Summaries from Concurrent Sessions

Dr A.J. Carty
Waterloo Institute for Nanotechnology
University of Waterloo

Track C

Good morning, ladies and gentlemen, and thank you Omi-san for bringing together such a distinguished group to this 5th STS Forum, to discuss some of the paramount issues facing science and society.

I was asked to report on the three separate but interrelated themes of Track C:

1. "New Materials: What Can They do for a Sustainable Society (C1)
2. "What can ICT do for Education (C2):, and
3. "What can ICT do for Health (C3)".

The threads of connectivity running through the three interconnected C1-C3 sessions are: the enabling capacity of modern information technologies across all scientific sectors and endeavors; coupled with the immense speed and power of computational tools and technologies. These allow, inter-alia, the prediction of structures and properties of entirely new materials ab-initio, the development of innovative new aids and approaches to education, and the rapid progress in the areas such as medical imaging, health diagnosis, robotic surgery and personalized medicine made possible through advances in computer hardware, software, visualization, and high throughput analysis.

Session C1:
New Materials: What Can They do for a Sustainable Society

Materials are the building blocks of our civilization and throughout history, the development of new materials (bronze, iron, steel, plastics, semi-conductors) has ushered in revolutionary changes in society. The advent of nanomaterials with unprecedented physical behavior (eg. super hardness, unique electrical, optical, and magnetic properties) similarly promises to impact significantly on our technological development. It is clear, for example, that in the energy field, new developments will come about largely through advances in materials-both incremental and disruptive. New "flexible electronics" –silicon-based thin film, solar photovoltaic cells, on flexible plastic substrates- may provide cheaper yet robust access to solar power, and new compound semiconductor materials, perhaps as quantum dots, hold promise for much higher solar conversion efficiencies than currently available.

It was pointed out that one-third of our energy usage is for heating homes and buildings, and one-third for transportation. With new innovations such as phase change materials and heat pumps to help reduce power consumption coupled with improved engineering design, zero-energy buildings are now a reality, although at a slightly higher cost. On the mobility/transportation side however, a massive shift away from the use of hydrocarbon fuels, to electric or fuel cell power vehicles, require breakthrough, disruptive technologies- new battery storage materials, new, cheaper polymer membranes for fuel cell stacks and a rapid transition to the widespread use of light metal alloy and composite materials in car frames, bodies, and engines. The pace of change here has been painfully slow, and one commentator

asked why the revolution which has occurred in the ICT and aerospace sectors over the last 40 years has seemingly passed by the automotive transportation sector.

Polymers and plastics are now ubiquitous in human civilization-we could even call our age the "Polymer Age", so widely used are these materials. Here, R&D efforts are now focused on the "greening" of chemical synthesis and engineering process technologies- to replace fossil fuel based hydrocarbon solvents with water, reduce multi-step processes to one-step reactions, and focus on "smart" polymerization and processing. New composite materials, for example concrete-the most important building material- modified by polymer additives to enhance hardness, strength and curing while reducing use of water can make a significant contribution to energy sustainability.

Finally, this summary would not be complete without mention of one particular scientific breakthrough which has reinvigorated the search for high temperature superconductors-materials which exhibit no resistance to the passage of electrical current, well above absolute zero. The demonstration of superconductivity at ambient temperatures is still a scientific "Nirvana".

A Japanese research group has discovered a new high-temperature super conducting material based on iron-with a critical temperature of 55K (-a value second only to cuprate based-superconductors which have been known for many years). The significance of this discovery is that it opens the door to the exploration of an entirely new structural class of superconducting materials- a very exciting development. However the practical application of high-temperatures superconducting materials for electricity transmission (with major energy savings) or magnetic levitation devices with superconducting magnets for rail transportation is still likely years away.

Session C2:
What Can ICT Do for Education?

This session began by recognizing the paradigm shift which has occurred in thinking about Information and Communications Technologies (ICT's) in teaching and learning and the respective roles of teacher, student, parents and new technologies in the learning process. From believing that the principal goal was to educated students to the technology, we have come full circle to the realization that students are the DIGITAL NATIVES, more familiar with and expert in using tools, accessing information and participating in social networks. Teachers are often less comfortable with the technology than the students and there is a new ecosystem of learning, where teachers are facilitators, parents are part of the network and expert students navigate the web and learn faster through self-study. The issue is more how to integrate ICT into the broader educational system as a tool, not a subject to be taught.

Within this ecosystem there is room for new enabling technologies. One speaker described the burgeoning marketplace for computerized whiteboards. Originally destined for corporate boardrooms, these are now embedded in classrooms in more than 100 countries-in some countries in more than 70% of classrooms. Successful implementation of this technology has been catalyzed by early adopters-teachers enthusiastic for the new tool, serving as guides and mentors to students wanting to explore and create with whiteboards. Interestingly, software has migrated from being teacher to learner centric.

Other participants agreed that teachers must become enablers, nurturing the talents of students, fostering excitement about science and technology and encouraging them to play a larger role in their own development. Communities of learning and on-line support frameworks for teachers can be valuable assets in improving productivity.

Access to technology is a stubborn problem in many places particularly in the developing world and in rural areas. There is a critical need for help in gaining access to digital information via internet connectivity in less developed countries. As one participant noted "the Public Highway of Science Should be Made Available to Developing Nations" particularly since, and I repeat the quote, "Education is the most powerful weapon to change the world".

Distance education, delivered by ICT can be a powerful asset for rural schools and for reaching out to talented students who are no longer challenged in their regular learning environment. However this should preferably facilitate learning via a seamless link to regular courses, and care must be exercised to ensure that such tools do not prevent hands-on lab experience or disincent collaboration.

One IT practitioner described an innovative approach to make information on the internet available to all kinds of learners in a culturally and linguistically diverse group of countries in South East Asia. By coupling satellite broadcasting with a low speed internet connection, clear images can be transmitted and effective 2-way interactivity established between lecturer and learner. This is particularly valuable in providing an opportunity for outreach and an interactive educational environment for students. Indeed, broadcasting and the internet have converged and interactive education can be achieved via IT technologies. With a network providing content to such a diverse user community, the issue of language of choice was raised. While the language of interaction between users is inevitable English, it is important that the information content be unveiled in the language of choice of the local community. Unfortunately machine translation is not yet practical. On the other hand software is internationalized and not language dependant.

Finally, the participants expressed overwhelming support for applications of technology to education and research and gave many examples of its use and potential.

Obstacles include resistance to change and copyrights on materials. The latter is a major, ongoing challenge. The existingeducational use exception does allow for using online materials, but new frameworks and laws are needed to allow educational collaboration in the online space

Session C3:
What Can ICQ Do for Health:

ICT now plays a role in almost all aspects of our daily lives and an important one is our health care. At the intersection of ICT and health a many great strides have been taken and many possibilities exist for future breakthroughs. It can be said that ICT has contributed to the rising cost of health care, but it will likely also be part of the solution.

In developed countries, populations are aging, and as a result, health care costs are rising exponentially. An important recent study reported that 20% of persons over 65 are dependents. Technological

solutions, such as monitoring systems and assistive devices, will be needed to care for these people, either at home (the cheaper alternative) or in care facilities.

Surgery and tissue sample procedures can be further minimized, and more targeted treatments for specific subsets of patients achieved with standardized records and imaging. Electronic hospital records also offer improvements in safety, accuracy, convenience and environmental impact. They can speed treatment for critical urgent situations, such as stroke, following imaging and diagnosis.

We can look forward to a much more informed consumer in both ICT and healthcare. One US study reported that 75% of Americans use the Internet for health advice and Google has become the number two resource for healthy information. Dr Google indeed! Patients want control and security for their medical information, but need to ensure its availability to family and caregivers when necessary. They also want more accurate information and more effective treatments on even shorter timeframes.

ICT can be of great help to developing countries, and can make a big difference. Unfortunately, ICT infrastructure is the least developed in these countries. The needs of developing countries can be markedly different from those of developed nations. In remote areas, broadband ICT infrastructure can help being doctors to patients and vice-versa. However, in many developing nations, basic ICT, such as cell phones and slow-speed Internet, remain luxuries. Even this low-tech ICT can make a major contribution to health care. Access to electronic books, journals and basic communications make a major difference to medical research in the developing world. It was noted that the majority of simple problems in rural areas could be treated without transport to a hospital if communications technology was available. However, electrical power generation alone remains a huge obstacle in many remote areas.

Numerous advances in ICT for health care were discussed, including optical sensors, higher-speed networks, mass data storage, and better communications between healthcare workers, including between first responders and subsequent care. Likewise, in high tech healthy care, advances have also been made against malaria and other diseases, and breakthroughs have even been made in stem cell research. Panelists discussed one cutting-edge area of drug research, the synergistic effects of combinations of drugs, which has produced several useful new therapies; some drugs unrelated to certain diseases are effective against those diseases when used in combination. Computational science was suggested as a future technology for predicting potential new contributions to cut the risks and difficulty of exploratory clinical trials.

ICT is of great importance for securing acceptance and motivation for action on health issues. Attendees expressed concern however that the most successful products are not always the most technologically advanced but often the cheapest ones. The STS forum could be influential in speaking out against barriers to ICT.

Overall, there was a general consensus that there was much more light than darkness here and that ICT has a great role to play in both the developed and the developing world, in terms of medical progress.