to pick the right tools for the job at hand and the environment in which one is working.

We hope that this paper will both answer and raise pertinent questions about the use of ICT to support health care in resource-poor countries. First and foremost, we would like to provide some pointers to other organizations that may benefit from our knowledge and experience to optimize their own use of ICT in general or handhelds in particular. But we also hope to stimulate discussion of some of the daunting questions that, while beyond the scope of this paper, must be considered carefully by the international health and development community if we are to realize fully the promise of ICT to improve health in the world's poorest countries. These questions include:

- Can we reach a consensus on what data we really need and how to manage it, then develop processes that respect the workload of care givers and get the data into the hands of those who can really use it to make a difference?
- Can we coordinate our efforts to make sure our technologies are not competitive or proprietary, but rather responsive to real needs, cost-effective, and compatible?
- What is it going to require to take the myriad successful projects "to scale"?
- How can ICT be used to stem the mass migration of educated healthcare providers from the South to the North and ameliorate the devastating

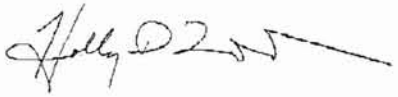
diminishment of medical and healthcare skills, knowledge, and experience in poor countries? And, given the stress on existing personnel, how do we manage the human resource challenges posed by introducing new technologies?

Our experience has proven that in discussing all of these issues, and however they are to be solved, we must keep certain goals constantly in mind. The driving motivation for all we do is our dedication to improving the lives and health of individual children, women, and men who, in the end, are treated by individual, hands-on healthcare providers. Whatever we do must be informed by a resolute commitment to these individuals as human beings. As health improves, so will the demand for education and economic growth. Our work must lay the foundation for meeting this demand by constantly building the capacity of local institutions and local people to manage their own healthcare systems, design and develop their own technology, educate and employ their own healthcare providers, and carry out their own academic and medical research to develop content relevant to their communities. Finally, we must proactively build institutions and infrastructure which foster the free exchange of ideas and information among the worldwide community of healthcare providers, with communication flowing equally well from South to North as from North to South.

While the focus of this paper is on handheld computers, we do not mean to suggest that the handheld computer is *the* solution to these monumental challenges. It is but one bridge across a large divide and but one of the tools we must exploit. The expanding reach of the cellular signal over the past five years has been remarkable indeed and opens up additional avenues for knowledge building and sharing. As you will read, our work in Uganda depends upon the growing cellular network to exchange information and we are excited about the number of sites we can now reach. But neither cell telephones nor handheld computers spell an end to information poverty. Rather, the progress we have made with these very powerful devices should encourage us to do more. In Rakai, Uganda, health workers who have used handheld computers are for the first time asking to be trained to use a desktop computer. They know that there is more just out of their reach and we need to find ways to expand their access.

We welcome your comments and questions on our work.

Sincerely,



Holly Ladd
Executive Director, SATELLIFE

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Voices of Our Partners

What is a PDA?

The terms "handheld computer," "personal digital assistant," and "PDA" refer to a small, lightweight computer designed to fit in a person's hand. They are powerful devices that make it possible to store, access, and organize a large volume of information quickly and easily. They can function as a date book, calculator, or address book; some versions also work as an alarm clock, telephone, or camera. PDAs can be used to send and receive email or to exchange information electronically with other devices. Information is entered into a PDA using a pen-like device called a stylus. Many early PDAs were powered by AAA batteries, but newer units run on self-contained rechargeable batteries.

Executive Summary

Using Technology in Health

Over the past four years, SATELLIFE has implemented handheld computer projects to support health care providers and institutions in a dozen countries. Based on its experience, partner feedback, and several independent evaluations, SATELLIFE recommends that organizations engaged in international health and development projects consider using handheld computers for both information dissemination and data collection and reporting. This document captures SATELLIFE's experience and lessons learned as a 16-year veteran of using information and communication technology (ICT) for health and an early adopter of handheld computers in low-resource environments.

PDA Basics: SATELLIFE has rigorously tested handheld computers in a variety of challenging environments, with these key findings regarding their basic utility:

- Portable, durable, and very powerful for their size, handhelds can perform many of the same tasks as a desktop or laptop computer at a cost of USD 100 - 200.
- Handhelds function well even in environments where electricity is only available through solar chargers, car batteries, or other alternative sources.
- Novice users have quickly adopted the technology, requiring only 1.5 – 2 days of training to master basic functions.
- Participants have reported high levels of comfort and satisfaction using handheld computers for both information access and data collection.
- Competent network and database managers require minimal training to support the use of handheld computers for routine information dissemination and data collection and reporting.
- Data and information can be shared rapidly across distances when handheld computers are used in conjunction with the existing telecommunications infrastructure, but the technology is also highly functional in remote locations where the telecom-

munications infrastructure is unreliable.

Information Dissemination: SATELLIFE has used handheld computers to deliver virtual libraries of information resources that would otherwise be unavailable to health professionals in resource-poor countries. This content has been adapted to the handheld format to facilitate ease of reading and navigation, and has included:

- medical textbooks, references, and newsletters
- drug databases
- national and international essential drug lists
- national and international disease treatment guidelines
- medical calculators
- diagnostic tools
- continuing provider development (CPD) and continuing medical education (CME) materials
- training materials
- local, national, and international news

Data Collection and Reporting: SATELLIFE has customized data collection tools for such diverse purposes as:

- patient tracking and record keeping
- pharmaceutical inspections and management
- program management
- public health program monitoring and evaluation
- routine epidemiological and public health data collection

Feedback from partners and independent evaluations indicate that handheld computers result in more rapid, accurate, and cost-effective data collection and reporting. This technology offers features that cannot be matched by traditional paper-and-pencil methods, including password-protected security, automatic back-up, branching, and self-checking. A cost-benefit analysis of a handheld computer network spanning two districts in Uganda indicated a 24% savings over traditional paper-and-pencil methods, with higher savings anticipated as additional surveys are converted to the handheld format.

Two-way Content Exchange: Used in conjunction with the cellular network, handheld computers are also capable of delivering health information to isolated communities without access to the Internet. For example, the Uganda Health Information Network (UHIN) relies on a mobile caching server to allow data collected in the field on a handheld computer to be transmitted to a central server via the GSM cellular network. Information flows equally smoothly in both directions: when an end user uploads data to the caching device, he or she may also download the latest news, clinical articles, continuing medical education materials, or virtually any other type of content that can be exchanged digitally. Two years into this project, over 120 remote facilities serving more than 1 million people without Internet access or, in some cases, electricity, are able to send and receive data , news, and medical updates.

Esther Nambala
Clinical Officer, Mbale District, Uganda

There is no doctor in residence at the health center where Ms. Nambala works. Ms. Nambala finds herself doing the work of a doctor.

"I use the PDA for many things…One of the major things is we fill in weekly and monthly surveillance forms and we take them to the district."

"I find it so interesting because the PDA is so portable. And you can read any where at any time, even when the lights are off or the lights are on. And I have been able to improve my knowledge as far as the medial field is concerned. It has really simplified work."

"[It has] helped people who didn't have any knowledge about the computer because basically it works like a computer….When people ask me what it is, I tell them a small computer."

"As time went on I discovered more things on my own—games and addresses."

Our Partners & Experience

Many of the lessons shared in this document have emerged from SATELLIFE's experience in building the Uganda Health Information Network (UHIN) in partnership with Uganda Chartered HealthNet (UCH) and Makerere University Faculty of Medicine, with funding from Connectivity Africa of the International Development Research Centre (IDRC) of Canada. SATELLIFE has also had the pleasure of partnering with a variety of other donors and organizations around the world to design customized handheld computer solutions to meet diverse data collection and reporting and information dissemination needs throughout the health care system. SATELLIFE has implemented handheld computer projects in partnership with:

- American Red Cross (ARC) to assess the efficacy of community outreach efforts for its measles vaccination campaign in Ghana.
- Strategies for Enhancing Access to Medicines (SEAM) Program, funded by the Bill and Melinda Gates Foundation and managed by Management Sciences for Health (MSH), to support the structured quality assurance processes developed for inspecting drug outlets (accredited and non-accredited) and pharmaceutical consignments received at the major ports of entry in Tanzania.
- Uganda Red Cross (URC) to manage blood donor recruitment and referral efforts.
- Nepali Technical Assistance Group (NTAG) to monitor and evaluate Vitamin A distribution as part of the dot-ORG initiative funded by the U.S. Agency for International Development (USAID) and managed by the Academy for Educational Development (AED).
- Access, Quality and Use in Reproductive Health (ACQUIRE), funded by USAID and managed by EngenderHealth, to support management of family health clinics in Bangladesh.
- Sustainable Healthcare Enterprises Foundation (SHEF) to manage inventory at locally owned drug supply shops in Kenya.
- World Health Organization (WHO) to assess the availability of HIV/AIDS related services in Ethiopia by collecting data from over 400 health facilities throughout the country.

Please see the Appedix for additional program information.

Beyond the Basics

While this paper addresses many handheld fundamentals such as power supply, software selection, and training, SATELLIFE's long experience in using ICT to support health professionals in the developing world has repeatedly shown that technology is only part of the equation. The successful deployment of handheld computer projects, or any other technology, depends at least as much, if not more, on a solid understanding of organizational change management and a sensitivity to the interests, needs, and concerns of the project's stakeholders. Key lessons learned in this arena include:

- The needs and interests of all stakeholders must be identified and addressed during the project design phase.
- A local champion, advocate, or thought leader can significantly improve a project's prospects for success.
- Introducing new technologies may disrupt established work patterns and relationships. Organizations must anticipate the challenges that arise from introducing change, and develop strategies to minimize and manage them.
- The individual user must be respected as an integral part of the team. Concerns regarding the impact of new technology on individual roles and responsibilities in the workplace must be anticipated and addressed.
- A sense of personal ownership of the technology should be cultivated so that individuals are inclined to safeguard their units and use them consistently and creatively.

Ollympia Kowero
Director, Inspection and Surveillance
Tanzania Food and Drugs Authority

"Inspection of pharmaceutical distribution outlets and ports of entry involves a lot of paper work and compilation of a lot of data and reports before decisions can be made. It was a costly and time-consuming process. The application of the PDA as an inspection tool has lessened time for inspection and decision making has been faster and, as a result, we have seen an increase in the number of inspections and an increase in the rate of compliance. The performance of the inspectors has also increased, and it totally justifies the cost of the PDA."

1. Handheld Computers: Not an Accessory, but a Lifeline

Handheld computers are transforming the way the health sector accesses and uses information to provide better service. A device costing just USD 100 can deliver a veritable library of life-saving information to frontline health workers, providing instant access to multiple textbooks, medical calculators, drug databases, and other critical resources, at the point of care. Handhelds are so useful in clinical practice that they have become commonplace in hospitals and are virtually *de rigueur* for new medical students – in wealthy countries.

Yet access-on-demand to critical health information need not be – indeed *should not* be – the prerogative of the well-to-do, especially when cost-effective solutions exist to expand that access to those in greatest need. SATELLIFE's recent work has demonstrated that handheld computers are capable of delivering urgently needed health information to the world's poorest communities, including those where the Internet and reliable telecommunications remain unaffordable luxuries. In rural villages where it is common for a lone nurse-practitioner to face a daily battle against AIDS, malaria, tuberculosis, malnutrition, and a host of other poverty-related diseases without the benefit of a medical journal, a telephone, or the World Wide Web, a handheld computer is not just a digital accessory, but an information lifeline.

SATELLIFE's award-winning work with handheld computers in Africa and Asia is another step in its efforts to combat information

Dr. Denis Bwayo
Subdistrict Bungokho South
Mbale District, Uganda

The rainy season's incessant downpour does not keep a long line of patients from forming outside Dr. Denis Bwayo's office in a small village about 150 miles east of Kampala. It is not unusual for him to see 60 patients in a single day at the outpatient department he manages at the subdistrict's headquarters. He also performs emergency surgery in the headquarters' 32-bed hospital and supervises the other 11 health centers in the subdistrict, a job that requires collecting weekly and monthly reports from all the sites and compiling a report for his district supervisors. It is no surprise that Dr. Bwayo characterizes his job as "a lot of work." "Many times you have to prioritize," he says. "You can't do everything."

But as Dr. Bwayo has discovered, with handheld computers, you can do more. Using handheld computers has significantly reduced the amount of paperwork he has to deal with every week. "It is easier to collect. The information is already electronic so I don't have to type it again into a computer." With a new line of people forming outside his office every day, he is already imagining how constructively he could use the time and money the district will save if handhelds can be used even more extensively in the future.

Dr. Patrick Okello
Project Manager, Uganda Health Information Network

Many forces conspire against health professionals' regular use of information in low-income countries, but Dr. Patrick Okello finds two of them especially vexing: there are virtually no medical libraries and, even if there were, health workers simply have no time to use them.

"We have been shown monuments that used to be libraries during colonial days, but there are no books inside them," said Dr. Okello. Universities and district health facilities do not have the resources to acquire the latest journals. Uganda's struggling economy also forces many health workers to take on two jobs. Medical doctors working at a rural health center earn about USD 250 per month, while nurses earn USD 50-100. The second jobs they take on to support their families leave little time for reading.

Handheld computers address both issues, carrying electronic libraries of information that health workers can consult at their convenience – on a bus ride home, over a quick break, or during a patient visit.

SATELLIFE's handheld computer work has received awards and recogntition including the Stockholm Challenge award for Health in 2002 (www.stockholmchallenge.se) and the Tech Museum Laureate in Health in 2004 (www.techawards.org).

poverty among health professionals in low-income countries. Founded on the complementary beliefs that access to quality health care is a fundamental human right and that information is the foundation upon which strong health systems are built, SATELLIFE sees barriers to information access as impediments to a healthier world. Its mission is to overcome these barriers and equip health professionals with the information they need to achieve the highest possible standards of care for their patients.

An "e-health" pioneer, SATELLIFE has developed a successful strategy for combating information poverty by:

1.) identifying cost-effective ICT tools to connect health professionals to each other and to vital information resources;

2.) using these tools to deliver content that meets their needs; and

3.) building local capacity so that end users and technical support personnel, including network managers, database managers, and trainers, are able to use and support the technology into the future, well after SATELLIFE has left the scene.

The simplicity of the "3 Cs" formula belies the many considerations that have led to SATELLIFE's success over the years. This report will address those considerations specifically as they relate to the organization's most recent work with handheld computers, in part because of the growing interest in the technology itself, but more broadly, because the lessons that emerge are relevant to many of the challenges involved in meeting the information needs of health professionals around the globe.

2. The Impact of Information Poverty on Global Health

In wealthy nations, information is the lifeblood of medical practice. The typical American or European patient would be shocked and alarmed if his physician failed to consult the latest research, treatment protocols, or drug guidelines related to his case. Even with the benefit of a well-informed practitioner, he is still likely to go home and do a thorough search on the World Wide Web, confident of finding a wealth of relevant information.

A typical patient in Africa has no such expectations about the role that information will play in her care. She knows that the nurse in the village's one-room clinic has no computer to consult, no textbook, and maybe not even a telephone to call a neighboring village for advice. There is simply no recourse to health information, no matter how complicated the case. The quality of care she receives, regardless of her condition, will be limited to whatever knowledge the nurse has retained from basic training.

While this scenario is all too common in rural communities, one need not travel to such remote locations to understand the crippling effects of information deprivation on global health. Urban health professionals and medical students are also handicapped by a lack of information. Leading medical libraries in Africa may subscribe to a handful of medical journals. By comparison, the Countway Library of Medicine at Harvard University

carries 3,000 journals.[1]

High-level decision making is hampered by information poverty as well. In countries such as Ethiopia and Uganda, where per capita spending on health is USD 14 and USD 57 per year[2], respectively, over strapped Ministries of Health must allocate their scarce resources wisely. Quite literally, every penny counts. Donor agencies must also make informed decisions about where to invest coveted aid and personnel. But the information required to make such decisions is often unavailable or unreliable. Paper-and-pencil data collection on such fundamental issues as births and deaths, disease prevalence, and drug usage is cumbersome and prone to human error during the transcription and data entry phases. The forms themselves are vulnerable to loss and damage. Months may elapse between the time data is collected in the field and analyzed for decision-making. Often, the people who can make the most use of the data – the health practitioners who collected it in the field – never even see the reports generated by their efforts. As a result, decisions are made at every level of the health system in a knowledge vacuum, with decision-makers unable to avail themselves of the information they need to develop appropriate responses to real health needs and to allocate resources as effectively as possible.

The Digital Divide – Far From Over

The concepts of "information poverty" and the "digital divide" are inextricably linked. Broadly speaking, information poverty results from critical information being unavailable in *any* format or media. It is not a new problem. However, the digital divide – the persistent disparity between rich and poor nations' access to and effective use of ICT – exacerbates the phenomenon by increasing the gap between the information "haves" and the information "have nots".

While a relatively small number of organizations, including SATELLIFE, the Association for Progressive Communication (APC), the Network Startup Resource Center (NSRC), and Volunteers in Technical Assistance (VITA) began addressing the digital divide in the 1980s, the issue moved to the forefront of the international development community's agenda in the mid- 1990s. An international coalition of donor agencies, NGOs, academic institutions,

foundations, and the private sector mobilized to combat the knowledge gap. With United Nations Secretary General Kofi Annan repeatedly expressing concern about the global ramifications of the digital divide,[3] the United Nations system, including the International Telecommunication Union (ITU) and the World Health Organization (WHO), assumed a leading role by launching such initiatives as the UNICT Task Force, the UN Information Technology Service (UNITes), the World Summit on the Information Society (WSIS), and the Health Internetwork Access to Research Initiative (HINARI).[4] Bilateral and multilateral donors, corporations, and foundations have also invested significant resources in combating the digital divide, as evidenced in the World Bank's Information for Development Programme (infoDev),[5] USAID's Leland Initiative[6], IDRC's Connectivity Africa and Acacia initiatives,[7] the G-8's Digital Opportunity Task Force (DOT-Force),[8] Hewlett Packard's World e-Inclusion Program,[9] and the Gates Foundation's Global Libraries Program,[10] to name just a few. The confluence of need and resources has resulted in hundreds of "e" projects in every sector: e-health, e-governance, e-commerce, and e-education. These efforts, combined with the inexorable march of market forces, have demonstrated notable success. Today, all of the 54 countries and territories in Africa have Internet access. [11]

Despite these strides, the digital divide is far from over. In a 2001 report entitled *Spanning the Digital Divide: Understanding and Tackling the Issues,*[12] Bridges.org noted that although developing countries have increased their access to and use of ICT, so have developed countries – at an even faster pace. Consequently the disparity between countries is increasing rather than decreasing. Within countries there also exists a divide between the "haves" and "have nots." As the "haves" exponentially increase their access to ICT, the "have nots" lag increasingly farther behind, widening the divide between the two internal groups. These disparities hit hardest among the highly vulnerable rural poor.

The rapid expansion of cell phone use in Africa provides a good model of how emerging technologies can help close these persistent inequities. A discussion draft of a 2005 World Bank Report, *Financing Information and Communication Infrastructure Needs in the Developing World: Public and Private Role*[13], points to the

"How will it help Veronica?"

by Rich Fuchs

Rich Fuchs, the Director of Information and Communications Technologies for Development (ICT4D) at the International Development Research Centre (IDRC) of Canada, recently traveled to Uganda for a firsthand look at the Uganda Health Information Network. While visiting a UHIN site in Rakai, Uganda, Rich met Veronica, a midwife participating in the project. His account of that visit powerfully illustrates how a simple PDA has transformed her life and brought new hope to her rural community. He and the rest of the IDRC team were so impressed by what they learned in Rakai that they began to gauge the value of other ICT4D solutions that were proposed during the trip by asking themselves 'How will it help Veronica?"

Veronica is a midwife in the Rakai District in southern Uganda. Hers is a "Level II" health clinic, or among the most rural in this region of 1.5 million people. As the senior medical officer supervising five other people, her clinic has no electricity, no running water and, until recently, no communication with the outside world. For the entire district, only twenty copies of the government-controlled popular daily tabloid, *New Vision,* come to just a few of the local leaders each week. GSM telephony is now possible, but hardly anyone in Veronica's community owns a cell phone.

Twice a week Veronica travels seven kilometers, either by foot or cycle, to charge the battery of the PDA she has received because her clinic has been connected to the Uganda Health Information Network. She invites me and my IDRC colleagues to sit down at the rough-hewn wooden clinic reception table, looks us straight in the eye, and talks.

Veronica uses her PDA for her work and for her community. She periodically travels to the wireless router that stores the surveillance report for the entire district and where she uploads her center's reports and can download news and medical information. If there is an outbreak of measles somewhere else in the district, she'll learn of it before it comes to her community. Then she can return and advise people how to prevent the illness that's nearby.

Equally, if her own report shows a local rise in cholera, the district will review her data and send medications and specialist assistance to help out. It used to take six months before the district would respond to this type of distress message, if at all. Only 20% of her previous paper reports made it to the district office because they would get lost or despoiled by weather en route. Now more than 90% of her reports get where they need to go.

A certified midwife, Veronica isn't a nurse but the local people call her "doctor". She is expected to know how to treat all sorts of illness, not just help families deliver their newborns. From the medical downloads to her PDA, Veronica learns how to diagnose and treat common illnesses, which weren't part of her medical training.

Just as important, Veronica gets news from Kampala and the world downloaded to her PDA. People come to the clinic to take turns reading the news on her PDA. She has to be careful about how she manages this. If too many people want to read from it, the battery will be exhausted even faster forcing her to make even more frequent trips to recharge the battery. A simple $40 solar charger would fix that.

My colleague asks her, "Veronica, what would you say if we had to take away your PDA? What would you do then?" Steely eyed, but smiling, Veronica ignores the question and responds, "I need a solar charger!" Needless to say, she'll get one.

---- adapted from "How will it help Veronica?" in a forthcoming book by the same author.

huge progress in mobile telephony access due to an immense infusion of private investment and favorable government interventions during the 1990s. The report states that as much as 77 per cent of the world's population may already be under the mobile footprint.[14]

The conclusion to be drawn from the report is not that cell phones have eliminated the digital divide. After all, living under the mobile footprint in Africa does not necessarily guarantee that someone can afford a cell phone with an average monthly cost of USD 27 in a country like Ethiopia where the annual per capita income is USD 100.[15] The object lesson is, instead, that there exist sufficiently favorable conditions in Africa for cell phones to be a viable tool in the battle against the digital divide. We can learn much from the successful market penetration and creative applications of this technology as we look for ways to integrate additional tools into the continuum of solutions for improving information access in poor countries. This continuum runs from high-speed, high-bandwidth Internet connectivity on one end to the old-fashioned "sneaker network" on the other. In between, every option available must be explored and exploited to maximize the potential for access while minimizing costs. Cell phones are clearly part of this continuum, as are smart phones, memory caching systems, and, as this paper discusses, handheld computers. The diversity of options and the speed with which new technologies are emerging demands creative thinking, funding, training, and collaboration among the many organizations that have a stake in bridging the digital divide so that limited resources are not squandered on systems that are redundant or incompatible, either with each other or with technologies already being used.

(Endnotes)

[1] Countway Collections Library Overview. 19 July 2005. <http://www.countway.med.harvard.edu/countway/collections.shtml>

[2] United Nations Development Programme. *Human Development Report 2004*. 15 July 2004. 19 July 2005. < http://www.undp.org.in/hdr2004/>.

[3] For example see, Annan, Kofi. "Kofi Annan's IT Challenge to Silicon Valley." 5 Nov. 2002. 5 July 2005.
<http://www.unicttaskforce.org/sg_challenge.html>.

[4] See websites <http://www.unicttaskforce.org>, <http://www.unites.org>, <http://www.itu.int/wsis/>, <http://www.hinari.org>.

[5] See website <http://www.infodev.org>.

[6] See website <http://www.usaid.gov/locations/sub-saharan_africa/initiatives/

leland.html>.

[7] See websites <http://www.connectivityafrica.org>, <http://www.idrc.ca/acacia/>.

[8] See website <http://www.accenture.com/xd/xd.asp?it=enweb&xd=aboutus%5Ccitizenship%5CDot_force.xml>.

[9] See website <http://www.hp.com/e-inclusion/en/>.

[10] See website < http://www.gatesfoundation.org/Libraries/InternationalLibraryInitiatives/>.

[11] "African Internet Connectivity." 19 July 2005. <http://www3.sn.apc.org/africa/>.

[12] Bridges.org. *Spanning the Digital Divide: Understanding and Tackling the Issues.* May 2001. 19 July 2005. <http://www.bridges.org/spanning/pdf/spanning_the_digital_divide.pdf>.

[13] The World Bank. *Financing Information and Communication Infrastructure Needs in the Developing World: Public and Private Roles.* February 2005. 19 July 2005. <.http://lnweb18.worldbank.org/ict/resources.nsf/InfoResources/04C3CE1B933921A585256FB60051B8F5>.

[14] Ibid, p. 10.

[15] United Nations Development Programme. *Human Development Report 2004*. 15 July 2004. 19 July 2005. < http://www.undp.org.in/hdr2004/>.

3. Breaking New Ground: Handheld Pilots in Ghana, Kenya, and Uganda

In 1999, SATELLIFE was well aware that many "last-mile" health practitioners remained unable to access critical information. The challenge was to find a technology that was affordable, easily adoptable by novice computer users, and functional in environments where electricity, Internet connectivity, and landline and cellular telephony might be limited or unavailable, and dust, glare, and other unfavorable conditions were the norm. The portability and relative affordability of battery-operated handheld computers suggested them as a possible solution, as did the growing popularity in the U.S. of tools such as Epocrates,[1] a drug database, and the Physicians' Desk Reference[2] for PDAs. But could they make a real dent against information poverty in Africa? Thanks to a grant from the Acumen Fund[3], SATELLIFE was able to explore that question in three countries: Ghana, Kenya, and Uganda.

In each country, a different population with different information needs was targeted. In Ghana, community volunteers used the devices to collect data from adults accompanying children to measles vaccination sites sponsored by the American Red Cross (ARC).[4] They collected data used by the ARC to assess the efficacy of their outreach efforts. In Kenya, medical students from Moi University Faculty of Health Sciences were equipped with handheld units loaded with content relative to their current rotations in obstetrics/gynecology, internal medicine, and pediatrics. In Uganda, practicing physicians affiliated with Makerere University Faculty of

Medicine were given handheld units containing basic reference materials. In each location, SATELLIFE explored several basic questions regarding the use of the handhelds: Would they function properly? Would participants learn how to use them quickly and efficiently? Would the content they contained be responsive to real needs?

The Ghana pilot yielded compelling evidence of the value of handheld computers for data collection and reporting. Thirty Ghanaian Red Cross volunteers, including several computer novices, were trained over a two-day period to conduct surveys on outreach efforts for a measles vaccination campaign. The surveyors then spread throughout the target region to conduct assessments over the course of the three-day campaign. The data from 2,400 surveys were turned into the ARC project leaders at noon on the following day and transferred from the handheld computers to a database on a laptop computer at a rate of thirty seconds per unit. Analysis was completed promptly and a complete report was delivered to the Ministry of Health by the end of the day. Typically, the data entry alone would have taken forty hours using traditional paper-and-pencil surveys.

The Kenya and Uganda pilots demonstrated the value of using handheld computers for information dissemination. The sixth-year medical students at Moi University and the physicians in and around Kampala received handhelds loaded with customized packages of content including:

- country-specific malaria, tuberculosis, and HIV/AIDS treatment guidelines from the national Ministry of Health and/or the World Health Organization (WHO)
- WHO Essential Drug list
- country-specific essential drug lists
- medical references and textbooks
- medical calculators

In Uganda, 95 per cent of the participants reported that using the medical reference materials over the course of three months improved his or her ability to treat patients effectively. Physicians cited improvements in diagnosis, drug selection, and overall treatment. In Kenya, where the handhelds were used over the course of two eight-week clinical rotations, the majority of students

Dr. Francis Abwaimo
Director, Mbale District Health Services, Uganda

Dr. Francis Abwaimo was doubtful about what handheld computers could do to help people in Mbale district, a mountainous banana and coffee growing region where many roads have remained impassable since landslides washed away bridges in 1999 and there is one doctor for every 15,019 people. "I was skeptical as to whether this could really succeed in a rural district," he admits. "To deliver something new will always bring difficulty."

He quickly changed his mind. Novice computer users among his staff took to the new technology immediately and enthusiastically. "They were amazed at what it was able to do," Dr. Abwaimo reports. His staff easily adapted to collecting data with their handhelds. There is no medical library in the district, and the Internet is too expensive for regular use, so they welcomed the continuing medical education resources and treatment guidelines the units carried.

Dr. Abwaimo confesses he was surprised not only by how well health workers integrated handhelds into their daily routines, but also by the level of interest shown by other departments in the district, including education and community development. "Teachers and social workers are also asking where they can get the training and where they can get the PDAs," he said. Such excitement could lead to the kind of inter-departmental cooperation that would make using handhelds possible not just in remote Mbale, but throughout the country.

Dr. Robert Mayanja
Director, Rakai District Health Services, Uganda

There is one doctor for every 22,467 people in Rakai, a rural district about 188 miles southwest of the capital city. With his staff stretched so precariously thin, the local Director of District Health Services welcomed the introduction of handheld computers in the district's health facilities because he anticipated that improvements in data collection and reporting would lead to better disease surveillance and more rapid responses to emerging needs. Dr. Robert Mayanja has not been disappointed.

Pointing to his district's program for the prevention of mother-to-child transmission of HIV (PMTCT), Dr. Mayanja explains how handhelds are helping to improve health in Rakai. Effective PMTCT requires a specific drug to be administered to newborns within two hours of birth, but lower-level health centers do not keep the drug in stock. Using the district's wireless handheld computer network, health workers can better manage the drug supply, ensuring that babies are treated during the critical timeframe and given the chance for a healthy life.

Patrick Madaya
HMIS Officer, Mbale District, Uganda
Mr. Madaya is a biostatistician in charge of the health management system for Mbale District and is responsible for sending reports to the Ministry of Health in Kampala. He also provides user support to PDA users at the district health centers.

"At the moment, those health center staff, those who are competent with the PDA, it is very easy now because when they come and beam it onto the Jack, it is very easy to get that information within the shortest time possible. [The PDA] is a very big advantage."

"For those of us who are connected to the Internet, it is so easy to send our information. And [the PDA] is cutting down some costs because we used to send the information to the Ministry and you needed to get some out-of-pocket money for transport. It has also reduced some risks. I'm talking of moving from Mbale to Kampala. Those accidents involved on the way."

"You can get some reading materials on the PDA, which you couldn't get before. Before you could get only maybe one book from the library which could be not be shared by many other people. Now if you have the PDA with that information, you read and then your friend can also read, but still it remains to keep on reading because it is now like a book."

actively used the treatment guidelines and calculator, and all of them referred to the medical references and textbooks during their clinical rotations.

Additional key findings included:

- In all three countries, participants mastered basic functions of the handhelds within approximately a day and a half of training.
- Volunteers, students, and physicians alike reported a high degree of satisfaction and felt the technology helped them to perform tasks better.
- In the case of Ghana, the ARC reported a significant cost savings as a result of using the devices to conduct interviews in place of the traditional paper-and-pencil methods and found that data collected with the handhelds was more accurate and timely. [5]

These results led an independent evaluation by Bridges.org to conclude that handheld computers are a useful and viable technology in the healthcare environments tested, that they are an effective tool for data collection in under-resourced areas, and that they are cost-effective. [6]

Encouraged by these results, SATELLIFE continued its work with handheld computers, seeking opportunities to develop projects that would test the technology under a variety of conditions. To date, SATELLIFE has implemented handheld computer projects in a dozen countries, responding to diverse needs at all health systems levels, including:

- patient tracking and record keeping
- pharmaceutical inspections and management
- program management
- public health program monitoring and evaluation
- routine epidemiological and public health data collection
- continuing provider development (CPD) and continuing medical education (CME)

For a comprehensive list of SATELLIFE's PDA projects, please see the Appendix.

Endnotes

[1] See website <http://www.epocrates.com>.

[2] Skyscape. "PDRDrugs: Physicians' Desk Reference", CD-ROM for PDA, 2002 Version.

[3] See website <www.acumenfund.org>.

[4] See website <www.redcross.org>.

[5] Kearns, Krystal. "PDA Results: Social Mobilization a Success." *American Red Cross.* 19 July 2005. <http://www.measlesinitiative.org/ghanaj.asp>.

[6] Bridges.org. "Evaluation of the SATELLIFE PDA Project, 2002." 19 July 2005. <http://www.bridges.org./satellife>.

4. Handheld Basics: Lessons Learned from Hands-on Experience

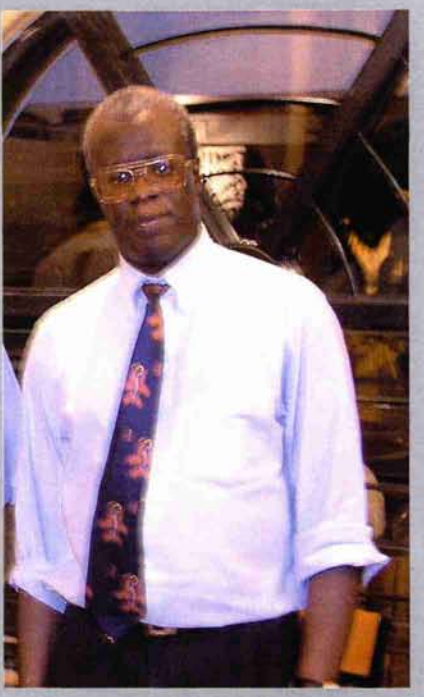
SATELLIFE has had to grapple with many fundamental questions regarding the overall viability, utility, and cost-effectiveness of handheld computer technology. SATELLIFE is not the only organization using handheld computers in low-income countries, but with close to 2,000 units distributed through unique projects, it is distinguished by its widespread and diverse uses of this technology. The best practices and lessons learned presented here are drawn from that experience for the benefit of others who may be contemplating introducing or expanding their use of handheld computers in the health sector and beyond.

PDA Basics

The nature of PDAs inherently conveys many benefits to the user, regardless of the environment in which they are deployed. Portable, durable even in harsh conditions, and very powerful for their size, PDAs can perform many of the same tasks as a desktop or laptop computer at a fraction of the cost. While it is not a substitute for a conventional computer, a PDA costing USD 100-200 is a workable and cost-effective alternative, especially in under-resourced environments.

SATELLIFE evaluated the viability of PDAs on the basis of several basic criteria, with the following findings:

Dr. Nelson Sewankambo
Dean, Makerere University Faculty of Medicine, Uganada



Dr. Nelson Sewankambo has been on the forefront of ICT for health in Africa for over fifteen years. Working in partnership with SATELLIFE since the early 1990s he has played a leading role in establishing the HealthNet Uganda project, delivering email and information resources to medical faculty and students before commercial service was available. Over time that project evolved into a full-fledged NGO, known today as Uganda Chartered HealthNet, with Dr. Sewankambo serving as the Chairman of its Board of Directors.

Dr. Sewankambo has been a vocal proponent of using handheld technology to support health workers in both urban and rural settings; under his guidance UCH has become the implementing partner of some of Africa's earliest and most ambitious handheld computer projects, including the Uganda Health Information Network (UHIN). While extremely gratified by the success of this work, Dr. Sewankambo does not underestimate the next set of challenges: scaling up and sustainability. The next phase of the project includes scaling up in both Rakai and Mbale. Sustainability requires buy-in not only from the Uganda Ministry of Health, but also from the NGOs that provide about 40 per cent of health care services in the country. But Dr. Sewankambo is undaunted. "Every so often we hit a bottleneck, but we go around it, and then we are moving again," he said.

Ultimately Dr. Sewankambo envisions a national electronic-based health care system in which data is collected, analyzed, and acted upon; medical practitioners can access appropriate information when needed; patient records are electronically stored and easy to retrieve; and technical and human resources are available to support the system. He is determined, but patient: "We are not underestimating what it takes to do that. We don't expect it to happen in five years – probably not even in ten years. But we hope we will be making one small step at a time. One small step at a time will add up to thousands of steps."

Fatuma Matovu
HMIS Officer, Records Officer of Rakai District, Uganda

Ms. Matovu is the coordinator of the PDA project in Rakai and is the health district's data manager. Health clinics in Rakai use the PDAs for gathering data for weekly and monthly reports. "The work was made easier, and reporting increased from 70% to 90%," she reports.

"The information [reported] was more accurate. Since it was a new technology, everyone was eager to learn because some of them had never even touched a computer. The users are so interested in seeing the daily news and other content." The health workers use the PDA to read medical journals and look up treatment guidelines. "They could get medical journals from every place, and then they can get more information about treatments for their own patients."

Using the PDAs has impacted how she does her job. "It is very easy. In fact I can now complete the data management work in just two days a month, and this used to take every day! I'm all finished with my work and I can do other things assigned to me by my boss."

Assessing Your Data Needs and Data Flow

The successful introduction of handheld computers requires an organization to think about a wide range of internal processes. Some of the questions that need to be explored seem obvious at first, but can yield surprisingly unexpected results, especially when they are posed to different stakeholders within the organization. SATELLIFE helps its partners articulate its data needs, map its existing data flow, develop a plan for integrating handhelds into existing work patterns, and navigate some of the bumps that arise during the transition to the new technology.

A number of key questions must be addressed at the outset of this process:

- *What data is being collected, and why?*
- *Is there agreement on the usefulness of the data being collected? On the specific questions being asked?*
- *How is data shared and moved between various stakeholders?*
- *Who has access to the data at various points in the data flow? Why?*
- *Which stakeholders are excluded from data access? Why?*
- *How often do various stakeholders need access to the data?*
- *Does analysis of the data make its way back to the field? How? If not, why not?*

Memory - The memory capacity of most PDAs is sufficient for even large data collection projects. A typical unit has a memory in the range of 8-64 MB, and this can be increased to 256 MB or more through the use of an expansion card. For all PDAs currently available commercially, a loss of power results in memory loss. However, future models will contain non-volatile memory.

Back-up - Redundant systems can be created to back up data directly on the unit, onto a back-up card, and into a central database.

Data Security and Privacy - PDAs can be equipped with password protection to ensure the security of the data in the event that the unit is misplaced or stolen. Governments and donor agencies are likely to have specific confidentiality requirements which can be met by customizing the security features of each PDA.

Training - Ease of use has always figured prominently in SATELLIFE's selection of technology, and PDAs have performed well in this area. With good training, novice users have consistently been able to master basic handheld functions in a day and a half and more complex functions within three days. Age, gender, and lack of previous computer experience have not been barriers to successful training.

Technical Support - The successful use of handhelds requires technical support from trainers and database managers. While this support can theoretically be provided remotely, SATELLIFE's experience has been that good on-site support – at least in a central office, if not in the field – is a strong guarantee of a handheld computer project's success. In most cases, SATELLIFE has found that existing ICT personnel with solid training and database experience have been able to acquire sufficient expertise to support the use of handhelds by their colleagues within a matter of 1-2 weeks. However, while handhelds are easily adoptable, problems and questions about their use inevitably arise after the initial introduction and training period. Project design, especially if the units are to be used for increasingly complex or protracted applications, should anticipate both this need and ICT staff turnover so that ongoing training or ad hoc problem solving can be provided to technical support personnel and database managers.

Screen Size - The relatively small screen size of handheld computer does not in and of itself constitute an obstacle to their widespread use, as long as content is designed or adapted accordingly. Most of the content SATELLIFE has distributed via PDAs, including medical texts and references, medical calculators, and data collection tools, has been easy to read. However, there are some types of content, such as diagrams and illustrations, which do not lend themselves particularly well to the small screen.

Durability & Maintenance - SATELLIFE has distributed close to 2,000 PDAs since 2002, with a failure rate of less than 1 per cent. Despite PDAs' durability, the lack of commercial distributors in Africa, and in many parts of Asia and Latin America, makes repair and replacement problematic. SATELLIFE purchases units in the United States, then ships them to its project partners around the world. Whenever possible, a small pool of back-up units is acquired in anticipation of loss and breakage.

Portability - The typical PDA measures approximately 4.4 inches/11cm x 2.9 inches/7cm and weighs 4.1oz./ 142 grams, making them highly portable.

Power - SATELLIFE has introduced handhelds in a variety of settings, ranging from urban universities to rural clinics. Each poses its own challenges in terms of powering units. In areas where the power supply is erratic, surge protectors are recommended during re-charging. In areas where there is no electricity, SATELLIFE has successfully used both AAA batteries and solar panels. Battery-operated units are increasingly difficult to purchase, and batteries are both expensive and difficult to obtain, so solar panels may be the most viable alternative for most locations.

Availability - Commercial distribution of PDAs in resource-poor countries is extremely limited at this time. SATELLIFE hopes that its own efforts and those of other organizations using PDAs successfully around the world will encourage industry leaders to recognize the potential of this market and make

the technology more widely available worldwide.

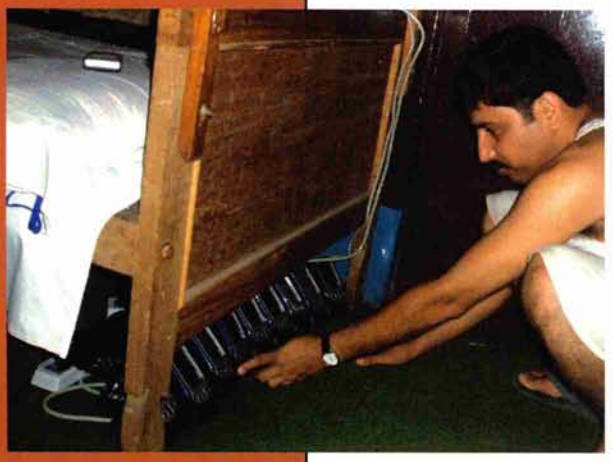
Content

Much of the power and potential of handhelds lies in their ability to hold a virtual library of information resources, both static and interactive. SATELLIFE and its partners have successfully used handhelds to disseminate a diverse range of content, including:

- medical textbooks, references, and newsletters
- drug databases
- national and international essential drug lists
- national and international disease treatment guidelines
- medical calculators
- diagnostic tools
- training materials
- local, national, and international news

The key lessons learned from SATELLIFE's experience in using handhelds to disseminate content are consistent with those it has learned in using other technologies:

- Content must be current, reliable, and relevant to local needs.
- To the fullest extent possible, content should be locally generated.



As is the case with any medium, SATELLIFE has found that adapting existing content to the handheld format requires careful consideration of how the technology will be incorporated into existing work patterns. Will the user need to check a reference quickly at the point of care or will she have time to study text at her own convenience? Will the user have the opportunity to download new content on a regular basis or infrequently? A thorough understanding of the end user's needs and the conditions under which she will be using the handheld results in a more effective tool. As mentioned earlier, while the screen size of a PDA is completely compatible with many types of content, some items, such as diagrams, illustrations, images, and tables may be difficult to capture in this medium.

Data Collection

In the face of the burgeoning monitoring and evaluation requirements of many donor-funded programs and the existing reporting requirements of local Ministries of Health and other government bodies, handheld computers have proven to be especially well-suited to data collection and reporting in resource-poor environments. The volume of data to be collected and analyzed by already over-burdened health workers is enormous. Efficiency is stymied by the painstaking and error-prone process of recording data with paper and pencil, manually keying the data into a computer database, cleaning and analyzing the data, translating it into usable reports, and circulating those reports back to stakeholders. Handheld computers make it possible to streamline this cumbersome and costly process.

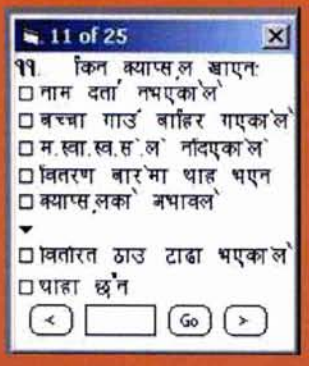
SATELLIFE's approach is to build the capacity of its partners to convert existing paper-based data collection forms to an electronic, handheld-compatible format, build and manage the requisite database(s), train end users, and provide ongoing technical support. SATELLIFE's goal is to leave each partner capable of independently continuing and expanding its use of the technology well into the future.

The conversion of existing paper-based forms to the handheld format can be accomplished using both commercial and open-source software [1]. SATELLIFE works with its partners to identify the appropriate software and analyze and adapt paper-based forms for successful conversion to the electronic format. Experience has shown that with proper training, electronic forms can be created and downloaded onto each unit by anyone who has a good understanding of databases.

Electronic forms can be fashioned with a variety of special features that are simply impossible to capture on paper. Prompted by an individual's response, branching makes it possible to skip automatically from one question to another. Verification can be built in to avoid such mistakes as entering too large a number for someone's birth date or number of children. Pull-down menus can be created to provide the data collector with all possible answers to a given

A Note on Language

The largest market for handheld computers has been in countries where the Latin alphabet is predominant. However, SATELLIFE has demonstrated that localization to non-Latin scripts is possible. As part of USAID's dot-ORG initiative, managed by the Academy for Educational Development, SATELLIFE and its sister organization HealthNet Nepal (HNN) worked with the Nepali Technical Assistance Group (NTAG) and local software developers to convert a paper-based data collection form written in Devanagari script into an electronic format compatible with handheld computers. SATELLIFE's strategy was to build local capacity to achieve the conversion. As the screen shot below illustrates, the effort was successful, enabling community health workers to use the handhelds to collect data on Vitamin A distribution in rural Nepal.



question. All of these features reduce the possibility of human error and save time. The conversion process requires a high degree of customization to meet the needs of specific organizations and institutions, but yields excellent results.

Properly executed, the conversion from paper to PDA produces a user-friendly interface. Questions (also known as "fields") appear on the handheld's screen and the user enters information using the handheld's stylus like a pen or pencil. For many types of questions, data entry can be as simple as pointing and tapping the stylus to select the correct answer from an on-screen menu or number keypad. For more open-ended questions, the user can learn "graffiti," the special alphabet recognized by handheld computers, or pull up a keyboard and "type" in data using the stylus. Once data is collected, the handheld unit is synchronized with a central database using a cable or cradle. Data is downloaded and available for analysis virtually instantaneously.

SATELLIFE has helped organizational partners use handheld computers to collect data for a wide range of purposes, as these examples illustrate:

- **Ghana**: To assess the efficacy of community outreach efforts for an American Red Cross-sponsored measles vaccination campaign.
- **Tanzania:** As part of the Strategies for Enhancing Access to Medicines (SEAM) Program [2], funded by the Bill and Melinda Gates Foundation and managed by Management Sciences for Health (MSH), to support the structured quality assurance processes developed for inspecting drug outlets (accredited and non-accredited) and pharmaceutical consignments received at the major ports of entry.
- **Uganda:** To manage the Uganda Red Cross' blood donor recruitment and referral efforts. [3] To record and transmit weekly disease surveillance data, monthly Health Management Information System (HMIS) reports, and for accessing medical information related to malaria, pneumonia, TB, and other health problems.
- **Nepal:** To monitor and evaluate Vitamin A distribution by the local NGO Nepali Technical Assistance Group (NTAG) as part of the dot-ORG initiative funded by USAID and managed by the Academy for Educational Development (AED). [4]

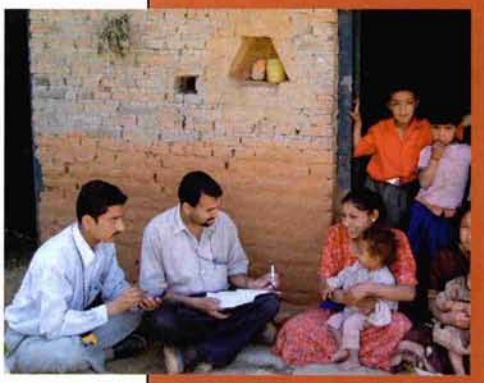
- **Rwanda:** To support the National Electoral Commission's country-wide voter registration efforts, also under dot-ORG. [5]
- **Bangladesh:** To support management of local family clinics under USAID's Access, Quality and Use in Reproductive Health (ACQUIRE) initiative, managed by EngenderHealth. [6]
- **Kenya**: To manage inventory at locally owned drug supply shops affiliated with Sustainable Healthcare Enterprise Foundation (SHEF). [7]
- **Ethiopia**: As part of WHO's Service Provision Assessment, to assess availability of HIV/AIDS-related services in Ethiopia by collecting data from over 400 health facilities throughout the country.

It is important to note that handheld computers may not lend themselves well to all data collection needs. For example, open-ended questions that require lengthy transcriptions of interviews are difficult to capture on a handheld. Data collectors must either write graffiti very clearly and rapidly or they must use the stylus to type onto the electronic on-screen keyboard, neither of which is convenient for long texts. SATELLIFE anticipates that this problem will diminish in the future as PDAs with built-in digital voice recording become more affordable.

Data Transfer

The movement of data from a handheld computer to another computer can be accomplished in several ways, including:

1. Synchronizing the unit directly with a personal computer or laptop via a cable;
2. Capturing data on a small, portable, memory card and transporting it from one point to another;
3. "Beaming" from one unit to another via infrared or Bluetooth;
4. Modem-to-modem transmission via the Internet involving either a landline or cellular telephone;
5. Using WiFi network in areas where WiFi radios ("hotspots") are available;
6. Using mobile caching servers for delivering content and applications to handheld devices through cellular telephony.



Of these, methods 4-6 are the most useful for transmitting large

Bluetooth technology uses a microchip that enables short-range wireless connections between computers, PDAs, cell phones, keyboards, printers, and digital cameras using a frequency that is globally available and compatible.

WiFi is a system of wireless networking that can connect computers to each other and to the Internet without the use of cables through high frequency radio signals.

volumes of data quickly across distance. However, they are also the most dependent on the local telecommunications infrastructure, the cost and quality of which may influence whether handheld technology is appropriate for data transfer in some locations.

Cost Considerations for Deploying PDAs in Health and Development Projects

When evaluating and comparing various methods of data collection in low-resource settings, there are both quantifiable measures (the costs of acquiring equipment, the training of staff, or the hourly costs of personnel) and intangible factors (the inconvenience of carrying large amounts of paper, the problem of long-term storage of data, or the caution required to protect a PDA from damage or theft) to weigh. A return on investment (ROI) analysis which does not account for these "soft" costs and benefits will not provide a true measure of the payback from deploying technology in resource-poor settings.

To date, our assessments of quantifiable data have compared the costs of deploying handheld computers to the cost of conducting business in traditional ways. In analyzing the costs of the application of handheld computer technology to data collection and surveys, one must recognize that the costs of the hardware, software, and training associated with PDAs will be amortized over many projects, while paper, printing, storage, and data entry costs are incurred with each and every project. We have consistently found that surveyors were able to complete more surveys in the same amount of time with a PDA as compared to the paper process. Additional savings are achieved when electronic transmission of data eliminates the time and the cost of sending staff to the field to collect completed forms or bringing surveyors to a central site to deliver them. Similarly, much time is saved when data from the handheld is conveyed electronically directly to a database on a central computer. Experience shows that this last step alone can save days or even weeks, depending on the number of forms (records) to be entered into the database. By eliminating delays created by data entry personnel keying each field from the accumulated forms, significant cost savings are realized.

Factors to Consider in Comparing Health Care Survey Costs:

PDA	Paper
unit costs	paper (supply and cost)
software	printing / photocopying
solar charger	forms development
forms development time	aggregation (paper collection)
training	training
transportation and logistics	transportation and logistics
deployment / field work	data confirmation
synchronization / data transmission	data entry
	paper storage

Using PDAs with Other Technologies

Handheld computers are versatile devices that can be adapted to serve many different projects, but sometimes a PDA accomplishes only part of the task at hand and additional tools are required. The appropriate tools have to be selected based upon a variety of factors including intended use, number of users, cost, and complexity.

Add-on devices for PDAs include those which can enable or expand the PDA user's ability to transfer information to other users or other storage devices. Cables can connect PDAs to cell phones or modems for data transfer. More advanced technologies include Bluetooth, for wireless data transfer among handheld devices and larger computer systems, and WiFi, which provides wireless Internet access.

Other technologies can increase the handheld computer user's ability to gather information quickly or allow him to gather different kinds of information. Cameras, voice recorders, bar code scanners, and global positioning receivers can be combined with PDAs possessing slots for either secure digital cards (SD cards) or compact flash cards (CF cards). Developers are working on smart card readers and even fingerprint

readers to extend the functions of the PDAs. These various add-on devices can increase the quality and scope of data captured. For example, photos can be attached to enhance teaching materials; bar code readers may contribute to effective management of the flow of goods and supplies; a survey of census populations can be mapped relative to services by including GPS coordinates; and patient records can be stored on smart cards which allow data retrieval at multiple sites using similar equipment as the patient travels though the network of providers and services.

While much of this advanced technology can be found integrated into high-end PDAs, the cost of these multi-functional units is quite high relative to the cost of single function equipment fitted with the appropriate add-on (for example, a Zire PDA + Garmin GPS + cable will cost approximately USD 250, while the comparable PDA with built-in GPS will cost between USD 400 and USD 500). Decision making about the correct devices is key to a project's success.

(Endnotes)

[1] SATELLIFE has used Pendragon Forms and Perseus to generate forms and is currently testing Happy. As mentioned elsewhere in the paper, SATELLIFE has also worked with partners in Nepal to develop customized forms in Devenagari script. AppForge and CodeWarrior were used in that project.

[2] Speed, Arin & Mwemezi Elnathan Ngemera. "Using New Technology to Increase Productivity: The Role of PDAs in Facilitating Inspection and Monitoring." *Management Sciences for Health.* 19 July 2005. <http://www.msh.org/seam/conference/presentations/Agenda/AgendaDay2/ArinSpeedParallelTrack.pdf>.

[3] See "The Uganda Red Cross Society Fact Sheet" http://www.ifrc.org/meetings/regional/africa/6thpac/panfs/uganda.doc>.

[4] See "dot-ORG Nepal Health Monitoring Pilot Project" <http://www.aed.org/Projects/dotorgnepal.cfm>.

[5] See "GLOBAL dot-ORG" <http://www.aed.org/Projects/globaldotorg.cfm>.

[6] See "What is ACQUIRE?" <http://www.acquireproject.org/>.

[7] See website <http://www.cfwshops.org/>.

View from an Organizational Partner ...

Michael Tetelman *is the Acting Director of the USAID funded dot-ORG Program at the Academy for Educational Development in Washington, DC. Through the dot.ORG initiative, AED and SATELLIFE have partnered on PDA projects in Nepal and in Rwanda. Rwanda presented an opportunity to step outside the health sector and test the use of the handheld technology in e-governance, working with the Rwanda National Electoral Commission.*

SL: Michael, how do you view the work in Rwanda in the context of paper versus electronic data capture?

MT: There's a real revolution going on in Rwanda voter registration in data gathering at a local level. And there's a critical need to think about how to deal with the major amounts of paper loss and inaccuracies due to a paper-based registration system.

As far as the pilot, I couldn't have been happier with it. Everyone acknowledged there wasn't a lot of time.... We didn't have time to really test out the capacity of the field staff of the NEC, who were trained on the PDAs, over several months, but it was enough to get a sense of how an implementation would go. It was an important snapshot into what are the initial challenges and strategies for building capacity of the staff, for helping them work effectively with voters who may be concerned with issues of security--having data put into this kind of new system--given the genocide and other incidents. SATELLIFE was very sensitive to that.

It was a successful pilot and pointed out some of the key issues when thinking about scaling up to a national level. Again, the project did focus on Kigali, the capital, which has in some respects different power and infrastructure issues than rural areas. So there are a lot of caveats. We weren't doing [the pilot] in the hardest regions in Rwanda. But at least we got our toe in the water, so to speak, in terms of identifying the basic processes for how data was gathered and then hot synced. And it was important in terms of helping us better define what the PDAs could truly be used for.

SL: So now the National Election Commission has decided to scale-up nationwide with the technology; how do you see that happening?

MT: The [Rwanda] National Electoral Commission said it was a very interesting pilot and we want to ramp this up to a national level. We want to get PDAs out to cover all 106 districts in Rwanda.... One of the big issues in development is there are millions of little pilots about the landscape and one of the concerns is that it would be nice to see how many pilots are taken to a national level or reach a level. So we were really behind this idea of trying to adapt [the pilot] for a national scale up, based on the lessons that we had learned from round one. *(The national scale –up started in June 2005.)*

What I hope for is in say a year's time, all the bugs will have been worked out of the system, NEC will have gone into it in depth and it is an embedded part of their process. There are many other parts of the region, many countries, and more broadly they could use this [approach] as well. NEC could serve as a resource for other countries that are looking to do the same kind of thing. ...There is information sharing. Election commission officials visit other countries in Africa and elsewhere about water marking, security issues, so hopefully this will be no different. ... And obviously there's so much potential in health and traceability, for example, in national resource management--logging products, you name it. The idea is to keep capitalizing on this wave. ... There's so much being condensed now in handhelds and the cost is going down. ...Hopefully, the sky's the limit.

(continued on page 40)

5. The Human Element: Managing People and Organizational Change in a Handheld Computer Project

Handheld computers are simply a tool; the people who use them will determine whether or not they are successful. None of the technical issues raised thus far factor as prominently into the success of a handheld computer project as do human beings. The failure to understand and plan for the needs, expectations, skills, concerns, and sometimes conflicting interests of various stakeholders can undermine the most technologically sound projects. As with any significant change, the introduction of new technology may be disruptive to an organization. SATELLIFE works with its partners to manage the change introduced by handheld computers and to anticipate and avoid some of the common pitfalls. Key lessons learned on the human element of technology projects are discussed in this chapter.

Identifying and Respecting Stakeholders

Identification of all the stakeholders – and there are always more of them than is first apparent – is essential. When something as politically charged as information access is at stake, the relationships between stakeholders, including policy makers, administrators, and program managers from the local to the national level, as well as health and technical support personnel in the field, are especially important to understand. How will the introduction of technology alter their relationships? Is there widespread agreement among them about the purpose for introducing

the technology? Does everyone agree about which need(s) the technology is meant to address? Do they agree that this technology is the best solution for those needs? Is there buy-in from everyone who can influence the implementation and outcomes of the project? Are roles and responsibilities clear? A failure to harmonize interests and expectations at an early stage will jeopardize the project.

Finding Local Champions

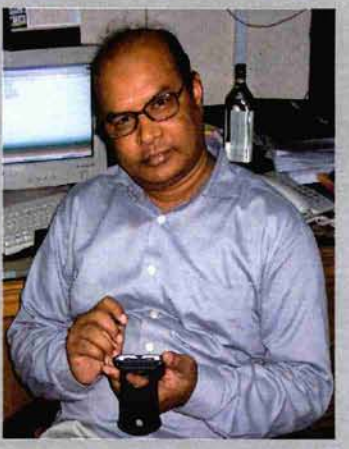
A perennially strong indicator of success for SATELLIFE's projects has been the presence of one or more local champions. These individuals need not occupy the highest rank among the stakeholders, but should be thought leaders and advocates who understand the potential of the technology and are willing to take a leadership role in its introduction. Champions can be extremely helpful in building a commitment to teamwork among the stakeholders and addressing local challenges, such as customs requirements or telecommunications regulations.

Assessing the Impact on Individuals and Nurturing Personal Investment

The introduction of new technology has an immediate impact on the end users. Until new handheld computers are mastered, for example, some tasks may actually take more time rather than less. Some individuals may suddenly be asked to learn new data collection and reporting procedures. An understanding of existing processes and work patterns and how they will change is essential in order to minimize disruption, and to increase tolerance for whatever disruption is unavoidable. When participants understand fully what to expect and accommodations are made for their existing responsibilities, they are far less likely to resist the new technology or resent the adjustments they are asked to make.

Some individuals may perceive handheld computers as a threat to their role in the organization, perhaps even to their livelihood. While the instantaneous download of data from a handheld computer into a central database

Liaquat Ali
MIS Officer, EngenderHealth, Bangladesh Country Office



SATELLIFE has worked with the ACQUIRE Project to introduce the use of handheld computers in its Bangladesh Country Office (BCO). ACQUIRE (Access, Quality and Use in Reproductive Health) is a global, five-year USAID-funded project led by EngenderHealth, an international NGO that works with governments and agencies to make reproductive health services safe and accessible for women and men in forty countries.

The partners took existing supervisory checklists, evaluated their content, redesigned them for the electronic format, and then installed the revised and reformatted versions on PDAs. Ali notes that the original checklist, which included information about the training of healthcare providers and information about the facilities—infrastructure, logistics, infection prevention information, and so on—needed to be considerably revised for the handheld format, but it has proved to be well worth the effort.

As the project approaches the conclusion of the first phase, Ali reports a positive response: "Even at the national level, the policy level people, they have shown an interest." The PDA has improved the quality of the data collected and reduced the time it takes to process the data. Ali himself found the project very rewarding. "It was my challenge because this kind of instrument is very new for me. It was my challenge to introduce this type of development." Based on the results so far, he is looking forward to facilitating more widespread use of the technology throughout his country.

Ali is able to program a checklist into the PDA in 1-2 days, and can synchronize the PDA data to the desk top in 15 minutes. As his colleagues began piloting the PDAs in supervisory visits, they found that the pre-coded variables were easily collected and the data entry, aggregation, and analysis was quicker than using the traditional paper form method. Ali's colleagues, all doctors, conduct their routine visits with the local Government of Bangladesh health supervisors. These supervisors have become interested in using the PDAs and it seems that their use of them has increased their time with their supervisees.

Ali and his colleagues have also found some down sides to the PDA use. In particular, the PDAs are much better suited to pre-coded checklists, but are somewhat cumbersome for entering qualitative text. Traditionally, supervisors complete the hard copy of the checklist, photocopy it, and then discuss the results with the staff on-site, leaving the photocopy with the facility for future reference. With the PDA use, this was not possible. So while there are pros to using electronic devices, some paper records or reports will still be necessary for local site managers who do not have PDAs or computers.

Michael Tetelman interview *(continued from page 37)*

SL: AED and SATELLIFE have now done a couple of projects together; what has been learned?

MT: It's such a complicated initiative to introduce handhelds in this kind of environment due to infrastructure issues, power—all these kinds of things. ... We've found SATELLIFE to be an ideal partner in helping us think through and to actually do the implementation from the very beginning in a very sensitive way, not trying to do too much in a pilot. But to take, very realistically, a couple of key districts in Kigali as focus groups and then work intensively with the IT staff at the National ElectoralCommission and go from there.

SATELLIFE's great to work with [because] of recognition of the human organizational side. It's not just a technology. In fact, that's the furthest thing from it. That's one thing I've been impressed with and also the thoroughness of their work so far. The devil's in the details--how equipment is appropriately shipped over, under what customs, to thoughtfulness about the M & E [monitoring and evaluation] side. A lot of organizations are good at one or two things. I've seen SATELLIFE be really strong across the board.

increases the accuracy and efficiency of data collection, it also reduces the need for manual data entry. Retraining of personnel in data entry or any other positions that are affected by the introduction of handhelds should be incorporated into the planning of handheld computer projects so that they are not made redundant, but rather drawn into the change process in a positive and proactive manner.

One way to help individuals adjust to the new technology is to provide a unit for their personal use and include applications that respond to their needs and interests. They should be encouraged to use the datebook and memo functions. Non-work related content, such as news and jokes, should also be included. SATELLIFE has found that when steps such as these are taken, participants are inclined to use the equipment more effectively, to charge it regularly, and to safeguard it. Many project participants' enthusiasm about PDAs has piqued their curiosity about technology in general and led them to increase their overall use of computers in the work place. Such initiative should be both encouraged and rewarded.

Supporting Behavior Change

For SATELLIFE, the ultimate goal of introducing new technologies has always been to improve health outcomes by influencing health professionals' behavior. This can only happen if health professionals adopt three different types of behavior change. First, and most apparently, they must learn to use the technology. Second, they must become consumers of the information made available by the technology. Third, they must act on that information in the delivery of health care. Optimal outcomes are only attainable if project design provides motivation and support for all three types of behavior change.

Understanding the Power of Information

Handheld computers can alter relationships based on information ownership because they make data more accessible to more individuals in the organization or institution. While this may empower some people, for example, the district manager who can suddenly use real data for decision making, it may also be threatening to people who formerly had exclusive control over the information, for example, decision-makers who carefully manage how health statistics about the country are released to the public. The role that

information access – or the lack thereof – has in conveying or denying power to certain people within the organization must be consciously examined prior to the adoption of this technology.

Preparing for Self-Examination

As the observations above suggest, the successful introduction of handheld computers requires organizations to look carefully at their existing processes and, sometimes, to make significant changes. The process of self-examination may force organizations to confront latent weaknesses in their existing data collection processes. SATELLIFE had the experience of converting a data collection form from a paper version to an electronic version, as specified by the partner organization. The electronic form required field-level data collectors to ask exactly the same questions as had appeared on the organization's paper form. During training, the data collectors complained that the handheld computers would not save them time in the field. In fact, the way the electronic form was designed, they would end up having to spend more time asking questions than before – hardly a benefit. It turned out that the field data collectors had been trained to skip certain questions that over time had been identified through "common wisdom" as having no practical value. However, this practice had evolved at a lower level in the organization than where the form had originated. The exposure of this gap between field practice and management's expectation – which may have remained undetected had it not been for the introduction of the handhelds – could have resulted in highly disruptive internal conflict. Instead, the organization used it as an opportunity to revisit and improve its data collection practice, constructively using feedback from the field and ultimately producing a more effective data collection form – with half as many questions as the original.

6. Uganda Health Information Network: A Case Study

The Uganda Health Information Network (UHIN)[1] is the largest and most ambitious handheld computer project SATELLIFE has undertaken to date, incorporating a new, previously untried element: digital networking of geographically dispersed handheld computers via the local GSM cellular telephone network to support the two-way transmission of information and data. Only two years into this project, over 120 remote facilities serving more than one million people that have no Internet access and, in some cases, not even electricity, are able to send and receive regular transmissions of desperately needed information and accurate, actionable data. For Uganda, which has one of the highest burdens of disease in the world but also some of the best cellular telephone coverage in Africa, the marriage of handheld technology and cellular telephony represents a watershed moment in the battle against information poverty.

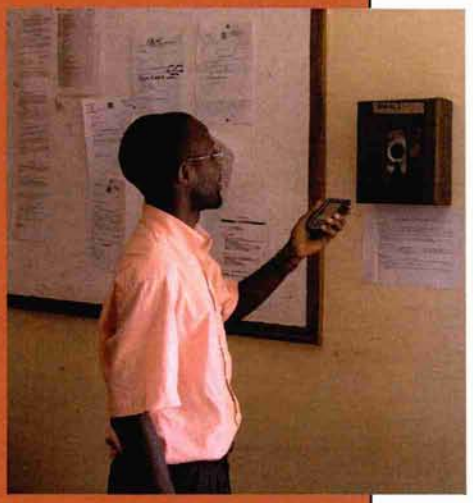
UHIN is a joint project of SATELLIFE, its sister organization, Uganda Chartered HealthNet (UCH)[2], the Makerere University Faculty of Medicine, and Connectivity Africa[3] of the International Development Research Center (IDRC) of Canada[4]. Rakai and Mbale District Health Officers and their staffs and Marie Stopes International (Uganda) are key participants.

Mobile Caching Servers: A High-Tech Concept in a Low-Tech Environment

UHIN relies on mobile caching servers also known as "Jacks" to transmit data over the cellular network. These devices, produced by WideRay, Inc.[5] of California, are self-contained, battery-operated, Linux-based computers containing a cellular modem and a large memory cache. End users connect

to the caching device using the infrared beam of their handheld units. The caching devices in turn communicate with a central server at the Ministry of Health (MOH) in Kampala via the GSM cellular network. Data collected in the field on a handheld computer can thus be uploaded to the caching device via infrared beam, stored on the cache until a regularly scheduled, off-peak call is initiated, then transmitted to the central server via the cellular network.

When SATELLIFE and its partners pioneered this technology in 2003, they found themselves once again looking at some basic questions: Would this technology that had never been tested in Africa function reliably? Would end users not only learn and use the technology, but also find it useful for their daily work? Would UCH be able to acquire the capacity to support the network without SATELLIFE's ongoing involvement? How much ongoing technical support would end users require after their initial training? What kind of start-up costs and ongoing operating costs would be incurred? Could the network be sustained after donor funding was exhausted?



These questions were addressed in the first phase of UHIN, during which nine caching devices were installed throughout Mbale and Rakai at health facilities that commonly consist of no more than a dirt-floor room with a table and chair. Handheld units were distributed to 200 individuals. Also during the first phase, UCH built its internal capacity to train end users, develop electronic data collection forms, and manage the network.

From its inception, the network was used for both information dissemination and data collection. Regular broadcasts initiated by UCH have featured:

- health information from SATELLIFE's information services
- continuing medical education and health updates on malaria, HIV/AIDS, and tuberculosis
- treatment updates
- general interest news from Uganda's mainstream media

In addition to receiving all this content, field-level health workers use their handheld computers for data collection employing the Ministry of Health's Health Management Information System (HMIS) forms for routine reporting.

UHIN Delivers Significant Results

Within months of deployment, UHIN began producing measurable results:

- A cost-effectiveness analysis of the first six months of the project, during which time only two of the fourteen paper forms used by the districts had been converted to the electronic format, showed that the network delivered a 24 per cent savings per unit of spending over the traditional manual data collection and transmission approaches, a figure likely to increase when additional paper forms are converted.[6]
- Rakai and Mbale District Health Services reported obtaining close to a 100 per cent compliance rate with their weekly Disease Surveillance reporting using the network, whereas the national average is 63 per cent.
- The districts reported benefits including improved data quality at point of collection, more timely access to data for analysis and decision-making, and more rapid response to emerging situations.
- Health workers at remote sites, even those with no fixed telephone lines or regular supply of electricity, routinely access critical information, including continuing medical education materials, which had previously been unavailable to them. They no longer have to travel long distances to the district headquarters to deliver data or to receive feedback, conserving time and resources for the health system.
- UCH not only acquired new staff and new technical and training capabilities, but also developed realistic strategic and business plans that forecast sustainability based on the organization's ability to deliver connectivity, training, and content on a fee-for-service basis to other NGOs, government agencies, and institutions.

Constraints & Solutions

The project partners encountered several challenges that presented excellent learning opportunities:

- *Power.* An unreliable power supply initially plagued many users who were unable to recharge their units as needed. The partners tested a variety of solar chargers and in general found them to be very cost-effective and reliable. Solar chargers are currently used in sixty locations. The partners will continue to explore solar power options with the goals of defining minimum specifications for a standard

A View from a Funding Partner....

Steve Song is the Director of Connectivity Africa, an initiative of IDRC. He has spent most of his career working in ICT for development and has lived and in worked in Africa and Europe. He is now living in Canada. Steve sat down with SATELLIFE to review the UHIN project, the use of handheld computers in Africa, and how this technology fits into the context of technology projects that support international development.

SL: Steve, you have the advantage of the broader view of technology development. How does the handheld computer fit into the overall development context?

SS: Right now PDAs are somewhat limited in what they can do. The ones that we've focused on use only infrared to transmit between units, however the next generation of PDAs will also use WiFi. They'll have more complex applications and be able to do more interesting things. What's interesting about PDAs is that they are more like cell phones than computers. You don't have to be trained to use them. Nobody goes on a course to learn how to use a cell phone. They pick it up by osmosis and experience. Well, it's not that much different with a PDA. You keep poking at the screen; you work it out quite quickly. It's very intuitive. In the early training I know SATELLIFE budgeted two days to train people. By lunchtime on the first day, people said, "OK, let's go." So PDAs are easy to use. They are also much better suited to difficult environments. Computers have fans. They suck in dust. They have hard drives that crash if you drop them. They're less tolerant of extremes of weather. PDAs have no moving parts; they are completely sealed, which means they are much easier; they're much more robust. You can drop a PDA and most of the time it carries on working.

The other thing is that PDAs are also similar in price point to mobile phones. The average mobile phone in Africa is about USD100 these days. People can aspire to owning a mobile phone and, in fact, a surprising number of people do own a mobile phone or have access to one. In terms of the average annual income of your average African, it's something that you might conceivably aspire to. I know for the nurses and health workers in Uganda—there are only a limited number of these PDAs and they're saying, "I want to buy my own PDA." You can't say the same thing about a computer. A computer is ten times as much money and more fragile and heavier and harder to protect. You have to lock it up in a room; you put a PDA in your pocket. I think a lot of ICT in development in Africa is about finding commodity technologies that are really good for development. The mobile phone is the best example of that.

SL: How do you see the UHIN project in the overall landscape?

SS: UHIN's success is in creating a data network over a mobile telephone infrastructure. That hasn't been done enough in Africa. Because seven out of ten telephones in Africa are mobile, if you're not trying to create infrastructure to support health information systems by taking advantage of the mobile telephone infrastructure, then you're limiting yourself to big cities. You've no way of reaching out into the rural areas. The Uganda Health Information Network is pioneering in creating effective data networks over very weak infrastructure. It's doing it in a way that is relatively affordable and sustainable. The amounts of data being sent over the networks are small enough that they're not causing massive mobile telephone bills for the network. The fact that UHIN is able to combine the power of data collection with continuing medical education, providing information to health workers isolated in rural areas, and ultimately, to provide email access via these devices -- that's quite powerful! Nobody else is doing this anywhere else. For us, part of what's exciting about this project is that others are coming and looking at it and saying, "Wow! We need to be doing stuff like this!

device and identifying an Africa-based producer.

- *Mobile Caching Servers.* The first model of caching devices (Wideray G20) tested in Uganda was prone to dropping calls or failing to connect or disconnect. When files reached the central server, UCH staff had to open them manually to determine where the data needed to be sent. A decision was made to upgrade the system to a newer model (SP320) with more memory that proved to be far more stable in the field.
- *Data Collection Software.* Once it was established that the mobile caching servers could interact with the GSM cellular network, the partners tested the network's ability to transmit standard data collection forms mandated by the MOH and used at health centers throughout Uganda. The form-generating capacity of WideRay's software meets basic needs, but lacks the degree of sophistication and flexibility required for the MOH forms. One form alone has over 300 fields, many requiring branching. Consequently, the partners had to identify alternative forms development software compatible with the store-and-forward data transmission protocols utilized by the WideRay system. The project partners found the Perseus software program to meet most, but not all, of the network's needs and will continue to explore options that provide more functionality, allow cumulative reporting in the field and facilitate the conversion of additional paper-based forms to the electronic format.

- *Training.* After trying a variety of training formats, UCH found residential training to be more effective than work-site training, especially when conducted over two days with small groups of up to twenty participants. In order to build local training capacity, appraisal mechanisms were used to identify the most highly motivated and competent users who could become district based trainers or provide user support to their colleagues.

UHIN: The Path Ahead

The second phase of UHIN, currently in progress, entails expansion to all fifty-seven health centers in Mbale and Rakai districts. The project partners have also set an ambitious agenda to study and disseminate the lessons learned from UHIN in order to promote global understanding of how emerging technologies

can be leveraged to bridge the knowledge gap between rich and poor countries. Key considerations will be:

- In communities where UHIN is used by local health workers, how does their access to information impact the quality of healthcare service delivery to the population?
- What are the requirements for moving beyond the pilot phase to a full national roll-out of the technology?
- What additional complementary technologies can be integrated into the network to maximize its reach and functionality?

Currently, discussions are underway to develop a nation-wide scale-up of handheld computers for health workers to support the national plan for continuing provider development. Each of these questions is relevant not merely to the project partners and those scale-up plans, but to everyone in the international health and development communities who is committed to harnessing the power of ICT to build a healthier world.

(Endnotes)

[1] See website <http://pda.healthnet.org/>.

[2] See website <http://portfolio.ljonn.com/uch/>.

[3] See website <http://www.connectivityafrica.ca/>.

[4] See website <http://www.idrc.ca>.

[5] See website <http://www.wideray.com>.

[6] SATELLIFE. "Draft: Cost Effectiveness Study Report for the PDA Data Capture and Transmission." Sept. 2004. 19 July 2005. <http://www.healthnet.org/coststudy.php>.

7. Reviewing Our Progress, Looking Ahead

The conclusions to be drawn from SATELLIFE's work with handheld computers are both practical and profound. On the practical side, quite simply, the technology works. It can be used successfully under very challenging conditions to disseminate information and facilitate data collection, thereby saving time, reducing costs, and delivering better results than traditional paper-and-pencil methods. Novice computer users can master the basic functions of a handheld computer in a day or two. The human issues around introducing new technology can be problematic, but with forethought and good management, these problems are surmountable. This is not to say that handhelds are without their drawbacks, or that they are *the* solution to the digital divide. Rather, they are a viable tool that brings us one step closer to bridging the gap.

Work still needs to be done to test the scalability of this technology and to test other technologies that respond to the gaps. Handhelds are not the answer for open-ended surveys, large data projects or at sites where more than basic data analysis needs to be accessible. They are limited by power supply. They can be stolen, lost, or broken. The small screen limits the amount of data viewable at one time and the memory capacity is limited.

Work is underway in several settings to test smaller, low-energy computers and smart cards for data transfer and patient record management. Other answers to information needs are being tested in other sectors and may prove useful to the health sector down the road.

But what of the bigger issues we are facing today? We are engaged in battles against some of the greatest threats humanity has ever faced: the scourge of AIDS, the flood of intellectual capacity from Africa that is leaving thousands of communities without trained health care providers, emerging diseases with pandemic potential. The toll of these problems can already be counted in the millions, of both lives and dollars, with lasting solutions still nowhere in sight. If there is to be a common denominator in finding those solutions, it will be information: the information to manage anti-retroviral drugs; the information to train a new cadre of health care workers; the information to develop and deliver vaccines. The demand for data from donors, policy makers, and practitioners, will continue to grow and place new burdens on already over-burdened systems. Sharing data will be ever more essential, the imperative to succeed ever more urgent.

We have already seen how vital a role ICT can play in getting information into the right hands. Not just handheld computers, but email, cell phones, satellite broadcasts, and radio. In the coming months and years, there will be an even wider range of ICT tools available to us. But our financial and human resources will remain limited in the face of great need. We need to pay attention to the lessons already learned as we chart the course ahead.

Demand will, at least in part, determine where investments should be made. SATELLIFE has worked with the Faculty of Medicine at Makerere University in Uganda to provide each first-year medical student with a handheld computer. Equipped with used PDAs donated by U.S. physicians, these students will leave medical school with new capabilities and expectations about the role that technology can play in their continuing education. Having utilized computers throughout their undergraduate and graduate education, they will not accept the lack of information upon returning to their communities. They will be powerful advocates for the expansion of ICT in health, and they will be educated consumers.

The need to allocate scarce resources ever more judiciously must also guide the decision making. As the demand for data increases, the cost of paper-based processes and the concomitant human resources will not be sustainable. The evidence-based use of ICT will not merely conserve resources, but save lives. It is therefore incumbent upon all of us engaged in ICT for development to share and heed that evidence.

Appendix
Summary of SATELLIFE'S Handheld Computer Projects, 2001-2005

Uganda Health Information Network (UHIN), 2003-2005

Partners International Development Research Centre (IDRC), Uganda Chartered HealthNet (UCH), Makerere University Faculty of Medicine (Uganda), Marie Stopes International (Uganda)

Location Uganda

No. of PDAs 350 (Phase1: 200 units; Phase 2: 150 units)

Project Purpose UHIN Phase 1: To expand access to health and medical information and support data collection and analysis through the use of handhelds connected via the local GSM cellular telephone network. Health centers owned and operated by the Ministry of Health and Marie Stopes International (Uganda) in the districts of Rakai and Mbale are using the network for sending and receiving HIMIS data and obtaining medical information.

UHIN Phase 2: Building on the success of Phase 1, this project has been expanded to include more levels of health centers in the districts of Rakai and Mbale. Phase 2, which will last for 12 months, started January 2005.

Nepal Health Monitoring Pilot Project, 2003-2005

Partners Academy for Educational Development (AED), U. S. Agency for International Development (USAID)-Nepal, HealthNet Nepal (HNN), Nepal Family Health Program (NFHP), Nepali Technical Assistance Group (NTAG)

Location Nepal

No. of PDAs 50 PDAs and 25 GPS units

Project Purpose To test the use of handhelds combined with Geographic Information System (GIS) and Global Positioning System (GPS) technologies for ongoing monitoring and evaluation surveys in Nepal. Initial data gathering focused on an annual vitamin A survey.

Development and Installation of Electronic Medical Record for Anti-retroviral Therapy (ART) Sites in Masaka Region, Uganda, 2005

Partners World Health Organization (WHO), Masaka Regional Hospital, Uganda Chartered HealthNet (UCH)

Location Uganda

No. of PDAs	10
Project Purpose	To develop and install an electronic medical record system covering up to 10 anti-retroviral therapy (ART) sites in the Masaka Region of Uganda using handheld technology and to establish data transmission system using cellular telephony.

Health Service Provision Assessment Using PDAs, 2005

Partners	World Health Organization (WHO), Ethiopia's HIV/AIDS Prevention and Control Office (HAPCO), Ministry of Health, Ethiopia
Location	Ethiopia
No. of PDAs	40
Project Purpose	To support the development of PDA-based data collection tools for assessing the availability of HIV/AIDS related services in Ethiopia.

Handheld Computers for Africa, 2005

Partners	Individual donors from USA, Makerere University Faculty of Medicine (Uganda), Valley Trust (South Africa), Indepth Network (Ghana), Moi University Institute of Family Medicine (Kenya), AfriAfya (Kenya), Agha Khan Foundation (Kenya), Healthmatch International (Nigeria), Centre for the Evaluation of Public Health Interventions (University of Zimbabwe)
Location	Uganda, Kenya, Ghana, Nigeria, South Africa, Zimbabwe
No. of PDAs	600
Project Purpose	To improve health workers' access to relevant health information and improve patient care management.

Support for "South Africa Community Based Voluntary Counseling and Testing (CBVCT)", 2005

Partners	Academy for Educational Development
Location	South Africa
No. of PDAs	4
Project Purpose	To carry out rapid assessment and survey of health clinics in South Africa.

PDA-Based Voter Registration and Verification Pilot Project in Rwanda, 2004-2005

Partners	Academy for Educational Development (AED), USAID, National Electoral Commission (NEC) of Rwanda, Uganda Chartered HealthNet (UCH)
Location	Rwanda
No. of PDAs	116
Project Purpose	To collect and validate voter registration data, to develop a protocol for transferring this data to the National Electoral Commission (NEC) database, and to train NEC staff.

Support for "Access, Quality, Use in Reproductive Health (ACQUIRE)", 2004-2005

Partners	Engender Health
Location	Bangladesh and Bolivia
No. of PDAs	20
Project Purpose	To support data collection for routine monitoring and evaluation of family health programs.

Support for "Strategies for Enhancing Access to Medicines (SEAM)", 2003-2004

Partners	Management Sciences for Health (MSH), Tanzania Food and Drugs Authority (TFDA)
Location	Tanzania
No. of PDAs	24
Project Purpose	As part of the Strategies for Enhancing Access to Medicines (SEAM) Program, funded by the Bill and Melinda Gates Foundation and managed by MSH, to support the structured quality assurance processes developed for inspecting drug outlets (accredited and non-accredited) and pharmaceutical consignments received at the major ports of entry.

PDAs for Enhancing Medical Education, 2003-2004

Partners	World Economic Forum, Digital Partners Foundation, Uganda Chartered HealthNet (UCH), Makerere University Faculty of Medicine
Location	Uganda
No. of PDAs	300

Project Purpose	To improve information dissemination, increase the availability of educational materials, and increase efficacy of conducting health surveys within the student and academic community of the Faculty of Medicine of Makerere University.

PDAS for Mother and Child Health Care Surveys in Kenya, 2003

Partners	Ministry of Health
Location	Kenya
No. of PDAs	10
Project Purpose	To conduct surveys related to mother and child healthcare.

PDAs for Drug Inventory Management, 2003

Partners	Sustainable Health Enterprises Foundation (SHEF)
Location	Kenya
No. of PDAs	5
Project Purpose	To manage inventory at locally owned drug supply shops.

Improving Quality of Safe Blood in Uganda Using PDAs, 2002

Partners	Uganda Red Cross (URC), American Red Cross (ARC), Uganda Blood Transfusion Service (UBTS), Uganda Chartered HealthNet (UCH)
Location	Uganda
No. of PDAs	45
Project Purpose	To introduce handhelds for blood donor recruitment activities of the Uganda Red Cross Society (URCS) and the Uganda Blood Transfusion Service (UBTS) in Uganda.

Piloting PDAs for Health in Africa, 2001-2002

Partners	Acumen Fund, American Red Cross(ARC), Makerere University Faculty of Medicine (Uganda), Uganda Chartered HealthNet (UCH), Moi University Faculty of Health Sciences

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