



Hello World: Technology Missionaries to a Crowded Planet

By

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ABSTRACT

This paper comments on the new Media Lab global initiatives such as the 2B1 Foundation, Center for Future Children, and Junior Summit. Ideas are presented for how existing Media Lab technologies can be integrated within the goals of these enterprises. These ideas are not necessarily limited to children and are mostly in the areas of health and education.

It's a human world

Technology inevitably advances. Moore's law states that computers double in speed every two years, and thus far this decade, it has held true. Unfortunately, there is no such Moore's law for describing progress in solving classic human problems such as disease, hunger, population, pollution, and illiteracy. In developed regions, computers, wireless links, and other information technologies have increased our productivity and improved our overall quality of life; however, most of the world remains alienated from the benefits of such technology. Should technological progress be measured simply by the number of transistors that we can squeeze onto a piece of silicon, or should it be measured in terms of the value it has to our quality of life?

Practical human problems may not be glamorous applications of technology, but if we are to speak of making technology that is more accessible to real people, we should not neglect real world problems. For many of the sponsors of the Media Lab who do business in developing regions, this is very much a practical issue, not merely a humanitarian one. Global human problems deserve at least as much attention as high-tech work and play. The concerns of many developing nations are very fundamental and practical. For example, in most

countries, the fields of industrial engineering and civil engineering are very popular, and the field of electrical engineering does not mean designing computer chips, but rather designing better power stations and generators for small cities and towns.

I don't advocate that the MIT Media Lab should be in the business of solving all the world's problems. However, our technology is so broadly applicable, that it shouldn't be a great stretch to consider a broader human context. In order to create the greatest permanent impact on our future, it makes sense to focus on children first. The new 2B1 Foundation, the Center for Future Children, and Junior Summit were formed to address some of these issues, focusing primarily on the concerns of children. While there seems to be some sense of trepidation concerning these new undertakings, I think there are many possible projects we can consider with well-defined objectives.

Where the bits don't flow

There is an endless traffic of digital bits around the world, but these "bits" only flow to particular regions of the world and to particular segments of the population. At the Media Lab, the primary short-term goal of the 2B1 Foundation is to provide connectivity to those geographical regions that don't have it. This is a very noble, generous, and worthwhile pursuit. The bad news is that we lack the resources to meet this goal. Even if we could raise tens of millions of dollars and buy several used satellites, we would still only reach a fraction of the children in Africa. The good news is that connectivity will probably come naturally, as the local infrastructure develops and it becomes possible to make use of other non-satellite connections such as trans-Atlantic optic fiber lines, local microwave or radio links, and cell phone networks. Also, as a greater number of satellites become available, we will be able to rent transponders on commercial satellites having much greater bandwidth than the transponders on older satellites.

Because connectivity will not be achievable everywhere to everyone, it is also important to consider various types of information technology that *does not require the Internet*. Even in regions which do have Internet access, sometimes the available bandwidth is very low, so technology is needed which can function with minimal connectivity. As demonstrated in the Things That Think consortium, however, creating portable intelligent physical objects (e.g. toys) that can interact with their local environment enables new ways of using and thinking about information technology. Providing the means for such objects to wirelessly communicate with each other enables an additional layer of intelligence as well as new applications. We could go further, and connect these communities of objects to the Internet, but it is not essential.

One might even argue that it is arrogant, in some sense, to insist that rural developing communities need to be connected to us and to the rest of the world, despite the fact that we would let them control their own information content. Of course, there are great benefits to providing Internet access to remote villages (some are mentioned in this paper), but I hope we also recognize the value of

letting a community develop its own potentially isolated information network and mold information technology in the way that suits it best. Information is most valuable when presented in a local context. Communities can create their own “bits,” and in the early stages of infrastructure development it’s important to let communities explore new technologies on their own. Like the Coke bottle that fell from the sky in *The Gods Must Be Crazy*, if people want to use it as a hammer or as a musical instrument, so be it; and if they decide to reject it, that should be fine, too.

When computers disappear

It is not necessary to travel far to realize that we live in a stratified world. Even within the US, in urban areas or rural Appalachia there are large segments of the population that have remained isolated from the affordances of modern technology. In many cases, these people are also the ones that are most in need of better health care and education. Many of these problems are interrelated.

On the global scale, the level of extremes between the haves and have-nots is even more pronounced. I have heard it said that we are a privileged high-tech society, for most of the world’s population has never even used a telephone. Additionally, even if “high-tech” hardware were made available to everyone in the world, many segments of the population would not use it and would remain technologically isolated. Part of the reason for this is that for the most part, computers of the past were designed by engineers for engineers. Even today, most electronic appliances which we take for granted (such as a VCR or an ATM machine) require some degree of technical skill and experience. We cannot assume or expect that non-technical people, other segments of society (such as the elderly), or other cultures will adapt to traditional computers. What is needed are new forms of information technology that are accessible to more types of people. This is one of the fundamental founding principles of the Media Lab’s philosophy and not unique to just health and education.

In creating new forms of technology, representation is extremely important. *The way information is represented greatly determines the segment of the population that will use that information.* In choosing a particular means of representing information, we are in effect isolating or shutting out various segments of the population. For example, displaying the vital signs of a medical patient in terms of a quantitative line graph on a computer monitor is very useful for a doctor; but to a child, or to an untrained observer, the information may be useless, not to mention boring. Alternatively, the very same information could be used to control the facial expressions on a toy; such a representation would be profoundly more meaningful to a child but less useful to a doctor, for example. The statement “computers will disappear” can be translated to mean that there are other ways of representing information other than traditional multi-media.

Opportunities

Most of the global needs for information technology fall into the categories of health and education. While educational institutions and world health organizations recognize the value of information technology, it is not clear exactly how computers can best be implemented. Initial forays into this application domain have involved introducing multi-media information, such as video teleconferencing for telelearning and telemedicine. The next wave of information technology to address these issues is less obvious, and will partially exist in the form of portable smart objects or appliances. These new forms of information technology are not only multi-disciplinary, but also transcend engineering and raise important issues of representation and social context. The MIT Media Lab is uniquely qualified to address many of these issues, and I list several opportunities below.

Education

Kids

The field of computers in education is vast and is also the driving force behind many of the Media Lab's global initiatives. As long as the world avoids the pitfall of substituting computer simulations in place of hands-on experimentation (e.g. closing school science labs), information technology holds great promise in two main areas: 1) using the Internet to enable global communities of children to grow and learn from each other 2) using microprocessors and wireless technologies to make toys come alive and allow children to design and to learn. At the MIT Media Lab, for many years Seymour Papert and Mitch Resnick have successfully demonstrated many constructionist ideas by creating rich learning environments such as LEGO/LOGO. Outside MIT, other forms of information technology have also impacted education in various ways, such as in the rural Australian outback, where some classes are conducted via 2-way radio.

This is an exciting time in education because we have found cheaper and better ways to interface computers with the physical environment. As Neil Gershenfeld says, "People often wondered what the next interface was going to be after the keyboard and the mouse, and it was so obvious that people didn't even see it: the next interface is the rest of the world!" We are now making low-cost wireless sensors (<\$0.10) and low-cost wireless data links (<\$10) which allow everyday objects such as toys to interact with each other, to sense the environment, and to communicate with the PC. By creating a richer variety of tools for learning, we place fewer constraints on a child's creativity.

A great example of digital object is a biscuit-sized device known as the "cricket" developed by Mitch Resnick's group. A cricket contains a programmable microcontroller (which children can program), a motor driver, sensor inputs, and a means of wirelessly communicating with other crickets (via infrared). These crickets have been successfully used by children to create their own science experiments and interactive toys.

Weather here or there

Our local environment can be more than just a topic of conversation. Studying the weather, locally or at a remote place in the world, teaches children about nature and about life in other parts of the world. I recall as a child making a hygrometer from human hair and a barometer from a mineral oil test tube and trying to make weather predictions based on the data. Children can be taught how to make their own simple weather instruments and can post their recorded data on the web to form a “junior weather map of the world.” In doing so they would learn, for example, that winter in the US occurs during summer in Argentina, or that some places never have snow.

A related topic is the problem of pollution and the environment. In addition to collecting weather data, children can also be taught how to perform simple tests of their air, soil, and water. Communicating this information with other children around the world would encourage an awareness of our natural environment, and more importantly draw attention to changes in the environment. Having access to global information via the Internet would help determine whether the detected changes are due to a local condition or to a global one.

Autism

A close friend of mine is a teacher for autistic children. She struggles with ways to capture a child’s attention and gently stimulate their curiosity and interactivity. It is known that live animals are an effective aid for increasing the responsiveness of an autistic child. Autonomous interactive toys, such as Mitch Resnick’s Lego creatures, are a promising alternative. Once again, it’s the physical object that makes the difference, not an animated creature on a computer screen. This is another example of information technology we can provide which does not necessarily require the Internet.

Social contact

Adopt a Grandparent

A friend of my family named Rose passed away this year. She was 94 years old. Her mind was very active and inquisitive. She would recite poetry to me from memory. She outlived most of her own family, so she lived in a nursing home. Unfortunately, there was nobody in her environment who could have a meaningful conversation with her. Ultimately, she died from loneliness and an unkindled spirit.

There are many people like Rose, particularly in the US, where the elderly often live removed from their families. Computers can be a means of providing needed social interaction, where face-to-face contact is not possible. Additionally, as Brian Smith and Walter Bender have shown with the Silver Stringers, given a group of elderly people, computers can also provide new activities (e.g. making web pages) which encourage people to get together and to discuss personally relevant issues. Social interaction, particularly for the elderly, is an important factor in mental health and even physical health. In the future, it might be interesting for the Media Lab to organize an international “Senior

Summit” or maybe to use global connectivity among children to also make social connections between the very young and the very old (“adopt a grandparent”).

Reach Out and Touch Someone

Physical information can often be more interesting than graphics or sound. Children like to touch things and see things move. Hiroshi Ishii has demonstrated various ways that humans can interact over a long distance using physical information transmitted via electronic rollers or solenoid arrays that a person on each end can feel and manipulate. Chris Dodge has created an art installation in which the pillow on a person’s bed would heat and vibrate if the person on the other end is hugging his/her pillow. Such technology can not only be integrated into games but also can provide a richer interaction between children over a long distance.

Angels

I’d like to have a thousand angels in the Media Lab atrium, suspended from the ceiling on gossamer threads. Each angel would represent a child from Junior Summit. Whenever each child logs into his/her computer, the corresponding angel would gently flutter its wings. What a beautiful sight it would be, to welcome each day with the sound of fluttering angels’ wings. (No special technology would be required to do this; I just thought it would be neat to do...) A related idea is to give each child an angel to keep next to his/her bed; the angel would be activated whenever one of the child’s friends logged on around the world. It would be like having a nightlight that keeps you company.

Health/Medical

Preventative health care: “Health Toys”

Health is closely linked to education. Certainly preventative health care is not about treatment but rather about educating people. If health classes are still taught the way I remember them, they are among the most boring classes taught in school. Ironically, these classes should be the most interesting, and with the most compelling demonstrations, because the goal of these classes is not only to foster interest but also to encourage students to practice what is taught. Certainly, many of the interactive learning tools which are being used to make science more fun, can also be applied here. In fact many of the “things” in the Media Lab’s Things That Think consortium can be easily tailored to perform health-related functions. We can have appliances that tell us health information instead of stock quotes (no one in my family even owns stock – such information is useless to me). Can we make a coffee mug that tells us our blood pressure instead? Maybe make refrigerators that count calories or suggest low-cal substitutes?

The Japanese Tamagochi “digital pet” craze was a very significant development. It introduced the notion that a toy can get sick and even die; digital pets require care to remain healthy. Obviously, such toys have a tremendous potential for teaching children about the importance of caring for their own health.

In the short Tamagochi life-span of three weeks or so, a child can witness the complete life cycle from birth to death, and it is very easy to see the effects of proper nutrition, exercise, and even medicine. Specialized Tamagochi's can thus function as health toys to teach a young child about preventative health care and make the child more comfortable with medical procedures such as vaccinations, for example.

Additionally, if we think of disease as an undesirable form of wireless information, one can imagine creating digital pets which interact and make it possible to infect each other with digital viruses, thus emphasizing the need for inoculation. In fact, the smart badges developed in Mitch Resnick's group have already been used to simulate the spread of a virus throughout a small population, but providing these objects with a digital life or a digital soul really makes a huge difference in the psychological impact of such a simulation.

House calls

Due to a shortage of doctors in less-developed regions, each doctor needs to cover a wide geographical area. In order to properly plan their route, doctors (or other health care workers) need to know where they are most needed. In undeveloped areas, this requires wireless communications and in many places the infrastructure is not in place for using cell phones. Low-cost 2-way radios are needed. Perhaps in the future, it may be possible to make use of satellite networks, such as Motorola's Iridium system, if low-cost Iridium telephones became available. Simply adding enough infrastructure to support a 2-way pager network would fulfill this need.

Automated Patient Records

There are several organizations (including ones which Motorola's David Morgan has founded) which address the issue of medical information and patient records. Thanks to Herculean efforts, many of the legal and political barriers to achieving a comprehensive computerized patient record system have been diminished. It is certainly to everyone's benefit, in developing and developed regions alike, to have a more efficient system for storing, retrieving and sharing medical records and data. As the infrastructure takes form, we can begin to address the issue of an appropriate user interface. An object-oriented philosophy can apply here as well. A trendy smart card could be used to keep our most common medical information (e.g. our latest dental X-rays) or (as inspired by the now famous "mouse pad demo") we can use a simple passive wireless tag in our watch or credit card as a pointer to our entry in a centralized database. No more "Can you please fill out these forms, sir?" as you are fainting in the emergency room.

Augmenting the Senses

Sandy Pentland's work in wearable systems and augmented reality has already been applied to helping handicapped people. One of Thad Starner's vision systems can automatically recognize American Sign Language, and there also exists commercial technology that can translate text to speech, Braille to

text, or even text to Braille. From the international perspective, intelligent wearable systems with similar functions can also help penetrate cultural language barriers even for non-handicapped people.

Diagnosis

Low-cost portable tools for performing medical diagnosis is always a vital need in developing regions. In the near future, wearable computers can be used to provide travelling health care workers with a form of “on-line help” as a diagnostic aid. Eventually such systems may evolve into the form of a small hand-held device which integrates the use of on-site biosensors for the patient; or perhaps as Neil Gershenfeld and Roz Picard have said, perhaps some day our own clothes will be smart enough to detect early signs and notify us when we are sick.

AIDS

While the rate of deaths due to AIDS is decreasing in the US, it remains an explosive epidemic throughout most of the world, particularly in Africa and southeast Asia. The spread of AIDS is also, in effect, a social phenomenon so there is no such thing as a purely technological solution. There are various ways of contracting the virus; however, a large part of the AIDS problem boils down to a single piece of information: knowing who is infected. Potential Media Lab technology, in the form of badges, tags, or biosensors, might be able to provide that information in a discreet and private manner. For example, it might someday be possible to have a watch that tells me if I had AIDS or tell me if the person holding my hand has AIDS. Another (potentially controversial) idea is to have a condom that changes color when it comes in contact with the AIDS virus. Biosensors that can follow a woman’s monthly cycle (e.g. via temperature) may also have applications in the area of women’s health and family planning.

While we don’t yet have biosensors that are sufficiently practical for everyday use, simply providing tools to help in educating children about such issues can be very important. Although sexual activity is usually associated with adults, it is important to realize that in many rural and urban areas, children are sexually active beginning at a very early age. As mentioned previously in the context of digital pets, how viruses are relayed among interacting people or interacting objects is an interesting problem in its own right, independent of health connotations. Since the spread of information (e.g. hyphos bacteria) is a function of the interaction between such people or objects, such health toys can be an important tool in demonstrating the effects of certain behaviors.

Infant mortality

Better infant care is a need, particularly for first-time mothers and in isolated rural or urban areas. I just recently co-developed a simple system in Hiroshi’s class which permits remote monitoring of a baby’s size, movement, and development. The system was created primarily for the benefit of parents who may be at work and also to provide a sense of closeness for far-away relatives. As Isolde Birdthistle pointed out, however, a system that is able to remotely record infants’ size and weight would be of fundamental importance to helping

populations suffering from disease or malnutrition. A baby monitoring station could potentially be shared by a rural community (with appropriate sanitary conditions) to automatically log data on many infants; infants could wear bracelets which would electromagnetically tag them and automatically link the sensor information to the corresponding baby in the database, for example.

Medicine/vaccine distribution

There is a need for improving the way medicines are distributed and administered. We need to be able to easily identify medicines, and record when and how much was administered. Diabetes, for example, is a widespread disease where compliance (following the prescribed treatment) is essential to maximize treatment. Wireless tagging and sensor technology can be used for all of these functions. I have been personally involved in researching this technology in coordination with one of our sponsors, Becton-Dickenson.

Tagging technology can also be used to ensure that the right medicines go to the right people, and can also aid in safety by checking to see that no one has tampered with the medicine's packaging. Also, by putting such sensor information online (privacy assumed), it is possible to remotely monitor a patient's treatment and progress. When large groups of similar patients are online, this sensor information also enables new automated forms of agent-based health information: for example, "Based on the behavior patterns and history of similar patients A, B, C, I think you may expect side-effects X, Y, Z."

Economic empowerment

Certainly, some of the benefits of information technology in developing regions can be purely economic. Being connected, a community can advertise to the outside world their goods/services and their needs as well. More interestingly, however, is the fact that cheap, portable, wireless devices lower the start-up cost required to do business. A smart card reader embedded in a pager, for example, can be a cheap but effective way for a street vendor to perform financial transactions online, such as credit card authentication. Obviously, privacy and security standards would be a necessary part of this.

Political voice

Political representation is also an obvious application of the Internet and information technology. Much of the population of this world (e.g. China) lives in rural areas and has little or no political voice. Many such places don't even have access to a telephone. If connectivity were possible throughout the world, enabling isolated people to post information on the Internet is an obvious first-step in solving this problem. There may be no way to force people to read information that is online, but simply having access to opinions and problems experienced by all segments of the population is step towards democracy.

Documentation

For most projects it will be useful to document people, places, and events around the world. A child may ask another child "please tell me your story." If language is a barrier, it is most natural to tell stories using pictures and sounds. Since most computers distributed in developing areas will presumably be of the desktop variety, it will be necessary to provide children and other people around the world with a low-cost portable means of recording pictures and sounds from their local environment. Cameras and sound recorders can be very cheap, but tapes, film, and film developing represent a significant expense. The ideas I mention here pertain to recording visual images (since photography is a large part of my life), but similar ideas exist for sound as well.

In the near future, Motorola's Iridium satellite network will make it possible to have a wireless digital camera that can be used anywhere in the world because it can communicate directly to the satellites; unfortunately, such cameras will probably cost several thousand dollars each and would be a prime target for theft. A more practical alternative for developing regions would be a portable digital camera that can wirelessly communicate with an existing PC (or IP node) over a distance of a kilometer or so. Small digital cameras (e.g. QuickCam by Connectix) are now available for \$99 via mail-order, and a simple wireless link can be added for an additional cost of approximately \$100 (e.g. the price of Motorola portable 2-way radios which use the new frequency bands allocated for recreational use). Therefore, for \$200 each, we would have portable wireless digital cameras that children could use to tell their stories on the Internet. The cost of such cameras would probably be much cheaper if produced in quantity, but even at a price of \$200 it would be possible to donate some of these cameras to poor regions, since there are no additional costs incurred (no film and developing required). For urban areas with pager access, another possibility would be to use a pager to relay image data (the image would probably need to be divided into multiple packets, but this protocol is supported by Motorola's new 2-way pagers).

Reverse Technology Transfer

Lastly, I would like to point out that developing nations are not solely consumers of technology and useful knowledge. Although developing countries may not have the resources to do "high-tech" research, the indigenous people possess a wealth of knowledge in the fields of agriculture, biology, and medicine. Remedies used by "witch doctors" in the rainforest, may not be widely published in medical journals, but such knowledge is now gaining respect and publicity. The scientific community has much to learn from the indigenous "non-mainstream" knowledge that has been passed down through the centuries.

Summary

The new Media Lab global initiatives, such as the 2B1 Foundation, Junior Summit, and Center for Future Children may seem daunting, but in terms of technology, the research required is not a significant departure from what the Media Lab is already doing. The MIT Media Lab is uniquely suited for this mission and has the opportunity to assume a leadership role in creating innovative uses of information technology to solve global human problems. *If we carefully focus our goals and objectives*, these programs can be very successful. It's an exciting time.

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