The Limitless Possibilities of Technology

The continued development of the BANG technologies (Bits, Atoms, Neurons, and Genes) promises a future steeped in both unprecedented scientific advancements and looming ethical dilemmas.

In our lifetimes, we have seen the personal computer shrink to fit in the palm of our hands. We can remember when the Internet first made its way into our homes at the oh-so-lighting-fast speed of the dial-up connection. In the last half a century, **information technology** has continued to make data exchange and storage easier, faster, and more efficient, and in the coming years, global societies will be inextricably connected through a series of wireless networks.

As developers work to constantly improve the **microchip**, we can expect its **storage capacity** to grow exponentially in the next 40 years. We will soon be measuring data in yottabytes (1 septillion bytes of data; in other words, 1 yottabyte = $1x10^{15}$ gigabytes), which could make throwing data away a thing of the past.

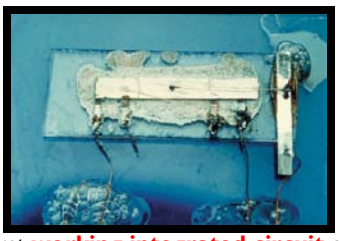
> *"The prospect that no digital information will ever need be thrown away will raise numerous possibilities, such as the ability to record and store every second of one's life on a computer" (Outlook 2009, p.3).*

What are the ramifications of having every moment of your life stored on a microchip?

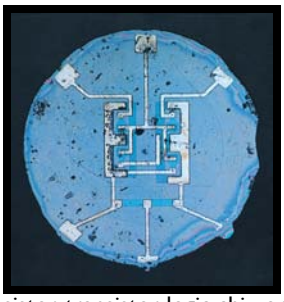
With the ability to store limitless amounts of data cheaply, governments, organizations, and interested parties around the globe have been working diligently to ensure their unfettered access to our Internet communications. Despite firewalls and encryption efforts, online anonymity is a thing of the past. The **death of privacy** on the Internet should make us think twice before we hit "send."

> *"Internet communications, a basic part of life for many people, are nearly impossible to protect against interception, and postings to blogs and Web forums are nearly immortal … Widespread surveillance of private individuals is technically feasible and economically viable, as tiny, powerful cameras now cost next to nothing. Increased surveillance has become socially acceptable in an age when many people fear terrorism and crime" (Cetron and Davies, p.11).*

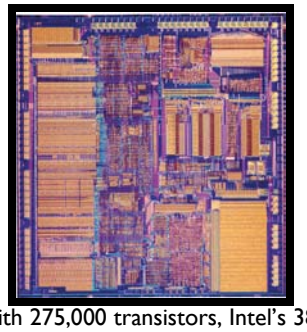
The Evolution of the Microchip



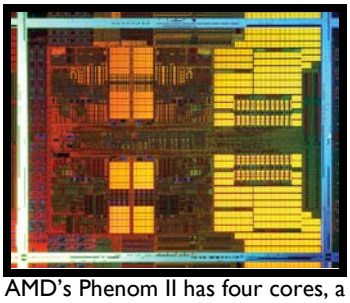
First **working integrated circuit** on germanium – Texas Instruments, 1958



Resistor-transistor logic chip on a **single piece of silicon** – Fairchild Semiconductor, 1961



With 275,000 transistors, Intel's 386 allows computers to work on **multiple applications** at the same time – Intel, 1985



AMD's Phenom II has four cores, a large shared cache, and around **758 million transistors** – AMD, 2009

Moore's Law: The logic density of silicon integrated circuits **doubles every 18 months**.

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Currently the number-one crime in the US, **identity theft** is already one of the most devastating consequences of advancements in information technology and online surveillance. And while we can expect to see this type of crime become more prevalent, experts predict there will be a wave of new **cybercrimes** to contend with in the near future.

> *"As wireless communications networks continue to become more prevalent, new cybercrimes will be invented. Designer nanobots may be [released] on the Web to engender types of mischief and destruction not yet contemplated" (Outlook 2009, p.6).*

How can you protect yourself from cybercrime?

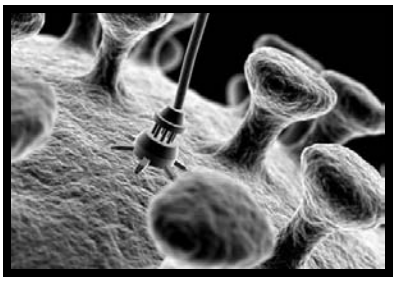
Some of the most promising technological advancements of the future are being developed at an atomic scale. **Nanotechnology**, the "microscopic method of construction," is changing the way we think about everything from healthcare to communication.

Scientists estimate that some of the first commercially viable **nanoproducts** will be tiny sensors that can enter a person's bloodstream and bring back information about its composition. By 2018, these micromachines will have the capability to perform basic cell repair.

Before 2020, ubiquitous and virtually invisible nanodevices will be sending and receiving information, providing constant **surveillance** of the entire population. With the advent of human nanoimplants, everyone will have a unique Internet Protocol (IP) address, facilitating constant interaction with an omnipotent global network. Not only will we be able to store every bit of data received, but anything once thought to be deleted will also be easily recoverable.

How can we hope to maintain our privacy in a world that is connected at the most microscopic level? Do the benefits of global surveillance outweigh the loss of anonymity?

Perhaps the most controversial of the BANG technologies, **gene research and biotechnology** give scientists an unprecedented look into what makes us who we are. One of the most critical advancements in the field of biotechnology is the mapping of the human genome, which was completed in 2001.



NEWS: Feb. 16, 2009 – In **cancer treatment**, it's all about search and destroy – search out and destroy cancer cells while leaving healthy tissue enhanced. A group of PhD candidates at Northwestern University are making the search far more precise with nanotechnology. The students are customizing **nanoconjugates** – submicroscopic titanium dioxide (TiO_2) particles attached to biological molecules. Read the full story **here**.

ONE TO WATCH

Sri Lanka is hoping to become a global player in the nanotechnology sector with the opening, in May 2009, of the Sri Lanka Institute of Nanotechnology (SLINTEC). According to Ravi Fernando, CEO of SLINTEC, "it's ambitious … but we will get there as our vision is to be the leading research and innovation platform for sustainable nanotechnology in Asia. With cutting-edge technology, this is the country's best-kept secret."

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Understanding the role genes play in everything from eye color to predispositions to alcoholism or certain types of cancer can pave the way for important breakthroughs in successfully **eradicating genetic disease**.

> *"Around 2012, a gene therapy for cancer is perfected. Five years later, almost one-third of the 4,000 known genetic diseases can be avoided through genetic manipulation. Throughout the early part of the century, the combination of a deeper understanding of genetics, human biology, and organic chemistry leads to a vast array of powerful medications and therapies" (Schwartz and Leyden).*

Cancer treatments are becoming **safer**, medical technologies are making it possible to **prevent or cure** certain diseases, and in England, researchers have developed a sterile **synthetic blood** that can be stored for months at room temperature, versus donated blood which has a shelf life of 35 days and must be refrigerated.

Experts estimate that by 2017, we can expect to see functioning artificial hearts, lungs, and kidneys. By 2020, artificial livers, fully functioning artificial eyes, and artificial peripheral nerves will have made their way from the research and development lab to the operating room as humans begin to receive these **synthetic organs**.

These developments bring us steps closer to **slowing the aging process** entirely. Millions of people in developed countries can expect to live longer and healthier lives, free of diseases and disorders that plague our populations today. Younger generations may very well live beyond the century milestone.

As advancements in biotechnology increase life expectancy across the globe, how will we care for our elderly population as our youth population continues to surge?

Despite the undeniable benefits of biotechnological advancements, understanding the human genome can open the floodgates for **genetic tampering** and **designer human beings**.

> *"If gene therapy lives up to its promise, parents may someday be able to go beyond weeding out undesirable traits and start actually inserting the genes they want – perhaps even genes that have been crafted in a lab.*

Mapping our Genomes

From NYTimes.com: "The dawn of **personal genomics** promises benefits and pitfalls that no one can foresee. It could usher in an era of personalized medicine, in which drug regimes are customized for a patient's biochemistry rather than juggled through trial and error, and screening and prevention measures are aimed at those who are most at risk." **Read Steven Pinker's journey to understanding his genomic profile.**

The Personal Genome Project

Knome

For **$99,500**, Knome can map your **complete genome** using whole-genome sequencing technologies. Learn more about mapping your genome at **knome.com**.

23andMe

For **$399**, 23andMe can provide you with a **custom genome scan** that, while not complete, includes data on over 90 traits and diseases, high-resolution maternal and paternal lineage, ancestry painting, and similarity to various global populations. Learn more about genotyping at **23andme.com**.

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Before the new millennium is many years old, parents may be going to fertility clinics and picking from a list of options the way car buyers order air conditioning and chrome-alloy wheels … The ethical issues raised by techniques emerging from the genetics labs are likely to be even more complex. What if parents can use pre-implantation genetic diagnosis to avoid having kids with attention-deficit disorder, say, or those predestined to be short or dull-witted or predisposed to homosexuality? Will they feel pressure from friends and relatives to do so? And will kids who are allowed to be born with these characteristics be made to feel even more like second-class citizens than they do now?" (Lemonick et. al).

What ethical dilemmas will arise as we develop the technology to genetically engineer humans? Should people be able to have designer babies? Should regulations on genetic modification be required?

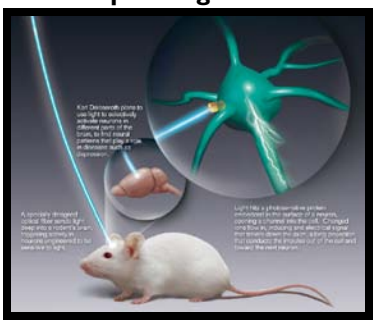
Complementing developments in biotechnology are the recent advances made in the arena of **neuron manipulation**. Understanding how to control the brain's neurons and the way they fire could allow scientists to precisely target their treatments of certain psychiatric and neurological disorders with greater effectiveness and fewer side effects.

Several years ago, scientists at the Max Planck Institute for Biochemistry designed the first **computer chip** that can record the firing of mammalian neurons, providing greater insight into how our most complicated neurological processes react to neuroactive drugs such as antidepressants.

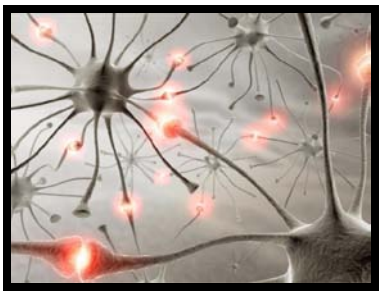
One of the most enlightening discoveries in recent years may allow scientists to develop a new approach in treating **spinal cord injuries**. Researchers discovered that dendrites – the treelike extensions on neurons that receive information from other brain cells – grow, shrink, and change over time. This is a clear indication that larger structural changes occur in dendrites, and while the link between these changes and the connections between neurons is yet to be understood, scientists remain hopeful and forge ahead with neuron research.

What industries will benefit from developments in biotechnology and neuron research? What industries will falter?

Manipulating Neurons



Neuron Control: Karl Deisseroth's genetically engineered "light switch," which lets scientists turn selected parts of the brain on and off, may help improve treatments for depression and other disorders. Read more **here**.



Artificially Firing Neurons: Edward Boyden, a PhD graduate of MIT, invented a precise, reliable neural switching system operating at thousandths of a second. Clinical applications are huge: delivered to the brain and activated by implanted optical fibers, the protein, Channel-rhodopsin-2 (ChR2), could give doctors the power to activate neurons with selected functions. That could give rise to radical new medical technologies to treat brain disorders such as Parkinson's disease or even some types of blindness. Read more **here**.

Monsanto's Law: The amount of useful genetic information **doubles every 18-24 months**.

Orbiting the Hairball:
A Futurity Series

The Limitless Possibilities of Technology

Technology undeniably plays a vital role in the future of industry and human life. Global corporations will constantly strive to perfect their niche in their respective markets while the **pace** at which new technologies emerge continues to gain speed. What will be perhaps most trying in the coming years is adapting to the ever-changing **product cycle**.

> *"Early in the twentieth century, the product cycle was 40 years. By World War II, the cycle had shrunk to 30 years. Today, for most consumer products, it is about six months. In computers and cutting-edge electronics, it is more like six weeks. Bring out a really hot product, and it is likely to be reverse-engineered, manufactured in China, and available on eBay in two weeks or less" (Cetron, p.33).*

How can companies harness new technology without getting sucked into the undertow of the increasingly rapid product cycle? How can your products and ideas stand out when knock-offs are cheaper and, often times, more easily accessible?

Sources:

Cetron, Marvin J. "Timeline for the Future: Potential Developments and Likely Impacts." The Futurist March & april 2009: 33-37.

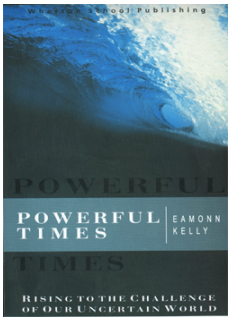
Cetron, Marvin J., and Owen Davies. 55 Trends Shaping Tomorrow's World. Rep. 2008. World Future Society. 9 Jan. 2009 <http://www.wfs.org/specialreports.htm>.

Lemonick, Michael D., David Bjerklie, Alice Park, and Dick Thompson. "Designer Babies." Time 11 Jan. 1999. 18 Feb. 2009 <http://www.time.com/time/magazine/article/0,9171,989987-2,00.html>.

Outlook 2009: Recent Forecasts from World Future Society for 2009 and Beyond. Rep. 1-10.

Schwartz, Peter, and Peter Leyden. "The Long Boom: A History of the Future, 1980 - 2020." Wired July 1997. 9 Jan. 2009 <http://www.wired.com/wired/archive/5.07/longboom.html>.

FOOD FOR YOUR BRAIN:
Suggested Reading



From Amazon.com:
"Understand the most revolutionary human transformation in four centuries … and prepare for it! We're not just living through an age of change: we're living through a 'change of age:' the most profound inflection point in human history since the Enlightenment. That's the thesis of Eamonn Kelly's remarkable new book *Powerful Times*. From terrorism and nuclear proliferation to emerging technologies and economic globalization, Kelly weaves together 7 powerful 'dynamic tensions' that will reshape human life in the coming decades. Kelly offers breakthrough insights into how these tensions will conflict – and how they'll resonate, creating giant waves of change beyond anything we've ever faced … Kelly draws on breakthrough 'scenario planning' techniques he pioneered: techniques hundreds of top organizations now rely on. Simply put, this book will help you prepare for humanity's most profound transition in 400 years."

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