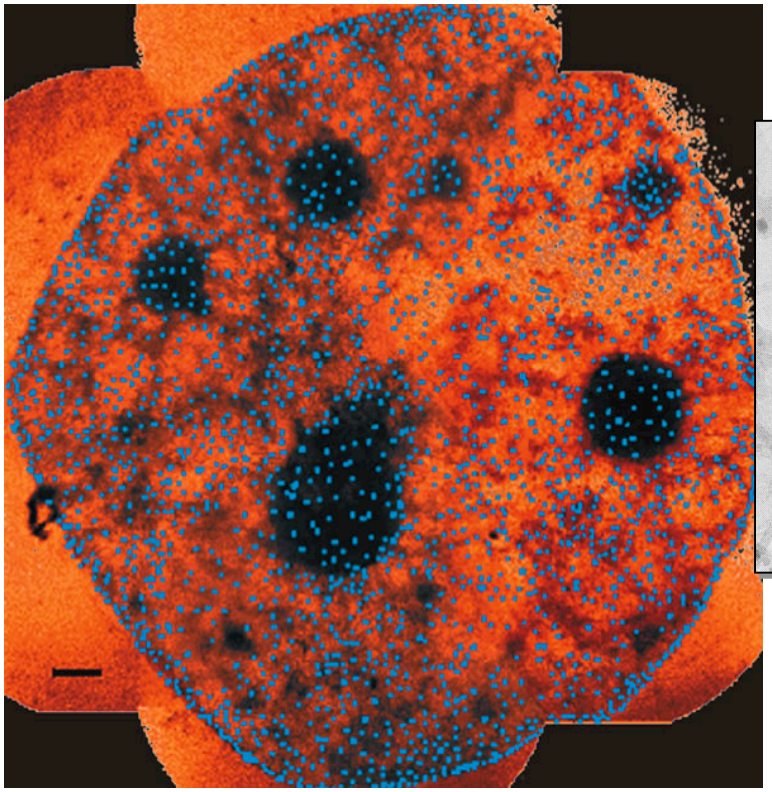
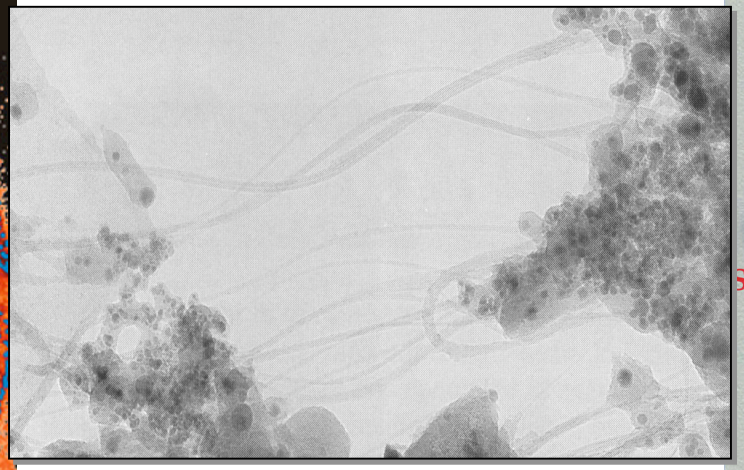
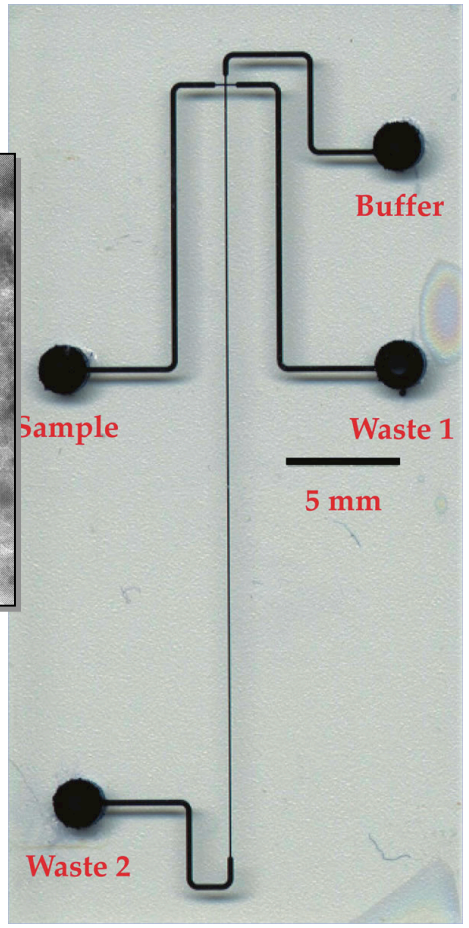
Nano-Bio-IT Convergence:
Can nanotechnology really be the ultimate Bio-IT interface?







Images this page:
U.S. Department of Energy
Human Genome Program
http://www.ornl.gov/hgmis
And
SRI International
http://www.sri.com

Brock Hinzmann
Technology Navigator

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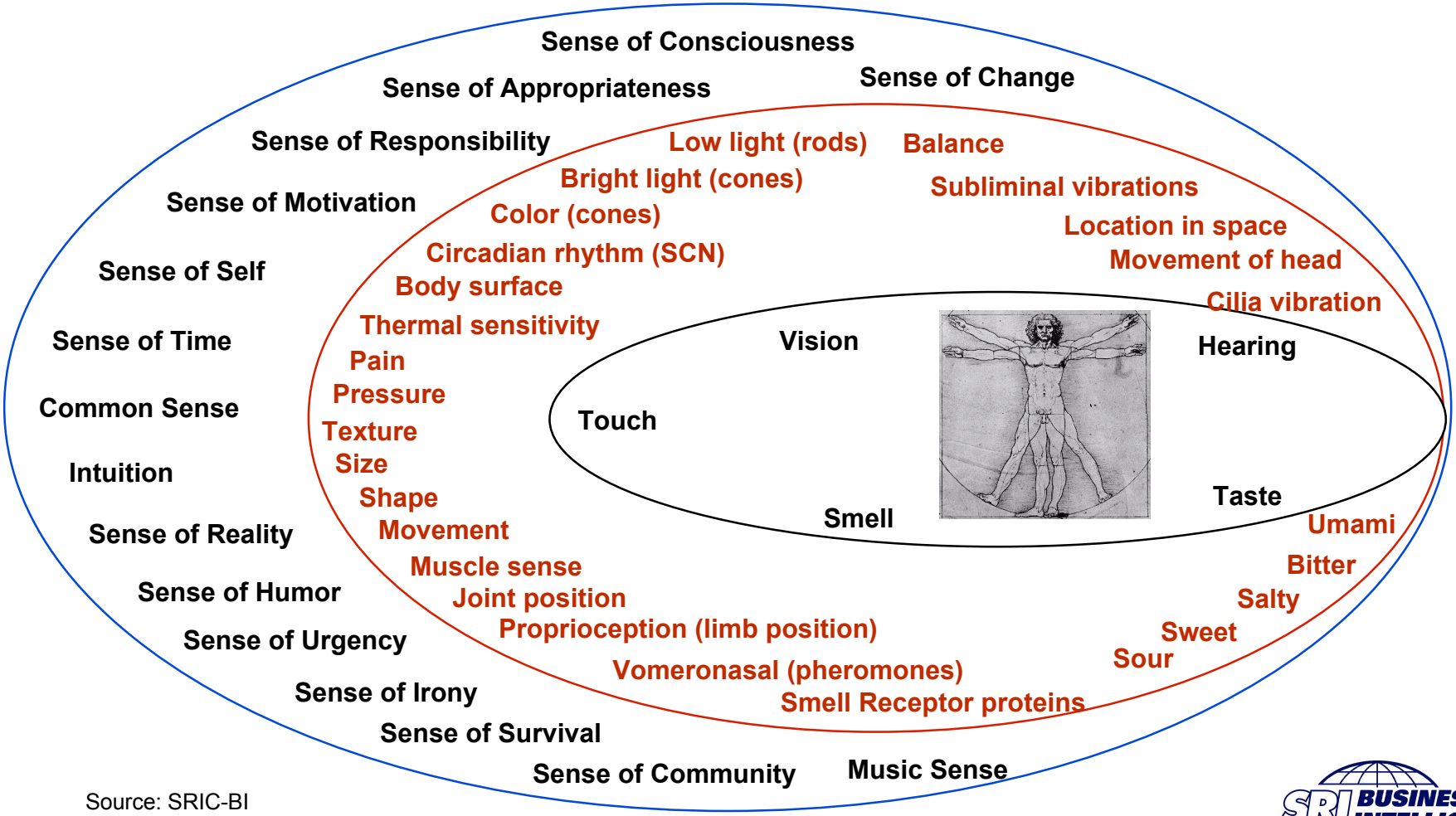
Human-World Interfaces



Source: SRIC-BI

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Definitions du Jour

- Nanotechnology: detecting, visualizing, and precise manipulation of atoms and molecules
- Biotechnology: understanding, modeling, mimicking, and altering living things
- Information Technology: recording, verifying and communicating data, awareness, knowledge, and intelligence

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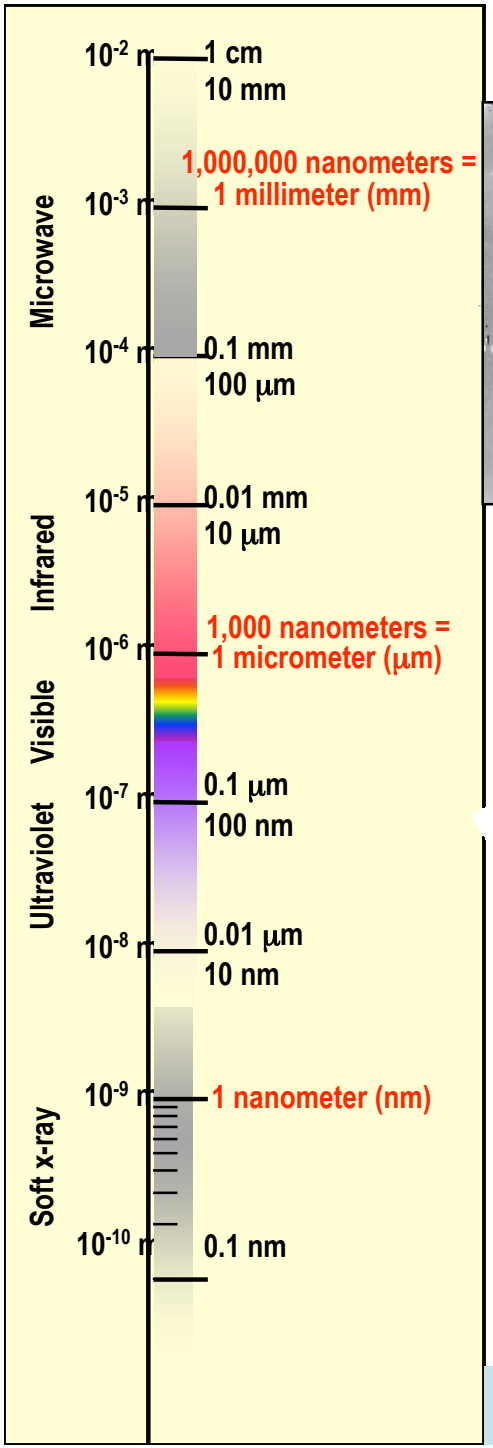
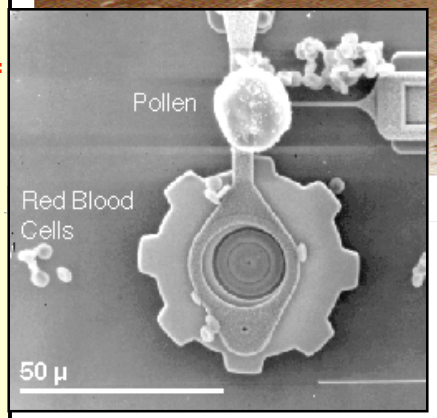
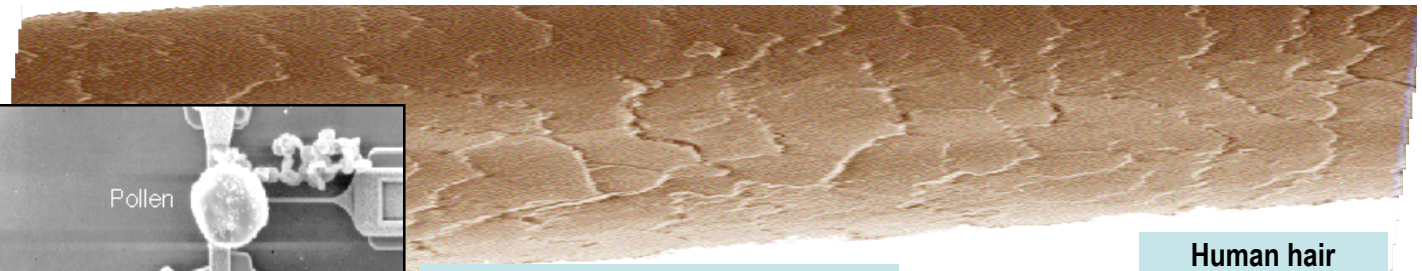
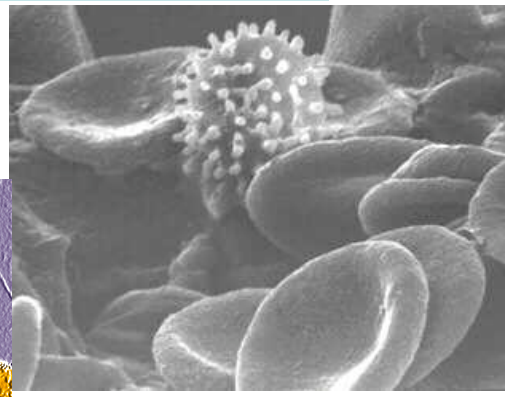






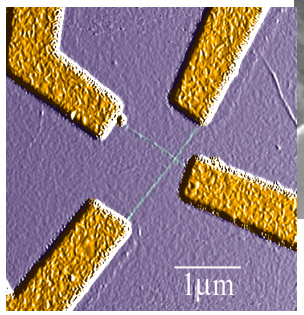
Human hair
~ 60-120 μm wide

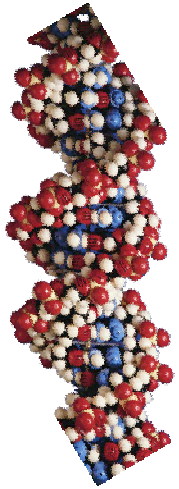
MicroElectroMechanical Systems (MEMS) devices
10 -100 μm wide



Red blood cells with white cell
2-to-5 μm

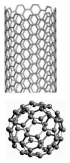
Nanotube electrode





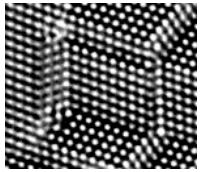
DNA
2-1/2 nm diameter

Source:
Office of Basic Energy Sciences
Office of Science, U.S. DOE
Version 10-07-03, pmd

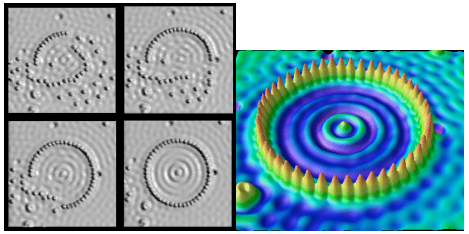


Carbon nanotube ~1.3 nm diameter

Carbon buckyball ~1 nm diameter



Atoms of silicon
spacing ~tenths of nm



Quantum corral of 48 iron atoms on copper surface positioned one at a time with an STM tip
Corral diameter 14 nm

Identification and Tagging

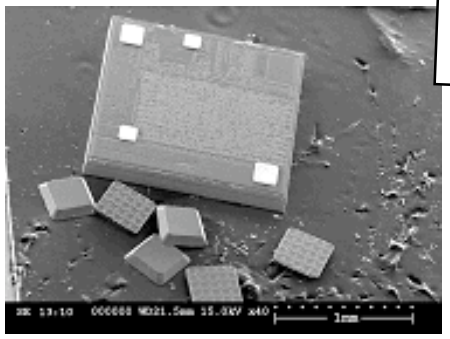
- Companies seeking to tag and to identify objects for supply-chain management and customer service are seeking ever smaller and cheaper alternatives.

Alien Technology, publicized as a nanotech company, isn't, but industry does want RFID tags ever smaller and cheaper.

Applied DNA Sciences will weave DNA from plants into textile fibers as an anticounterfeiting technology for the U.S. Department of Commerce. DNA inks for authenticating computer chips also exist.

The U.K. Department for Environment, Food, and Rural Affairs wants to use DNA bar codes to label and track genetically modified foods.

A controversy: Should consumer-product companies, including Gillette and Benetton, place RFID tags in their products?



Nanoparticles and DNA may be the enablers for the tagging and tracking of virtually every object. As that happens, some activists will form a backlash against the technology that enables an invasion of privacy.

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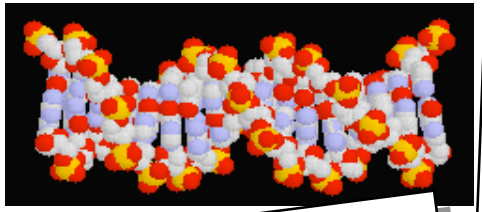
Tiny Power

- Virtually every Scan meeting includes portable power, power on a chip, fuel cells, batteries, and photovoltaics. Nanotech may have solutions to technology barriers in those areas.



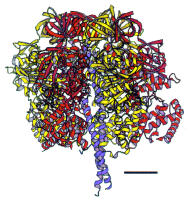
The Weizmann Institute states that the ability of DNA to store energy and to act as a power source for molecular computing is underused.

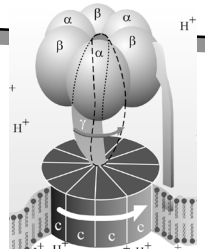
The Hosei University, Japan, reports being able to put microbatteries on a computer chip, which should be a practical application within five to ten years.

NTT Corp. and Seiko Epson have developed a wireless system powered by a small thermal-electric generator. The thermal source of the power is human body heat.

Several companies are attempting to introduce fuel cells. The platinum catalyst is an expensive limiting factor.

~10 nm diameter





ATP synthase

The broad definition of nanotechnology now includes working with DNA, attempting to use it for mechanical, computing, and power applications. Nanosize particles offer high surface-to-volume ratios, which may lower the cost of expensive power systems.

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Naturally Smart Materials

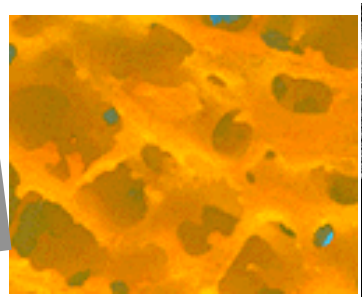
- Users are seeking unmet material needs in new and unusual places, often in nature, to be responsive to human needs.

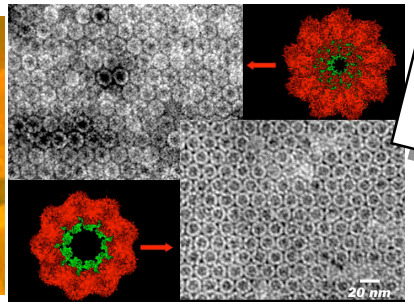
Microbia is offering "precision engineering" to regulate the genes of microbes for use in bioprocessing of drugs and chemicals.

Biomimetic materials imitate structures in nature to create surfaces that are easy to clean (based on the microsurface of the lotus plant) or can have unusual colors (based on the interwoven layers of bird feathers).

NASA is using extremophile proteins that form in rows and columns and have pore holes through the middle to pattern electronic substrates with conducting nanoparticles (gold).

UC San Diego researchers are creating custom-designed 3-D scaffolds for tissue engineering by exposing photosensitive, living-cell–filled polymers to UV light.





University of Oregon is using helical axis of DNA as a template to assemble gold nanoparticles.

Many companies and researchers are looking for new design concepts in biological models. Precise positioning of nanoparticles might enable such new capabilities and products.

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Questions for SVWIC Pub

- Since electronics researchers can already project they will be able to stay on the Moore's Law curve for another decade using well-known conventional technology, and that large electronics companies are conducting their own nanotechnology research, can nanoelectronic start-up companies have any commercial impact in that timeframe?
- Will the concern over the environmental and health impacts of using nanoparticles slow the development of the technology?
- If nanotechnology really does make it possible to put cheap sensors, sensor networks, interfaces, and nanoactuators everywhere, what would be the benefit?

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