NEUROPROGRAMMING:

CODING THE BRAIN FOR DESIRED BEHAVIORS, CAPABILITIES, AND FUNCTIONS

when everything is programmable: LIFE IN A COMPUTATIONAL AGE

Advances in neuroscience, genetic engineering, imaging, and nanotechnology are converging with ubiquitous computing to give us the ability to exert greater and greater control over the functioning of our brain, leading us toward a future in which we can program our minds. These technologies are increasing our ability to modify behavior, treat disorders, interface with machines, integrate intelligent neuroprosthetics, design more capable artificial intelligence, and illuminate the mysteries of consciousness. With new technologies for modulating and controlling the mind, this feedback loop in our co-evolution with technology is getting tighter and faster, rapidly changing who and what we are.

THE BRAIN AS COMPUTATIONAL SYSTEM

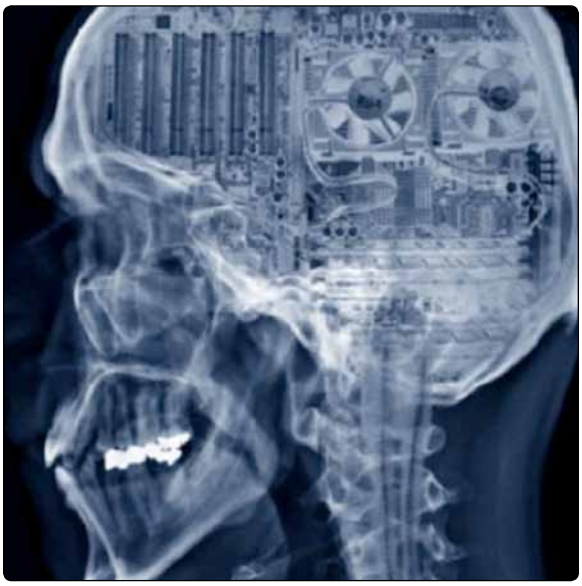
Advances in dynamic scanning and visualization of brain processes are bringing greater resolution to the neurophysiology of cognition and behavior. Analysis of neural networks and functional structures is yielding insight into the complex pathways of communication within the brain and shedding light on the results of their disruptions. These tools are helping researchers to build complex models of the brain, run simulations to predict behaviors, and design programmatic interfaces to capture and modulate neural processes. Creativity, happiness, and even spiritual experience will be invoked through neuroprogramming.

PRECISION MODULATION

New research and technologies are allowing us to more precisely modulate cognition and emotion. Optogenetics targets specific neurons to express light-sensitive receptors that can be excited or inhibited by implanted laser arrays. Transcranial magnetic stimulation (TMS) is being used to treat depression, Parkinson's disease, ADHD, and to provoke spiritual experiences. Deep-brain implants have been used to capture incoming visual information and output the images to a video monitor, evolving the syntax of how the brain represents sensory information and suggesting the possibility of directly programming perception. These techniques will radically expand our knowledge of the brain and give us powerful new levers of control over our basic neural functioning.

CONVERGENCE OF COGNITION AND COMPUTATION

With rapid advances in medicine and materials science, massive investments in military and industrial research, and the hybridization of engineering and biology, human cognition is being distributed into our external devices and is steadily merging with information architectures. Computation is moving into our bodies in a co-evolutionary process that will both illuminate the mysteries of consciousness and reveal the next frontiers of artificial intelligence. The shadow world of data and virtual transactions is becoming ubiquitous, washed across our world and wired into our brains. Our interface with these blended realities will bring new ways of interaction and expression while expanding and challenging what it means to be human.



An artist's rendition of a programmable brain

Signals:

BRAIN IMPLANTS TO RESTORE VISION
(THE BRAIN AS COMPUTATIONAL SYSTEM)

Researchers at Harvard Medical School are designing a visual prosthesis that may be able to restore sight in people who are congenitally blind by placing an implant in a part of the vision system hitherto ignored, the lateral geniculate nucleus (LGN). The key to their research is an investigation of how stimulation of the LGN elicits images in the brain. The device they envision will translate images from a digital camera into neural impulses and then feed that information into the visual system, allowing the wearer to see it.

Source: http://www.biotele.com/vision.html

OPTOGENETICS (PRECISION MODULATION)

Optogenetic techniques are yielding advanced interfaces to the brain that reveal neuro-functionality and enable direct modification of dysfunctional neural bodies. Using optogenetics, Karl Deisseroth's Stanford lab has been able to reprogram the motor cortex of a mouse to cancel the effects of Parkinson's disease while confirming that the specific nerve bundle was indeed the source of the ailment.

Source: http://scienceblogs.com/neurophilosophy/2009/03/optogenetics_controls_brain_signalling_and_sheds_light_on_parkinsons_therapy.php

TMS ENABLING BRAINS TO SPEAK TO COMPUTERS
(CONVERGENCE OF COGNITION AND COMPUTATION)

Implant technologies offer unprecedented control over neural processes, but noninvasive approaches encourage a much broader audience for neuroprogramming. Transcranial magnetic stimulation (TMS) devices are showing progressive efficacy in treating disorders, modifying cognition, and enabling brains to speak to machines and computers. Increasingly, such interfaces will be used for entertainment, relaxation, remote piloting, and group collaboration.

Source: http://usfweb3.usf.edu/absolutenm/templates/?a=1130&z=41

What difference does this make?

The rise of neuroprogramming invites the emergence of a new transhumanity directly coupled to machine intelligence and the global mind. This process may yet reveal powerful new models of human cognition and consciousness.

BETTER INTEGRATION WITH MACHINE PROSTHETICS IN MEDICAL, INDUSTRIAL, AND MILITARY DOMAINS

Prosthetic limbs will connect directly to the brain to provide precision control and realistic sensation. Medical repair of injury and dysfunction with implants and prosthetics will move onto the battlefield as wounded soldiers receive augmentations. Surgeons, pilots, investors, and military commanders will use brain-computer interfaces that monitor fatigue, fear, and risk assessment.

DEEPER, MORE ACCURATE REGULATION OF NEUROPHYSIOLOGY AND BEHAVIOR

Elective programming of behavior and cognition will give immediate access to beneficial cognitive states such as relaxation, creativity, focus, and wakefulness. The same ability will be wielded by third parties seeking to control criminal behavior, limit or enforce cognitive states, induce receptivity, and constrain focus to work tasks.

MORE CONTROL, CAPTURE, AND PROGRAMMING OF SENSORY INPUT

Recording perception by capturing sensory input from within the brain will enable a deeper understanding of human awareness and offer the possibility of sharing wide-band personal experiences. Likewise, explicit multisensory experiences could be programmed directly into the brain, bringing new depth to social networks, augmented reality, entertainment, and virtual worlds.

RISE OF ETHICAL, MORAL, AND LEGAL DEBATES

Many ethical, moral, and legal debates will arise around the use and development of these technologies. While helping the injured and disabled is socially acceptable, electively enhancing cognition for personal gain has historically been a matter of great debate. Socioeconomic realities will likely limit enhancement to an economic elite, and legislative intervention may challenge the growth of neuroprogramming technologies.

What to do differently?

Anticipating when neuroprogramming technologies will become commercialized and broadly adopted will enable an empowered and proactive posture. Understanding your position on neuroprogramming ahead of enhancement debates and possible legislation will help you influence the dialog and quickly mobilize away from pitfalls and toward opportunities.

TRACK MAJOR MILESTONES IN BRAIN-COMPUTER INTERFACE TECHNOLOGIES

Watch for neuroprosthetics that replace broken senses with enhanced devices, and implants that allow minds to communicate with computers and machines. Expect neurotechnologies to impact nontechnological fields such as law, finance, and business. Pay special attention to the movement of R&D from medical to military and commercial applications.

EXAMINE YOUR POSITION REGARDING COGNITIVE ENHANCEMENT AND BEHAVIORAL MODIFICATION

Create a human resources strategy regarding cognitive enhancements in employees and managing potential social divides. Consider applications of cognitive ergonomics and brain training to increase vocational aptitude and performance. Investigate ways that neuroimaging and neuroprogramming technologies may be employed in user research, usability, and marketing efforts.

CONSIDER HOW THE COMPUTATIONAL METAPHOR APPLIES TO YOUR ORGANIZATION

At its core, neuroprogramming represents the height of the computational metaphor, inviting us to engage our brains as programmable systems. This perspective can reveal opportunities to program human systems. Look for data streams hidden in workflows, and processes that can be captured and revealed for optimizations. Create feedback systems to input change and track impacts. Develop software agents to manage redundant tasks.

INSTITUTE FOR THE FUTURE

Technology Horizons Program
124 University Avenue
2nd Floor
Palo Alto, CA 94301
t 650.854.6322
f 650.854.7850
www.iftf.org