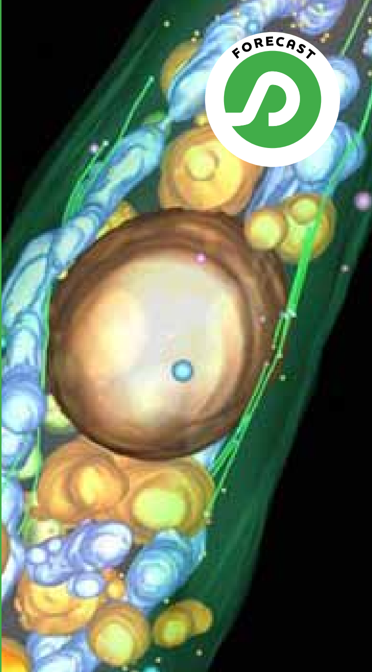
synthetic biology



Synthetic Biology: Assembling biological organisms and systems

At the intersection of the biosciences and engineering, researchers are designing and building living systems that may not exist in nature. By reprogramming biology, scientists will create organisms with extraordinary capabilities, such as bugs that glow red in the presence of certain environmental contaminants and digest the toxins, biosynthetic solar cells that mimic a plant's light harvesting systems, or bacteria that convert waste paper or biomass into octane for fuel.

SIGNALS:

1 | BioBricks Foundation: orchestrating a "parts store" of standardized DNA components that encode biological functions

2 | Biological Robots: engineering slime molds capable of computation and manipulation of objects

Image Source: http://technofender.com/blog/wp-content/uploads/yeast-cell-synthetic-biology-hms.jpg

designer social networks

5 Designer Social Networks:
Optimizing sociability

People are viewing their online social connections as programmable data streams that can be designed to create interactive feedback. Real-time data, cloud computing, and online profiles are the tools that will allow us to crunch our social data into new nuggets of information. The structure of social data will begin to matter more as we seek to generate insights from people's online footprints—and to protect ourselves from others seeking to do the same to us.

SIGNALS:

1 | Personas: analyzes Web data to create unique "persona vectors" that depict a set of pre-determined categories in which that name shows up most frequently

1 | Picnic Festival Hack: Mediamatic taught people how to create their own software to "read" and "talk to" the social network data on the festival's website

Image Source: http://personas.media.mit.edu/personasWeb.html

quantified self

FORECAST

Quantified Self:
Your body and health as a data system

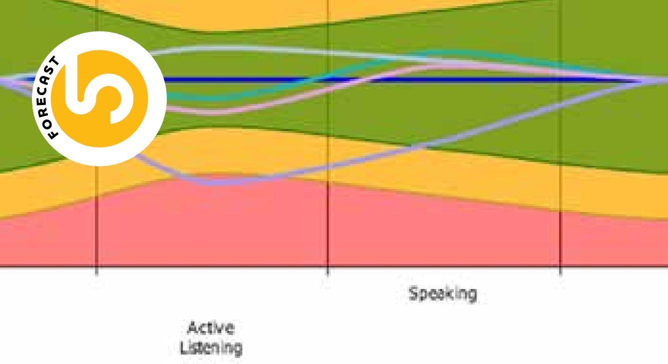
An increasing number of people are applying sensors, social networks, and online data repositories to track their biological processes and behavioral patterns. Using a mix of medical, athletic, Web 2.0, and DIY self-tracking technologies, they collect, analyze, and compare information about myriad physical metrics. These pioneering practitioners of self-surveillance point toward a future where we will continuously monitor our personal states in great detail and close the feedback loop by reprogramming our lives for improved performance, health, and happiness.

SIGNALS:

1 | Flowing Data's Personal Visualization Project: translating personal data into beautiful information graphics

2 | Patients Like Me: social network health site where members track personal symptoms and treatments for various diseases

Image Source: http://www.boingboing.net/2008/09/10/flowingdatas-persona.html



new taylorism @ work

New Taylorism @ Work: Productivity through packet-switching

More of our work-related activities and interactions are becoming quantifiable and we are able to analyze the data, see previously invisible connections, and program serendipitous work processes for desirable outcomes. While in the past we were able to do this in factories and assembly line processes, we are increasingly applying programming to services, knowledge, and creative work. As we learn to understand and measure aspects of knowledge work, the "science of productivity" will be used to program our work environment for optimal results.

SIGNALS:

1 | Google's Hiring Algorithm: programming human resources

2 | Liveops: engineering "visibility and control" for the service sector

Image Source: http://www.hirelabs.com/hr/index.php?ACTION=LOADJOB&tab=behavegraph#

embedded governance

5 **Embedded Governance:**
Downloading laws into objects and the environment

Embedded governance will leverage cloud computing, wireless networks, biometrics, and context-aware sensing and feedback to make law and policy downloadable into our official documents and physical environment. Law is code, and when government is programmable, enforcement, regulation, and policy will be rendered automatic and universal—written into the fabric of our core infrastructures, our devices, and the tools of our everyday lives.

SIGNALS:

1 | Electronic Passports: tracking citizens across borders using RFID

2 | National Pricing for Road Infrastructure: automating toll collection for every vehicle on the road

Image Source: http://www.secure.vimigroup.com/news/?p=152

neuroprogramming

Neuroprogramming: Coding the brain for desired emotions, capabilities, and functions

Brain-computer interfaces, neurofeedback tools, augmented cognition, pharmaceuticals, and targeted brain stimulation are giving us the power to alter our mental capacities for specific conditions or desires. As our precision of use with these devices grows, so will our ability to "dial" our minds to certain states at certain times, giving us the ability to program our minds.

SIGNALS:

1 | Therapeutic Forgetting: selectively deleting memories is on the horizon

2 | Augmented Cognition: understanding and overcoming cognitive limitations

Image Source: http://encefalus.com/cognitive/does-tweety-have-self-awareness/

neurocentric learning

FORECAST 5

Neurocentric Learning: The new pedagogy

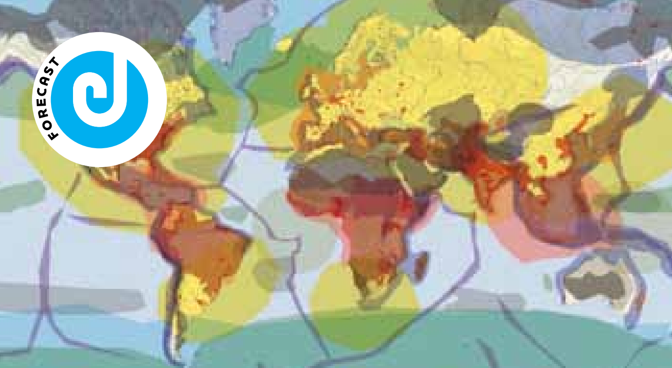
The process of learning involves persistent changes to the way synapses fire and connect in the brains of individuals. We have affected these synaptic changes through teaching formal systems. Now, deeper understanding of neural plasticity is showing us how learning actually takes place in the brain, and how people learn differently and more effectively. Neurocentric learning will use the knowledge and technologies from neuroscience to customize the pedagogic process around the actual and distinct capacities of the mind.

SIGNALS:

1 | Magnet School: improving skill acquisition through transcranial magnetic stimulation

2 | Brains.org: applying current brain research to the classroom experience

Image Source: http://homepages.uni-tuebingen.de/karnath/fotos/ExtinctionLaesionen.jpg



model(ed) industries

Model(ed) Industries:
Previews and re-do's for business and organizations

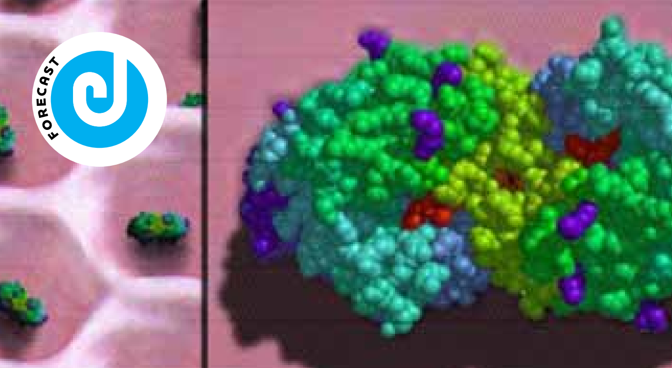
The diffusion of sensors and mobile devices is creating a huge influx of new quantitative social data, including demographics, behaviors, locations, and other previously invisible aspects of our societies. The accessibility of new data and advances in the theory and modeling of complex networks are providing an integrated framework that will bring us closer to the elusive goal of predicting the behavior of complex techno-social systems.

SIGNALS:

1 | Reality Mining: sussing out social systems by crunching data

2 | DIYCity: simulating patterns of urban development and organization

Image Source: http://www.di09.rca.ac.uk/wp-content/uploads/2009/06/323117029_dd7cd4efb5_o-1024x723.jpg



combinatorial manufacturing

Combinatorial Manufacturing: Harnessing natural processes

Technologies are being integrated in various combinations to enable a new kind of organic manufacturing. Human-designed computer programs create nano-materials and synth-bio cells that can orchestrate themselves into useful configurations. These autonomous cellular automata will transform the manufacturing process into a world where the scripts and templates for self-assembling objects will be as valuable as the objects themselves.

SIGNALS:

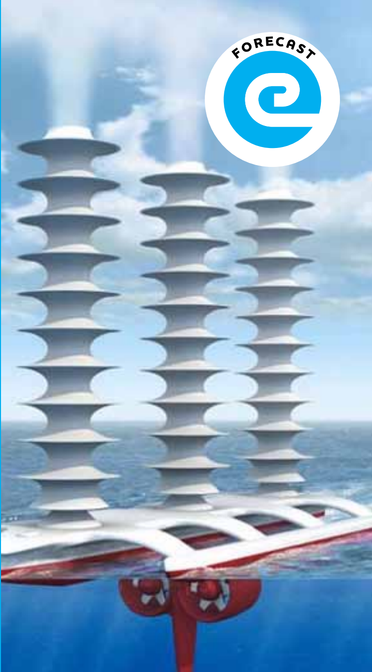
1 | Softmachines: thoughts on the future of nanotechnology

2 | Queen City Jazz: a world where humans and bees communicate with digital pheromones

Image Source: http://genome.gsc.riken.go.jp/hgmis/graphics/slides/images/SAMMSenzyme.tif

geoengineering

FORECAST



Geoengineering: (Re)programming the Earth

As humans begin to acknowledge our role in the profound alteration of the Earth and its climate, we are looking for ways to mitigate many of the destructive changes we have wrought. Geoengineering, the artificial manipulation of the environments of the Earth as a means of counteracting global warming, is one controversial method. Robust global models will be developed to provide proscriptive mitigation programs with specific tasks, milestones, and instructions for programming the natural Earth.

SIGNALS

1 | MIT Integrated Global System Model (IGSM): comprehensive tool analyzing human-climate system interactions

2 | Cloud Ships: modifying the weather

Image Source: http://www.energytwodzero.org

FORECAST

smart cities & spaces

Smart Cities & Spaces: Sense-able planning

Rich streams of operational data about cities—collected from sensor-laden infrastructure, context-aware vehicles, and citizens' mobile devices—will enable planners to monitor complex large-scale systems and calibrate sophisticated simulation models. These real-time bird's eye views will enable feedback to be directed back into the city, shaping large group behaviors in beneficial and predictable ways.

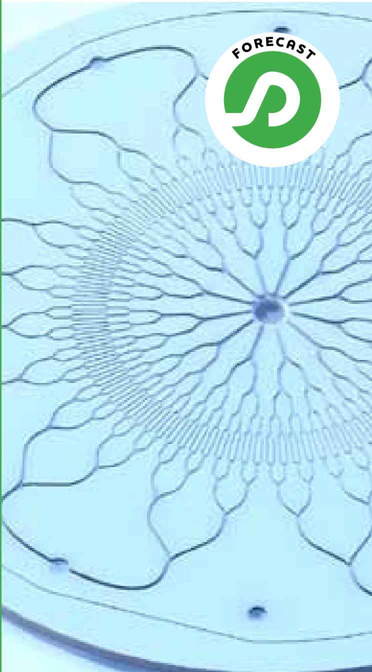
SIGNALS:

1 | MIT SENSEable City Lab: experiencing Rome in real time

2 | Marta C. Gonzalez, C A. Hidalgo & A L Barabasi "Understanding individual human mobility patterns" *Nature*

Image Source: http://www.citysense.net/trac/citysense-public/attachment/wiki/WikiStart/street-light_node.jpg

mind over morphology



Mind Over Morphology: Designing bodies and body parts

At every scale of biology—from cells to populations—the boundaries between the natural and the artificial are blurring. At the level of individual bodies and body parts, we are designing and incorporating artificial replacements and augmentations into ourselves. Artificial organs, wetware implants, and cyborg augmentations are allowing us new freedoms and control over the structure and function of our bodies.

SIGNALS:

1 | Grace V. Jean, "Creating the Body's Microenvironment to Grow Artificial Organs" *National Defense Magazine*

2 | Boston Retinal Implant Project (BRIP): "novel engineering solutions to treat blinding diseases that elude other forms of treatment"

Image Source: http://www.xconomy.com/wordpress/wp-content/images/2007/09/trimetric_view_vascular_rendering_041807.jpg

everyone is a programmer

Everyone is a Programmer: Making the world a control system

As people begin to live in, and interact with, a world in which everything is programmable, there is a need for tools and institutions that teach the skills required for a programmable reality. Novice-friendly programming languages, early education in algorithmic thinking, and technologies built to teach the fundamentals of programming will enable us to manipulate our built environments, and enhance our interactions with the different programmable domains of our lives.

SIGNALS:

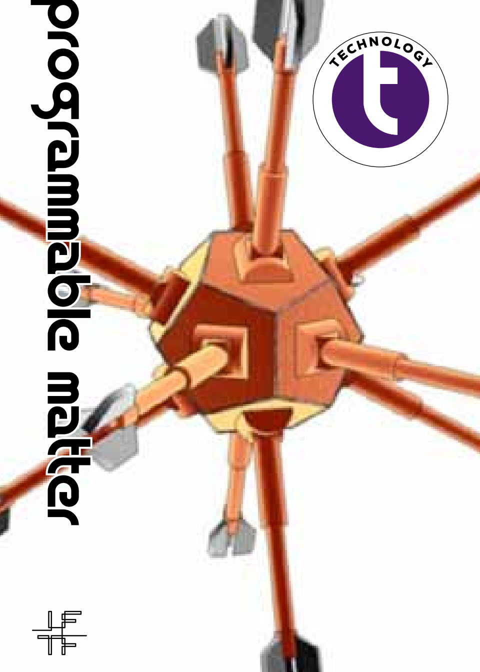
1 | DIYbio make biology accessible to citizen scientists and amateur biologists

2 | Scratch: programming language that aims to help teach the fundamentals of programming to children

Image Source: http://kidconfidence.com/blogs/wp-content/uploads/2007/10/scratch1.png

programmable matter

TECHNOLOGY



Programmable Matter:
Morphing materials

Programmable matter is material with embedded computational qualities that can physically change shape on command. For example, groups of reconfigurable robots could rearrange themselves into new structures—from a scalpel to a cup, or an aircraft's wings might morph in-flight for improved aerodynamics and efficiency.

SIGNALS:

1 | DARPA's Programmable Matter Project: developing a "functional form of matter which can reversibly assemble into complex 3D objects upon external command"

2 | Carnegie Mellon University researchers are developing self-assembling modular robots, called "Catoms" (claytronic atoms)

Image Source: http://mems.sandia.gov/gallery/images.html

metamaterials

TECHNOLOGY

Metamaterials:
Artificial structures beyond nature

Metamaterials are artificial materials that exhibit properties not occurring in nature. The behavior of the metamaterial is determined by the sum of its parts—the molecular “ingredients” and also their arrangement. Metamaterials have a wide variety of potential applications, from supermicroscopes with theoretically perfect focus to an invisibility cloak capable of bending light around an object.

SIGNALS:

1 | University of California, Berkeley Engineering: making the visible invisible with refractive materials that can bend light in any direction, including backwards

2 | Max Planck Institute for Biochemistry: developing a lens with perfect focus and methods to make smaller, more powerful wireless devices

Image Source: http://fightrobots.com/?p=90

molecular engineering

Molecular Engineering: Building from the bottom up

Molecular engineering designs and builds novel structures, devices, and materials at the atomic or molecular scale "from the bottom up." The aim is to control the placement of molecules using a variety of means, from manual manipulation using atomic force microscopes to piggybacking on DNA self-assembly. Nanofactories may be developed where nanoscale molecular assemblers, resembling industrial robot arms would position molecules with atomic precision.

SIGNALS:

1 | Berkeley Lab Molecular Foundry: nanofabrication and nanomanipulation tools

2 | The Foresight Institute Guidelines for Responsible Nanotechnology Development: examining the downsides of molecular engineering

Image Source: http://thereadingroom.epsilonfoundation.com.au/technology/nano-tech-godzilla/


mems
TECHNOLOGY

MEMS: Micromachines on the head of a pin

MEMS (microelectromechanical systems) are tiny machines fabricated in bulk from silicon with techniques similar to those used in integrated circuit manufacturing. MEMS nozzles are already used in inkjet printers and MEMS velocity sensors tell cars when it's time to trigger airbags. Advanced MEMS that link moving parts directly with digital processors on the same chip will be the basis for tomorrow's micro robots and sensors smaller than a grain of sand.

SIGNALS:

1 | Sandia National Laboratory: designing MEMS-based sensors, microfluidics for "lab-on-a-chip" applications

2 | University of Waterloo: building a magnetically-levitating MEMS robot

Image Source: http://img125.imageshack.us/img125/9962/hbjpvytfpxgenr700xa.jpg

personal fabrication

TECHNOLOGY

Personal Fabrication:
From the factory to the desktop

Personal Fabrication is a method of distributed, lightweight manufacturing in which individuals design and produce fully functional manufactured goods, at home or in local "fab labs." The technologies underlying such "desktop factories" include easy computer-aided design (CAD) software, 3D printers, computer-controlled milling machines, and printable electronics.

SIGNALS:

1 | MakerBot: a sub-$1000, open-source 3D printer that spits out layers of ABS plastic based on a digital design

2 | *The Coming Revolution on your Desktop* by Neal Gershenfeld

Image Source: http://store.makerbot.com/media/catalog/product/cache/1/image/5e06319eda06f020e43594a9c230972d/c/u/cupcake-cnc-final.jpg


simulation
TECHNOLOGY
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Simulation:
Modeling possibility space

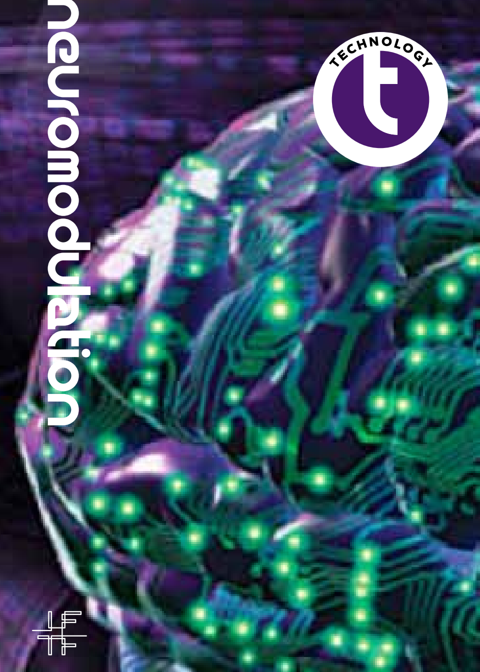
Simulation recreates and represents the key characteristics or behaviors of a real system, in an artificial environment. As simulations become more advanced and simple to create, they will transform how we interact with our world, conduct business, and make life decisions. It will be possible to translate all physical systems into code that can be reprogrammed, "run," and optimized for desirability, practicality, and validity.

SIGNALS:

1 | Sim Man: a sensor- and microprocessor-laden mannequin that can be programmed to exhibit a variety of symptoms and emergency scenarios

2 | Exploratory Simulation Technologies: modeling and simulation tools associated with national security issues related to climate, seismic, and atmosphere wave propagation

Image Source: http://appadvice.com/appnn/2008/09/spore-origins/


neuromodulation
TECHNOLOGY

Neuromodulation: The new mind control

Neuromodulation is the intentional alteration of activity in the brain and extended nervous system for treatment of medical conditions, behavioral modification, and cognitive enhancement. Neuromodulation can be accomplished by several means, including electrical, magnetic, and optogenetic stimulation, pharmaceutical intervention, neurofeedback and brain training, and neural prosthetics.

SIGNALS:

1 | Miller, G. "Optogenetics. Shining new light on neural circuits." *Science*

2 | Kipke DR, Shain W, et al. "Advanced neurotechnologies for chronic neural interfaces: new horizons and clinical opportunities." *Journal of Neuroscience*

Image Source: http://scienceblogs.com/neurophilosophy/2008/09/neuronal_light_switches.php

neuroimaging

Neuroimaging:
Peering into the open mind

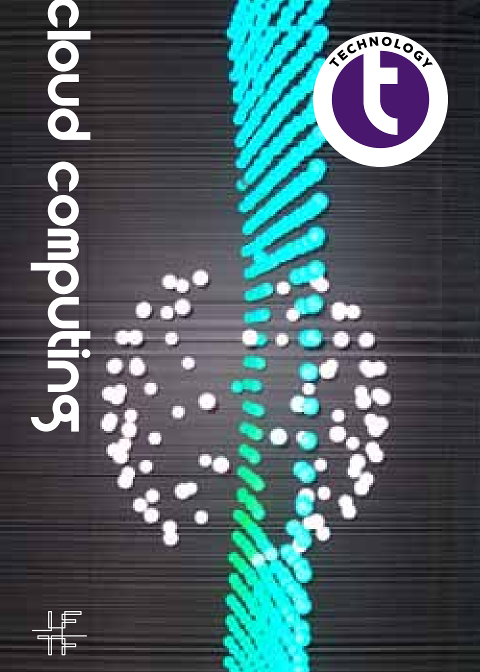
Neuroimaging is the visualization of data produced by neural activity. New imaging technologies have allowed scientists to uncover processes and structures that were previously unknown. Neuroimaging technologies are advancing rapidly, and include electroencephalography, positron emission tomography, computed tomography, functional magnetic resonance imaging, and diffuse optical tomography.

SIGNALS:

1 | Poldrack, Russell A, "The role of fMRI in Cognitive Neuroscience: where do we stand?" *Current Opinion in Neurobiology*

2 | Muehlemann, T, et al. "Wireless miniaturized in-vivo near infrared imaging"

Image Source: http://www.sciencedaily.com/releases/2008/01/080103161531.htm


cloud computing
TECHNOLOGY

Cloud Computing: Supercomputing on demand

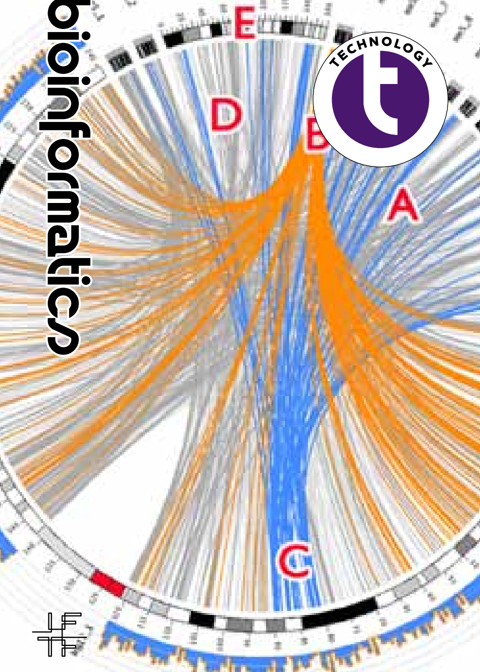
Individual computers are being linked together over ubiquitous networks to create clusters of utility cloud-based supercomputing services. Google, Amazon, HP, and others are offering on-demand access to computational resources in the cloud. Pervasive access to supercomputing will enable a pattern recognition in biometric measurement and imaging, and the creation of high-resolution simulations for research education, therapy, and patient information.

SIGNALS:

1 | The Global Lambda Visualization Facility: infrastructure for computationally intensive visualizations

2 | Google AppEngine: plugging your application into the Google infrastructure

Image Source: http://farm4.static.flockr.com/3318/3333935268_7534a00fd3_o.jpg


bioinformatics
TECHNOLOGY
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Bioinformatics:
Life as data

Bioinformatics involves the translation of life into mathematical and computational languages in order to understand and analyze complex biological processes. These computational algorithms can uncover and model DNA sequencing, protein folding, and biochemical interactions. Huge databases of biological information are being created and mined to uncover hidden patterns and mechanisms of disease, biological function, and evolutionary change.

SIGNALS:

1 | GeneCards: database of human genes

2 | BioSim: deciphering meaning from brain information

Image Source: http://gchelpdesk.ualberta.ca/news/02jun05/images/circos-002.png


sensory data
interfaces
TECHNOLOGY

Sensory Data Interfaces:
Re-routing perception

Sensory data interfaces translate analog human senses into digital information. These technologies can substitute one sense for another—reproducing "sight" through taste or touch, for example. Brain imaging of users of these interfaces suggest our capacity for sensing is malleable—prosthetics "trick" the brain into believing the original sense is used.

SIGNALS:

1 | BrainPort: visual prosthetics for the blind

2 | Spatial Orientation Enhancement System: wearable augmentation for human spatial orientation

3 | vOICe system: translating images into sound

Image Source: http://www.synchro-blogue.com/synchro/2009/08/voir-avec-notre-langue.html

deep web

Deep Web:
Semantic engineering of linked data

Sir Tim Berners Lee, inventor of Worldwide Web protocols, defines the deep web of linked data as "a global data space connecting data from diverse domains. Linked data browsers allow users to start browsing in one data source and then navigate along links into related data sources." Creating a protocol for linking not just websites, but the data residing in machines and databases below the Web, will create new possibilities for data mining, search, and access.

SIGNALS:

1 | The Linked Data Research Centre (LiDRC): bundling activities around linked data

2 | The Decentralized Information Group: exploring technical, institutional, and public policy questions

Image Source: http://spacecollective.org/userdata/C4Uni4Kk/119887919 6/cvs3.png


location-based
computing
TECHNOLOGY

Location-based Computing: Everything knows where it is

A wave of hackers and developers are creating mashed-up apps with Google Maps, Flickr, and del.icio.us, and a cadre of open-source digital geographers and semantic hackers have been building first-generation versions of powerful open-source web mapping service tools. A true geospatial web, inhabited by spatially tagged hypermedia is emerging. This geospatial web is the platform for following generations of location-based computing applications.

SIGNALS:

1 | Precision Indoor/Outdoor Personnel Location Project: enhancing the safety and effectiveness of first responders

2 | Location Intelligence Conference: location technology is driving business effectiveness

Image Source: http://www.desktoprating.com/wallpapers/games-wallpapers-pictures/3d-map-gta-3-wallpaper.jpg

parallel programming

Parallel Programming:

Applications for a multi-threaded world

The advent of multicore supercomputers on a chip, and cloud-served supercomputers to execute thousands of multi-threaded processes, concurrently require programmers to learn new parallel computing skills. To compete, programmers need three new skills: 1. to identify computing applications that can be solved in parallel, 2. to factor the programming task into many parallel threads, and 3. to program the solution to run in parallel.

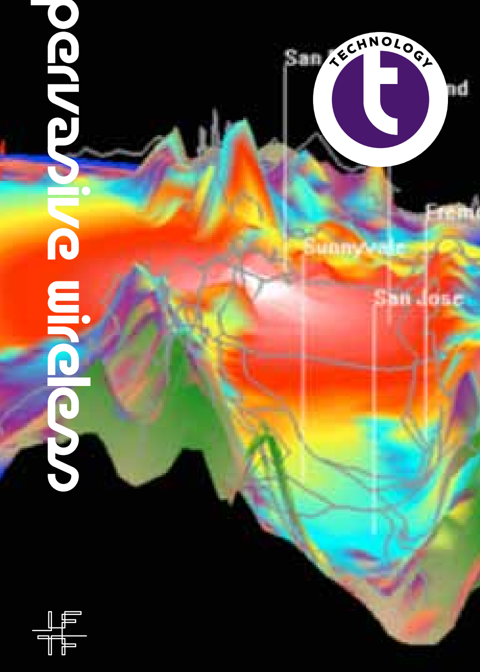
SIGNALS:

1 | Go-Parallel: programming concurrent, multi-threaded multi-core computers

2 | RAD Lab: programming the next generation of cloud-served supercomputers

Image Source: https://publicaffairs.llnl.gov/news/news_images/bigpix/powerwall.jpg

pervasive wireless



Pervasive Wireless:
Continuous connection

We are surrounded and saturated by wireless signals: Wi-Fi, GSM cellular, CDMA cellular, GPS, digital TV, AM, FM, VHF, UHF, satellite, and shortwave. Each of these often runs on separate hardware, for different applications. New receivers are being developed that may be able to receive and process the cacophony of signals at once, allowing many network-enabled tasks to be performed continuously regardless of location.

SIGNALS:

1 | Universal radio: a fast, ultra-broadband, low-power radio chip, modeled on the human inner ear, that could enable wireless devices that can perceive signals at million-fold higher frequencies

2 | MIT Viral Communications Lab: explores the basic technologies of network capabilities that leverage ubiquitous wireless

Image Source: http://www.v-soft.com/images/sanfsig.gif


TECHNOLOGY
sensors & sensor networks

Sensors & Sensor Networks: Everything in its right place

In the same way that the development of the Internet transformed our ability to communicate, the ever-decreasing size and cost of sensors is setting the stage for detection, processing, and communication technology to be embedded throughout the natural and constructed physical world. These low-cost sensors will be linked together with each other and the Internet by increasingly fine-grained agile, wireless, and physical networks.

SIGNALS

1 | Center for Embedded Networked Sensing (CENS): focused on developing wireless sensing systems

2 | The Responsive Environments Group: exploring how sensor networks augment and mediate human experience

Image Source: http://www.meteo.uni-bonn.de/projekte/tr32-wiki/lib/exe/fetch.php/np-eifel_monitoring_engl.jpg

TECHNOLOGY

ubiquitous displays

Ubitquitous Displays: Every surface is alive

Today, interaction with digital displays is a deskbound or device-dependent experience. Tomorrow, a new generation of ambient and organic light-emitting displays will turn tabletops, walls, chairtops, signage, public display boards—almost any surface—into a web-enabled, interactive portal.

SIGNALS:

1 | CallT2 University of California, San Diego: world's highest-resolution scientific display system with nearly 287 million pixels of screen resolution

2 | Microsoft's vision: ubiquitous display technology

Image Source: http://sparkingtech.com/wp-content/uploads/2008/02/microsoft_surface.jpg


wireless power
TECHNOLOGY
t

Wireless Power:
Always-on mobile devices

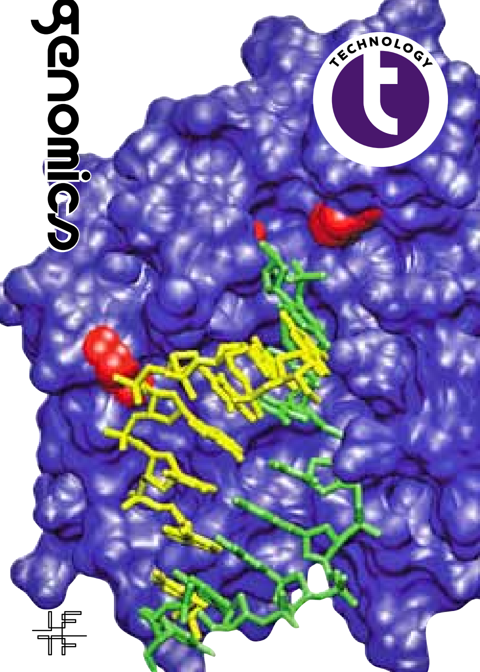
In the late 19th century, the realization that electricity could be coaxed to light up a bulb prompted Nikola Tesla to design a system to beam electricity around the world—wirelessly. Now, researchers at MIT are using magnetic resonance coupling to power a 60-watt light bulb. Tuned to the same frequency, two 60-centimeter copper coils can transmit electricity over a distance of two meters, through the air and around an obstacle.

SIGNALS:

1 | MIT Physicist Marin Soljacic: working toward a world of wireless electricity

2 | WiTricity Corporation: founded in 2007 to commercialize an exciting new technology for wireless electricity invented at MIT

Image Source: http://news.cnet.com/i/tim//2009/06/19/IntelResearchgallery5_540x487.jpg genomics



Genomics:
Reading the book of life

Genomics is the study of genes and their functions. All living cells contain genetic instructions—programming that determines how cells grow and function as part of larger organisms, whether as tiny bacteria or a human being. As we learn to read the DNA "book of life," we will develop new cures for genetic diseases, increase human longevity, and improve the nutritional value and robustness of food crops.

SIGNALS:

1 | 23andMe: affordable DNA analysis for individuals to learn about their genetic inheritance

2 | Allen Institute for Brain Science: developing a genome-wide map of how genes are expressed in the human brain

Image Source: https://publicaffairs.llnl.gov/news/news_images/bigpix/dna_protein.jpg