New Village – "Leapfrogging the Grid" on a Micro Scale*

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by

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TRADITIONAL SAYING: Give a person a fish and he will eat for a day; give him a net and teach him how to fish, and he will eat for the rest of his life.

1. INTRODUCTION

The primary idea to be explored in this paper is the use of miniaturized electronic devices and "mini units" of electricity to help a poor village leapfrog over the "industrial age" and enter the "information age." This is technically possible at a modest financial cost because powerful and flexible miniature electronic devices have become very inexpensive and they use small batteries that are easily and cleanly recharged simply by walking, shaking, or hand cranking. Such electronic devices can purify drinking water, put boundless knowledge and powerful educational tools into the hands of teachers and students, and empower nurses and paramedics to deliver significantly improved medical care. Just as importantly, such devices also can be used to increase dramatically the financial resources available to a village population, enabling them to purchase goods, services and opportunities that come with participation in the information age.

Goals of this paper

With these ideas in mind, this paper describes relevant technologies and explores ways to deploy them in a poor village in an underdeveloped country. The paper considers what is technically possible, but only briefly discusses cultural and political issues. The technologies already exist and are rapidly decreasing in price, but in the long run, cultural, religious, political and psychological considerations are likely to be more important in determining whether new technologies can – or should – be introduced into a society. The people themselves, if they wish to introduce the technologies into their community (with help from others), must find ways compatible with their own values and culture if the consequences are to be happy ones.

Generating "mini-units" of electricity

Microcomputer circuits, new materials, and a variety of other recent technological developments have led to the creation of electronic devices that require very little electric power, even though they provide invaluable services and useful capabilities. For example, there now exist flashlights

(in Europe one calls them "torches") that require no replaceable batteries and no old-fashioned light bulbs. Instead of a replaceable battery, there is a coil of wire and a magnet that slides back and forth through the coil when one gently shakes the torch. This motion charges a permanently installed rechargeable battery embedded in the torch. The old-fashioned light bulb has been replaced by a permanently installed crystal that lights up when a small electric current flows through it. Thirty seconds of gentle shaking of the torch provides twenty minutes of medium-bright light. The torch is hermetically sealed and made of very tough plastic that can withstand dropping, kicking, water pressure to 130 meters, and temperatures well below zero Celsius. Another example of a useful easily charged device that already exists today is a radio (AM, FM, and Short Wave) that is powered by a rechargeable battery. Simply by turning a small crank on the radio for about two minutes one gets an hour of playing time.

These two examples are illustrations of the fact that, today, there are many ways – hand cranking, shaking, walking, solar panels, micro windmills, micro water turbines, and so on – to recharge small batteries. As a result, it is possible to generate power easily, cheaply, and cleanly for a wide diversity of useful devices – torches, radios, laptop computers, palmtop computers, cell phones, medical instruments, and so on. An interesting example recently was described in the *New York Times Sunday Magazine*: In 2003, a clever inventor created a children's seesaw that charges a battery while the children play on it.[1] Soon there will be entire playground sets of seesaws, swings, merry-go-rounds, and other moving items that recharge batteries from child's play. A school's laptop computers might be powered in this way, or a medical clinic's electronic instruments and communication devices. In addition, animals pulling wagons or plows also can recharge batteries to be used in a variety of miniature electronic devices. Such possibilities, when appropriately developed, can enable remote villages in underdeveloped countries to leapfrog into the information age. (See the discussion below.)

2. Description of "Old Village"

Imagine a remote village of one thousand people – let us call it "Old Village" – in an underdeveloped country far from any industrialized city or town – far from electric wires, telephone lines, gas pipelines, paved roads, and other typical infrastructures of the industrial age. Old Village has about 300 adults and 700 children. An average family ekes out a living by earning the equivalent of 100 American dollars per month. The roads in and around Old Village are muddy paths with deep ruts created by animal-drawn wagons. There is much water in and around Old Village – in swamps, streams and muddy puddles – but this water is very unhealthy to drink because it contains not only particles of soil and rotting plants and feces, there also are germs, viruses and various dangerous and debilitating parasites. Because the citizens of Old Village drink this water, they often are ill, and their youngest children frequently die from diarrhea. The village has two people who act as nurses in a makeshift medical clinic, but their medical training is poor and few medical supplies are available. Parents and the oldest children in a family are typically away from home during most days in order to secure enough income and resources for the family to survive. In addition, younger children stay home to take care of infants and toddlers, so it is almost impossible for children of any age to go to school.

The economy and lifestyle of Old Village could be transformed dramatically with the help of information age education and resources that could provide safe drinking water, improved health care, much better schooling, and significantly increased income for the whole community. All of

these improvements are technically achievable at a modest cost in "foreign aid" from the industrialized nations of the world. Consider the examples described below.

3. CLEAN DRINKING WATER

One of the major medical and economic problems for Old Village is the lack of healthy drinking water. This problem often leads to the death of young children, and regularly debilitates those who do not die from it, robbing families of vital resources and stamina. Obviously, if an inexpensive and effective way could be found to solve this problem, the entire village would benefit dramatically – both from a health perspective and an economic one. Fortunately, a solution is "just around the corner" in the form of an inexpensive, electronically equipped "ultraviolet water bottle" that could provide unlimited supplies of healthy water for everyone in the village. Such a bottle does not yet exist, but the technology to create it is already available, and – using mass production techniques – the price of such a bottle would be very modest. Every person in the village would be able to have a one-liter bottle which would disinfect water for several years. If a mass-produced bottle cost 50 American dollars, a tiny "foreign aid" donation of 50 thousand American dollars would provide an ultraviolet water bottle for every citizen of Old Village to use for several years – a remarkable accomplishment with huge positive consequences. The economic benefits to the village might even enable future replacement bottles to be purchased by the village citizens themselves without additional foreign aid.

The ultraviolet water bottle

In 2001, solar engineer Miles Maiden invented a device which he called the "SteriPEN™."[2] It is a small stirring rod that generates ultraviolet light and can be powered by AA batteries. It weighs less than 200 grams. Using ultraviolet light, the SteriPEN is stirred in a container of water and can disinfect a liter of water within two minutes. During its useable lifetime, the SteriPEN can disinfect 2300 liters of water, which (at two liters per day per person) is about a three-year personal supply. The SteriPEN purifies water to a level that meets the USA Environmental Protection Agency protocol for water purifiers, and it kills 99.9% of bacteria, viruses, fungi, protozoa and algae. The ultraviolet light from the SteriPEN is generated by a small electronic circuit that uses very little electricity.

With the invention of this new technology, it now seems possible to create an inexpensive water-purifying bottle that can be described as follows: The bottle would be made of very tough plastic that would not break easily, even in extreme temperatures. It could be easily carried around, and rough handling by children would not break it. An electronic circuit that generates ultraviolet light within the bottle would be embedded in a way that protects it from damage when the bottle is handled. The bottle also would have an embedded battery that is recharged by gentle shaking, or by turning a crank stored in the bottom. Alternatively, small rechargeable batteries could be inserted into a compartment on the side of the bottle. Such batteries could be recharged by an unattached hand-cranked device, or even by the body movements of the bottle owner during everyday activities. The inner wall of the ultraviolet water bottle would be a mirror that causes the ultraviolet light to "bounce around" within and thereby create maximum distribution of the light throughout the bottle. The lid of the bottle would be a filter-holder with a cupped shape. Specially designed filter papers (somewhat like those used in coffee makers) would be placed in the lid, and then water from nearby streams, ponds, swamps or puddles would be poured into it. The paper filter would be fine-grained enough to remove all visible solids – living and non-living – leaving clear-looking water inside the bottle. The filters could be mass-

produced in industrialized nations at a fraction of a cent each. Once water has been filtered into the bottle, the ultraviolet generator could be activated to kill all dangerous organisms within two minutes. As long as the original water did not have harmful chemicals dissolved in it, such an "ultraviolet water bottle" would produce clear and healthy drinking water quickly and efficiently, even from brackish swamp water or muddy puddles.

Impacts

The impacts upon Old Village would be dramatic and very positive: The overall health of the community would improve and small children would stop dying from diarrhea. Older children and adults soon would have better health and more stamina, increasing the family's ability to earn a living.

4. EDUCATIONAL OPPORTUNITIES

If everyone in Old Village were to get healthy drinking water, and if there were a dramatic increase in the average family's income (see section 7 below), younger children would need less care, and older children would *not* have to spend all day helping the family earn a living. This would generate "free time" for the children to go to school. The increased income in the village also would make it possible to hire teachers who are citizens of Old Village. As such, they would be part of the culture and the local economy, so they would understand the local language, values and circumstances. Foreign aid from industrialized nations could provide scholarships to village citizens, enabling them to attend schools and universities that would appropriately educate them, as well as train them to use new electronic educational tools. After such training, the new teachers would return to their homes in Old Village to help their community enter the information age.

The teachers' new tools

Today there are powerful palmtop computers that use very little electricity and can run hundreds of educational software programs covering language skills, mathematics, science, economics, and a host of other subjects.[3] These devices also enable one to "surf the Web," send email and instant messages, and (when fully equipped) function as mobile phones and digital cameras. Mass-producing such devices for use in underdeveloped lands would bring down their cost to about 100 American dollars. Thus, with a modest investment of 50 thousand American dollars, half of the people in Old Village – including teachers, school children, nurses, and many other members of the community – could possess a powerful tool for communicating with each other and with the rest of the world. With connections to the Internet (see section 6 below), the village would have boundless sources of information, including many of the world's libraries, newspapers, museums, medical schools, business schools, scholars and artists. Properly trained teachers – citizens of the village who speak the local language and understand the village culture – could instruct school children, as well as adults, on the effective use of such resources.

The teachers also would have available to them powerful laptop computers which run on internal batteries that can be recharged by turning an attached crank. A few minutes of cranking would yield an hour of computing. Such computers can provide to teachers state-of-the-art software and powerful information processing that could be used to create a wide variety of educational experiences for students and community gatherings.

Impacts

Initially, the newly arrived teachers would have to instruct children and adults on the use of palmtop computers. At first, the citizens of Old Village would use these resources to improve language, communication and math skills to a point where they could then learn about health, business, government, and other useful knowledge. They also would learn how to use cell phones, email and instant messaging to stay in touch with each other and to cooperate in joint projects and activities. Eventually, the more advanced students of Old Village could study a full range of subjects from science and engineering to history, art and culture – first locally, and then as scholarship-supported students at distant universities. To minimize social disruption, and to preserve community values, the political and social leaders of Old Village (and the surrounding culture) would determine the appropriate subjects and skills that their people should pursue.

5. IMPROVED HEALTH CARE

The availability of healthy drinking water made possible by the ultraviolet water bottle, would be the beginning of significant improvements in health care in Old Village. Using palmtop computers and information available over the Internet, village teachers could instruct the population on a wide variety of health-related subjects. Changes in the behavior of the citizens of Old Village, consistent with the community's own values, could bring about dramatic improvements in health. In addition, some members of the community could be provided scholarships to enable them to attend schools and colleges in other lands and thereby become nurses or paramedics informed about contemporary medicine and sanitation practices. These Old Village citizens would then return home to run an information-age medical clinic.

An electronically equipped medical clinic

The newly trained nurses or paramedics who return to Old Village could set up, with a modest investment of foreign aid (about 50 thousand American dollars), an electronically equipped medical clinic that uses small, battery-powered medical devices to measure a patient's temperature, blood pressure, blood sugar, and a variety of other medically relevant characteristics. In addition, equipped with powerful, hand cranked laptops, and medical software, a nurse or paramedic could get helpful medical advice and assistance from the computer itself. If the computer is unable to provide the needed assistance, the nurse or paramedic could use a cell phone or email (see section 6 below) to seek advice from medical experts in other lands. Doctors in distant medical schools and hospitals could even examine patients virtually using increasingly effective "telemedicine" techniques. For 200 American dollars, or less, the clinic could secure a small solar-powered refrigerator for vaccines and other medicines that must be stored at low temperatures. These capabilities, combined with newly available medical supplies – purchased through improved village income (see section 7 below) – would significantly improve health care in Old Village.

Impacts

Good health and quality medical care are among the many benefits enjoyed by people in an "information society." Old Village, if it became such a community, could provide these benefits without having to pollute the earth and heat the atmosphere with an industrial infrastructure. Instead, miniaturized electronic devices powered by small, easily recharged batteries – or by solar panels, mini windmills or micro water turbines – could make this possible at a very modest cost.

6. The Need for an Information Center in Old Village

It is clear from the above discussion that Old Village must have an "information center" (called an "RIC" – rural information center – in sub-Saharan Africa). Such a center would provide connections to the Internet plus local mobile phone services. In sub-Saharan Africa, some of them already provide electronic libraries, computer schools, and community video halls in addition to telephone and Internet services.[4] The RIC in Old Village would need a small cell-phone tower for local telephone services and a modest satellite dish for long distance telephone and Internet communications.

The cost to equip such an RIC would be about 50 thousand American dollars. In addition, three or four citizens of Old Village would have to be educated and trained to run and maintain the RIC equipment. One of these newly trained technicians could maintain the RIC's equipment and also repair laptops for teachers and nurses, as well as the occasional palmtop for a student or a parent. Initially, foreign aid or a private investor would provide funds to set up the RIC and train its personnel. Eventually, as the economy of Old Village is transformed into an information age economy (see section 7 below), the village would be able to pay for the RIC itself, and also pay a return on the original investment.

The small cell phone tower and satellite dish with associated electronic equipment would need more electricity than could be generated by hand cranking or other "mini methods" of charging batteries. To achieve this, while avoiding pollution and atmospheric warming, the village could use solar panels, or small windmills, or water-driven micro turbines, or other rapidly developing technologies with a very modest price.

7. "Local" Employment in the Information Age – The Birth of "New Village"

Given clean drinking water, quality medical care, good schooling, and a well-functioning information center, Old Village would be in position to transform itself into "New Village" – a 21st Century, information-age community that has leapfrogged over the industrial age. This is possible because people who know how to use computers and modern communication devices can work at home, or in a local "business center," pursuing a rapidly growing number of information age careers that can be conducted over the Internet or via telephone: *data entry services, telephone answering services, database management, software engineering, data mining, accounting, graphic arts, typesetting, editing, translating, web site design, web site maintenance, and on and on.* In New Village, the average family income from such careers could climb into the thousands of dollars per year, instead of a few hundred dollars. This newly created wealth within the community could pay not only for ultraviolet water bottles, improved medical care, better schooling and an RIC; it also could provide funds for additional advantages and opportunities of the information age.

8. Conclusion – Cultural Considerations

This brief "concept paper" has focused upon the *technical feasibility* of using already available information and communication technologies to leapfrog over the industrial age right into the information age. It is important for the world to see that this can be done with a very modest investment of funds – and without polluting the environment or warming the atmosphere.

It also is important for people who live in underdeveloped countries to realize that miniature computerized devices, especially when combined with local generation of electricity, can be *culturally and psychologically empowering*! These technologies can place in the hands of

individuals and local communities themselves the power to improve and economically transform their lives in ways that are consistent with their local and personal values. Properly used, therefore, miniature computerized devices can increase freedom, opportunity and hope, and return to individuals and their local communities the power to be in charge of their own lives and futures. Technology that brings about freedom, opportunity and hope is worthy of society's attention!

Of course, this paper does not deal at all with many relevant and very difficult political, religious, and cultural concerns. For example, people in underdeveloped lands often are suspicious of electronic technologies, because they view them (with good reason!) as means used by a few powerful countries and a few wealthy companies, to get rich while ignoring the fact that they could be undermining the values of other cultures. If "leapfrogging the grid" is to be possible and encouraged – and ethical! – it must deal seriously with such issues.

END NOTES

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[1] "Kid Power" [Report on an invention by Raj Pandian], *New York Times Sunday Magazine*, December 14, 2003, page 80.

[2] For details regarding the SteriPEN™, see the following web site: www.hydro-photon.com (accessed on January 30, 2004)

[3] For example, palmOne™ offers palmtops like the Zire™ 71 and the Tungsten™ T3. See www.palmone.com (accessed on January 30, 2004)

[4] See, L. Natalie Sandomirsky, "Women and Information Communication Technology in Sub-Saharan Africa" forthcoming in Krystyna Górniak-Kocikowska and Elzbieta Pakszys, Eds., *Women and Information Technology* [tentative title], forthcoming.