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Think Small!

From Housecalls to House Calls

Synopsis of the May 20, 2004 WFS Washington DC chapter dinner program presented by Dick Smith; summarized by Dave Stein

"My toilet sent me," you might someday find yourself saying when you visit your doctor. Or perhaps it was your house or even your clothes that made the referral. So predicted leading futurist Dick Smith in his address to the National Capital Region World Future Society on May 20, 2004, in which he described how nanotechnology (NT) will revolutionize healthcare and the practice of medicine.

IT'S A SMALL WORLD, BECOMING SMALLER

The roadmap starts with the advent of molecular sized structures that are as complex as a human cell and yet 100 times as strong as steel. According to Mr. Smith, this may happen within 10-20 years as nanotechnology becomes a mature science. While nanobots are not near-term, important developments have already been made. For example, passive "fullerene" materials that conduct electricity exist now. Actually, passive nanodevices were first developed around the year 2000. They are useful for preliminary software design and simulation. Other implementations of passive nanotechnology include nanolasers as well as "Buckyballs" that can contain and deliver medicines.

Active nanodevices can be expected around 2014, said Smith. The first active nanodevices may be disassemblers as opposed to full nanobots. Self-assembler (replicating) nanodevices can be expected after 2020. Mr. Smith was careful to explain the nano-scale, which is larger than the molecular scale but smaller than the dimensions that characterize viruses, microbes, or cells.

The envisioned applications of NT are pervasive as well as diverse. Potential information technology (IT) applications include semiconductors, memory, displays (Buckytube elements), micro-electromechanical systems (MEMS) and nano-electromechanical systems (NEMS) processors for "the laptop after next," and digital signal processing for communication. Both MEMS and NEMS devices can be built today, and medical diagnostic as well as therapeutic applications are envisioned.

Materials applications include smart and controllable materials or fabrics, including clothing (with temperature adjustment capability, for example), combinatorial chemistry, clear aluminum, paint, plastic, steel, glass, and conductive polymers, as well as bodies for cars, airplanes, and boats. Possible energy and environmental applications include water purification and desalinization (which will become

increasingly important as sea levels rise and contaminate fresh water plants), catalysts and filters for brown field remediation, solar cells that are cheap and efficient (perhaps made from plastic sheets not much thicker than Saran wrap), safe and efficient fuel cells (that store hydrogen safely without the need for a heavy container), and perhaps even safe fusion.

Then there is homeland defense. Potential NT applications here include detection of nuclear, biological, and chemical agents (including detection of dirty bombs), nuclear shielding (for nuclear materials being sent to storage), and soldier enhancements (including lighter batteries). Even oil-free energy is a possibility, as are weapons development and weapons suppression technologies. Mr. Smith noted that the US accounts for only one-sixth of the total investment in NT.

MEDICAL APPLICATIONS

So what's in it for medicine? Mr. Smith envisions improved, better-performing, and more reliable diagnostic devices and sensors that will detect diseases earlier, when they are less expensive to treat. Custom pharmaceuticals are another possibility. Today, pharmaceuticals are often too strong for some people and not strong enough for others. Worse yet, in some people they have side effects. Tomorrow's pharmaceuticals, if based on NT, can be tailor made for you instead of being mass-produced for "generic" people like you.

Still another promising application, according to Smith, is to early detection and treatment of cancer. The present approach uses biopsies and mammograms for diagnosis, followed by surgery, radiation therapy, or chemotherapy for treatment. The results of the biopsies and mammograms are often delayed, giving the cancer time to spread further. In contrast, NT-based detection offers the prospect of diagnostic test results that are immediately available. On the treatment side, one might see a light-activated Buckyball electron gun that that attaches to cancer cells and kills them with low dose radiation – "smart bomb" style without adverse effect on the healthy cells.

The future might see improved burn and wound therapy that will save lives, lead to faster recovery, and result in fewer cases of disfigurement. Improved body parts may also be "in the cards." Stress levels might be monitored along with the conventional vital signs. There is even the possibility that new food packaging technologies might warn of food that has spoiled.

Although not exactly a medical application, NT may lead to improved public safety by monitoring structural stresses in bridges and buildings. Even special clothing that reduces impact trauma has been envisioned.

RADIO DOCTOR

The radio doctor concept is not new. In fact, it dates back to 1924. Back then, however, it was not viable, because bandwidths sufficiently wide to provide pictures were not available. Furthermore, licensing arrangements were not in place to permit doctors to practice medicine across state lines. For example, a resident of Maryland might want to obtain the services of a physician in Virginia, but the physician might not be licensed to practice in Maryland and might not even meet Maryland's licensing requirements, or vice versa. That world contrasts profoundly with the age of the Internet, in which (short of the restrictions on Internet access imposed on citizens of totalitarian countries), it is difficult to stop the flow of medical or other information across national boundaries. As a result, the technology is in place for a US citizen to obtain medical advice, diagnosis, and treatment from a physician in India.

NEW PARADIGMS

Today, when you get sick, you make an appointment to see a physician, or perhaps you go to the emergency room. In either case you wait, the difference being that one wait is measured in days while the other wait is measured in hours or fractions of an hour. Then you see the doctor, get tested, and wait again, this time for the test results. These waits give the illness or other condition time to get worse. Finally, when you are given pharmaceuticals, you are given the "one size fits all" drugs that everyone else gets.

In tomorrow's world, your house or clothing may monitor your health on a constant basis, provide administrative telediagnostics, and automatically call the doctor when necessary. Armed with the telediagnostic information, the doctor or clinic will have remote triage capability. Information on the success rates of all doctors may also be readily available. In situations involving mass casualties, instant triage will likewise be possible. Japan already has "smart toilets" that monitor the health conditions of their users. Imagine going to a doctor or hospital saying, "My toilet sent me." Just imagine!

The new paradigm is envisioned to make healthcare more affordable and available. You will visit your doctor only when you are sick, not to find out if you are sick. The doctor hours thereby saved can enable more patients to be seen as needed. At the same time, NT-supported telediagnostics will support earlier interventions that can avert the need for prolonged treatment regimens and expensive medicines. An added payoff is that people will benefit from monitoring their own health through NT-enabled feedback loops.

AT THE CELLULAR LEVEL

In five years, NT may make possible "cellular stethoscopes" – sensors that measure the health of individual cells. Diabetics may benefit from continuous monitoring of blood sugar levels, with automatic insulin injection when needed. NT may find a role in assisting the filtration processes performed by the liver and kidneys and in otherwise filtering the blood as needed. For defense against anthrax, NT may offer sensors, phages, and filters.

Improved pharmaceuticals may include deep lung inhalation drugs to fight pulmonary disorders as well as blood brain barrier crossing drugs to cure multiple sclerosis and Alzheimer's disease. NT medical payoffs of a more structural nature may include rejection-proof new organs, improved bone-bonding capabilities that reduce fractures among the elderly, computerized stents for the circulatory system, and perhaps even printed arteries and joints.

HOW DO WE GET THERE FROM HERE – AND WHERE IS "THERE"?

Mr. Smith envisioned that eventually, 80% of diagnoses will be at the molecular level and that 75% of treatments will be by nurse practitioners and other non-physicians. Modeling change by the formula

change = dissatisfaction *x* vision *x* first steps,

he postulated the condition for change as

pressure to change > resistance to change

As Smith observed, several factors drive dissatisfaction. Chief among these factors are the high costs of healthcare and the large number of uninsured people. In addition, people are living longer, and statistically, they experience more diseases and disorders after retirement, when they can least afford healthcare. The opposing force is resistance to change, which can be anticipated from those who prosper under the current system.

Q&A

Q. Which advances depend on nanotechnology and which ones will happen anyway with NT being a "best supporting actor"?

A. Telemedicine does not depend on NT. However, home-based diagnostics are more likely to be effective if patients don't have to do anything complicated like hook up to the equipment. Perhaps it will be as simple as putting on a monthly patch, and such patches can be inexpensive as well as easy to distribute. Nanotechnology doesn't draw blood, and a nanotechnology diagnostic device may have enough wells to perform comprehensive analyses. It is also possible that diagnostic tests can be done in pharmacies, without appointments. In addition, 80% of homes in the United States have computers that may support remote diagnostics, and kiosks offer still another possibility. Another possible outcome is that pharmacies as we know them may go away, to be replaced by shipping companies that deliver your medicines to your door.

Q. Moral question – if self-replicating machines are developed, who will have access to them?

A. It is not too soon to begin asking such questions.

Q. The present health care system is actually an illness system. What in NT is prevention-oriented?

A. Feedback loops. "Your pulse is too high (or low)." "Your blood pressure is too high (or low)." "You didn't walk far enough today." "You should be eating more salad today."

Q. Who would be a "resistance" function?

A. Those who benefit from the status quo.

Q. How do you see the "resistance" breaking down?

A. That's the 64,000 dollar question. Maybe you arrange for the devices to be sold by the pharmaceutical companies, to get their buy in.

ALL GOOD THINGS COME TO AN END

And so, with renewed hope for affordable and timely healthcare – perhaps tempered by apprehension that their vehicles might refer (or take?) them to their respective doctors – the participants began their trips homeward, and back to the year 2004, as closing time approached. Like all monthly dinner programs sponsored by the NatCapWFS, the evening was an opportunity to learn from a leading futurist, meet and talk with amazing people, expand one's horizons, and expand one's waistline by

overindulging in the delicious faire!

... but not just yet!

Follow-on discussion from our post-program interactive Web forum

Carl Pinches
Registered: Thu May 20 2004

One area of interest that can up during discussion period was impact on current rolls. Nanotech will enable remote diagnostics and eventually remote treatment then how will the following roles be transformed: Who are you going to calling: Nurse, Doctor, Pharmacist, Lab Technician, Paramedic, Equipment Vendor's Hardware or Software Technician, Morgue. Any other ideas for this list?

John Meagher
posted Tue June 22 2004 11:23 AM

Carl,

You raise a good point on the need to have qualified folks in the IT medicine loop for this to work.

You might be interested in an article by Dr. Barbara Starfield from Johns-Hopkins, I think in JAMA around 1998. It was updated by others last year. She and her colleagues found that the third leading cause of death in the U.S. is medical treatment. Her numbers were low and just hit the obvious (example: wrong med, wrong organ-oops your dead). Morbidity was not counted in her article, only death from medical treatment (here's a treatment, oops you don't need it, oops you had a stroke-but you live on with poor quality of life and dozens of other goofs too numerous to mention) because its difficult to get data on performance outcomes and in fairness it is gray area in terms of treatment/performance/outcome.

However, U.S. medical treatment could be vastly better and Dick is on the right track.

I think the best solution is quality control and removing the error prone human being from the medical process except where necessary, or it is deemed that is the best treatment option. Hospitals / medical staff are very well intentioned, capable people, but I think they are overworked and are in sore need of better quality control and relief through IT/nanotech to do no harm, and do medical good.

I hope Dick's nanomedicine and other inventions of home med become a reality soon, we need it. The system of medical care now is not changing fast enough to improve treatment quality to reduce malpractice liability. We do not want to carry forward the quality problems of today into the future.

John M.

POINTS FOR THE CLASSROOM *(send comments to forum@futuretakes.org):*

"Chime in."

- *What relationships might exist between health demographics, healthcare needs, and factors that may drive an increase in the retirement age? How might these relationships vary among various countries of the world?*

- *Also, given the opportunities for unintended adverse consequences (which good futurists take into consideration), who will certify the NT application as safe, and how will the testing agency ensure that its results are accepted by the stakeholders?*