

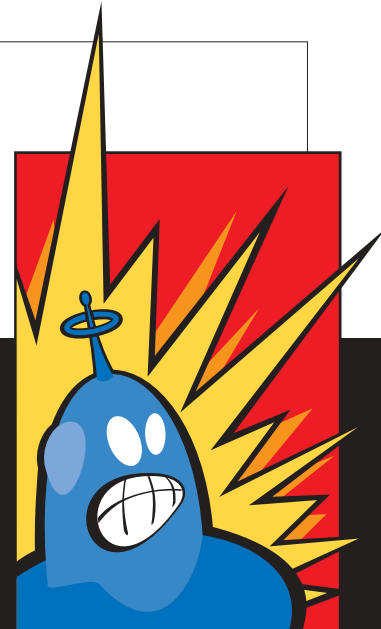
# empire

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## S.E.E.L.

### Hatching the New Convergence: Science Meets Ethics and the Law

- ▶ Tetanox – the New Botox
- ▶ Leadership in the Booming Hispanic Market
- ▶ Blacked Out – The Sun is in Your House
- ▶ Putting your IRA to Work in New Ways
- ▶ Get Out and Walkabout Downunder



## Robot Warriors of Brooklyn

Flying robots, the high-tech war machines of the future, are being built in Brooklyn. Life-saving and cost-effective, these machines are part of the new world of warfare.

▶ Page 26

▶▶ MONEY

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28

# FEATURES

## CONVERGING TECHNOLOGIES 28

The next Renaissance in science and technology will be convergence; the merging of ethics, law, distinct technologies, industries, or devices into a united whole. **By Sonia E. Miller**

## TOXIC TREND – THE NEW BOTOX 16

Botox may just have to step aside as the most common deadly substance used for cosmetic and therapeutic purposes. If you recoil at the idea of injecting that lethal substance into you as a beauty treatment, you'll be mortified at the latest idea: Tetanus. **By Chris Travers**

## LATINO MARKET EMERGING 20

The Census Bureau announced this summer that a milestone has been passed with Hispanics now being the nation's largest minority group: 38.8 million and this group has a purchasing power of \$500 billion and rising fast. **By Chris Travers**

## BRANDING THE TEN SECOND WORLD 36

Short attention spans. Instantaneous information. We all market our brands in a Ten Second World. That's all the time we get to make a lasting impression. Ten Second World Inc. integrates corporate and product communications that aim at reaching client's business and brand-related goals through customized strategic and creative campaigns. **By Duquesne Ramsey**



16



20



36

# DEPARTMENTS

- 2. From Where I Sit ■ Editorial
- 7. Tradin' Trash ■ Ebay of Waste
- 8. LegalView ■ David Lubin, Esq.
- 11. Multicultural Experts ■ A Guide
- 12. Got Voice Mail ■ Hosted Communications
- 14. Desktop Gold Rush ■ Persistent Tech
- 24. Small Biz Insurance ■ Unique Needs
- 26. Flying Robots ■ Brooklyn's Warriors
- 32. Ombudsmen ■ Workable Solutions
- 34. Anthropologists ■ Among Consumers
- 38. Marketing ■ No Bull
- 40. Web Services ■ Intellibank
- 43. Growing Sales ■ Not Numbers
- 44. Finding Customers ■ Database Route
- 46. Underwater Stocks ■ Deal or Drown
- 47. Outsourcing IT ■ The Future
- 48. Your Portfolio ■ Make It Work
- 49. Disaster Recovery ■ Three Guidelines
- 55. Finance ■ Venture Money Stable
- 54. Exec Tech ■ Advanced Tools
- 66. New Spirits ■ A Taste Trend
- 68. Treat Your Skin ■ The Groove
- 70. Not Just Kid's Stuff ■ Music Biz
- 72. Travel ■ Australian Walkabout
- 74. Urban Flavor ■ NYC
- 76. Golf ■ On Course for Biz
- 78. Restaurants ■ An American Revival
- 80. Office Diaries ■ Donna Flagg



WHAT IS IT?  
WHY YOU NEED TO KNOW ABOUT IT.

# CONVERGING TECHNOLOGIES

The next Renaissance in science and technology will be convergence – the merging of distinct technologies, industries, or devices into a united whole. Scientific leaders across disciplines, industry experts, and policy makers envision that unification of science and technology will achieve vast improvement in our physical, mental, and social capabilities and well-being, as well as in enhancing our quality of life, upgrading our educational systems, and increasing our nation’s security and economic clout.

“Convergent technologies” refers to the “synergistic combination of four major ‘**NBIC**’ provinces of science and technology, each of which is progressing at a rapid rate: (a) nanoscience and nanotechnology; (b) biotechnology and biomedicine, including genetic engineering; (c) information technology, including advanced computing and communications; and (d) cognitive science, including cognitive neuroscience” (Roco and Bainbridge, 2003).

## Nanotechnology

Simply defined, the **N** province of **NBIC** is the ability to measure, organize, and manipulate matter on the nanoscale, or 1 to 100 billionths of a meter. This ability to control matter atom-by-atom, molecule-by-molecule, and nanostructure-by-nanostructure will lead us to scientific advances we cannot yet even imagine.

Nanotechnology enhances or enables new approaches and applications in manufacturing, electronics, medicine and the human body, pharmaceuticals, materials, transportation, energy, environment, space exploration, and national security. In so doing, it has great societal, environmental, ethical and legal (“SEEL”) implications, including unintended consequences for both users and innovators. There is also the potential risk of creating a “nano-divide”.

While advances in medical treatments can benefit the elderly by improving their life span and quality of life, this shift in demo-

*Continued on Page 30*

BY SONIA E. MILLER







Continued from Page 30

graphics could adversely impact the economics of our state healthcare benefits, federal retirement plans, and corporate pension arrangements, in addition to our testamentary laws, and employment and labor laws, thereby draining the economy, corporate America, the insurance industries, healthcare providers, and legal systems.

Another SEEL implication is the difficulty the U.S. Patent and Trademark Office ("USPTO") has in dealing with nanotechnology. Patent examiners, historically, have researched and granted competent patents in only one field of science. Because nanotechnology is multidisciplinary in nature, and the USPTO does not have sufficient nanotechnology expertise, it recognizes the need for additional training of its patent examiners in order to better understand the associated patent applications.

Michael Crichton's latest science fiction book, *Prey*, has made some readers worry that carelessly designed nanoparticles could become self-replicating and harmful to human beings in the natural world outside the laboratory. The Precautionary Principle (Brown, 2002) was publicly connected to nanotechnology in 2002 when the U.S. already allocated approximately \$50 million to studies addressing environmental implications and remediation (Roco, MRS Bulletin, 2003). David Blackstein, a Senior Scientist at the National Council for Science and the Environment in Washington, D.C., stated it best: "To me, the whole idea of looking at nanotechnology as having an environmental impact seems unusual, given that it's really an issue of scale, it's not that there's a particular process in mind. It's baffling" (Brown, 2002).

Nanotechnology offers environmental benefits too. "Green" manufacturing techniques will help eliminate pollution, mitigate environmental hazards, detect contaminants, reduce emissions, avoid toxic leaks, and improve energy efficiency. Nobel laureate Richard Smalley, founding director of the

Center for Biological and Environmental Nanotechnology at Rice University in Houston, Texas, promotes nanotechnology as the key to a cleaner, more efficient, and equitably distributed energy system (Stuart, 2003).

### Biotechnology

Small Times headlined it as *The Road to Wellville: Devices Offer Medical Benefits But Challenge Regulators*. Larry Bock, Nanosys CEO, says, "Twenty years ago, the biotechnology revolution changed the way we live and redefined the way that business was done in the pharmaceutical industry and in the venture capital community. Today, nanotech is a new revolution. It will impact a far greater number of industries than biotech ever did." The **B** component of **NBIC** is Biotechnology, and the confluence of nanotechnology with biotechnology could transform humanity.

Nanobiotechnology is the means through which genomics, combinatorial chemistry, high-throughput robotic screening, drug discovery, high-throughput sequencing, and bioinformatics (the melding of biology and computer science) are quickly advancing. With biochips, an individual's entire genetic code could be mapped in seconds, enabling pharmacogenomics to prevent the harm that today's primitive use of drugs can cause, as well as maximizing the curative effectiveness of medicines. Labs-on-a-chip could be applied to cell separation, to new drug discovery and delivery, to biosensors for health and security. Nanobiotechnology could replace the use of x-rays in magnetic resonance imaging or exploratory surgery for diagnostic purposes. An individual would be injected with a fluid containing trillions of molecule-sized nanoparticles (nanodevices) - nanoscale encapsulated medicines or diagnostic materials - which could also automatically dispense biochemicals lacking within one's body (such as a diabetic's insulin), predict the onset of disease through smart contrast agents, offer testing to discover predispositions to diseases, achieve real-time monitoring



Tomorrow's spacecraft, through the convergence of nanotechnology and information technology, will provide greater physical as well as medical safety in travel. Nanotechnology will enable new health monitoring and healthcare delivery systems, together with bio-compatible sensors to better detect health information of the astronauts, and future space tourists, at the cellular level.

of the disease's progression, replace worn or damaged body parts, or deliver therapeutics targeting specific tissues or cells.

One SEEL implication is that biological instability could interfere with the operation of a nanobiotechnology device. Healthcare will be revolutionized by anticipating the need for drugs by studying a person's haplotype. Enhancement of fetus capabilities and designer baby options are strong concerns, where open dialogue is necessitated. A definition of what it means to be a person and a human may be legally required.

The question of who has access to, owns, controls, monitors, and stores your genomic-phenomic profile will need to be addressed. Can a prospective employer discriminate against hiring you because your genetic profile reflects a propensity for a disease or addiction? Can the insurance companies increase your premiums and cancel your policies contingent upon your profile? Where are the privacy and security instruments needed to guard and protect your consumer rights? Who will protect and handle your data and database schemes? Can someone else patent and own your genetic code? How quickly will the U.S. Food and Drug Administration ("FDA") review and approve proposed medical devices advancing biomedicine? What if an implantable nanoparticle creates injury?

#### Information Technology

The **I** component of **NBIC** is Information Technology, and computing power will increase exponentially as nanotechnology advances. The nanotechnology-assisted gathering, storing, transmitting and processing of information will transform the manner in which society communicates. Pervasive and ubiquitous sensors and communication systems will modify concepts of community, privacy, and protective rights forever.

In the sigmoid curve ("S-Curve"), or the logistic curve of Technological Change (Roco and Bainbridge, 2003), the first communica-

tions-computer revolution evolves slowly, then grows more rapidly, then finally slows again nearly to a halt. But progress need not stop, because a new S-Curve of development can begin with a fresh set of innovations. Moore's Law may halt as soon as five years from now. But convergence of nanotechnology with information technology could keep Moore's Law going another twenty years – which would be a factor of 8,000 in the power of a computer at constant cost. That is, a computer as small as a button on your shirt – and as cheap – could contain a computer more powerful than a desktop work station of today, connected to the ubiquitous web and bringing you any information you wanted if you simply whisper your question.

Tomorrow's spacecraft, through the convergence of nanotechnology and information technology, will provide greater physical as well as medical safety in travel. Nanotechnology will enable new health monitoring and healthcare delivery systems, together with bio-compatible sensors to better detect health information of the astronauts, and future space tourists, at the cellular level. New pilot training approaches have been developed through biologically inspired neural nets, integrated with the advances expected through nanoelectronics, to deal with aircraft maintenance, aborts, and recovery. Man-machine interfaces are currently being perfected to better understand and cope with the issues of space and physiological alterations encountered in microgravity and chronic radiation exposure. Artificial intelligence via enhanced biomolecular computing will enable focused therapies and early intervention of disease. "Fast" will be the keyword in the next 5-10 years (Frost, 2001).

What SEEL implications will these invasive sensors pose? Will the gap between the information haves and have-nots be closed or further divided? Will we have lost our sense

*Continued on Page 53*



# CONVERGING

Continued from Page 31

of privacy forever, or will the meaning of privacy change to parallel the leaps in scientific advancement?

## Cognitive Science

The **C** area of **NBIC** – Cognitive Science – is a convergence of multiple disciplines: psychology, social psychology, cultural anthropology, linguistics, economics, sociology, neuroscience, artificial intelligence and machine learning, in order to study human, non-human, and machine intelligence, including perception, memory, decision, and understanding.

Through convergence, neuroscientists will be better equipped to analyze and simulate the neural networks of the brain, thereby better understanding intelligence, human thought, the mind, its nervous system, how it processes data, feelings, makes decisions and judgments, and increasing its intellectual capabilities. New design approaches can humanize computers, robots, information systems, and man-machine interfaces. Robotics, control technology and theory will play a crucial role in the future of neuroscience.

To increase cognitive capabilities, brain resolution and bandwidth, converging technologies will allow us to glean knowledge about the structure, function, dysfunction of the human mind. Reverse engineering of the human brain could occur within two decades. An artificial brain might be capable of partially simulating the actual brain. The question of whether aspects of human consciousness could be achieved by machines might be answered within our lifetimes (Roco and Bainbridge, 2003).

Alzheimer's and Parkinson's disease might be eradicated. Physically and mentally challenged individuals might view life in a manner never envisioned. Paralysis may be wiped out.

SEEL implications? A new field of ethics must discuss the rights and wrongs of the treatment or enhancement of the human brain (Safire, 2003; Dana, 2002). What is the morality of using genomics, molecular imaging, and pharmaceuticals to affect the human brain? Arthur L. Caplan, director of the University of Pennsylvania's

Center for Bioethics, purports that “the ethical hot potato of this coming century is... new knowledge of the brain, its structure, and function” even more than genetics (Lucas, 2003). Converging technologies can produce direct interfaces between the human brain and machines, thereby transforming the workplace environment, automobile transmissions, sports, and communication between people.

## The Age of Transitions

Is the law keeping pace with the high speed within which disruptive technologies transform our world? Can the legal system as it exists today, protect and prepare the unwary consumer and willing user, when NBIC technologies are vastly improving human performance? Can intellectual property and technology licensing practices cope with the rapidly changing realities, as technologies converge?

“Law is not simply an instrument for dispensing justice, but a constitutive societal force that shapes social relations, constructs meaning, and defines categories of behavior...Law permeates social life...The rule of law shapes our experiences of meaning everywhere and at all times” (Bellia, 2003).

We have entered the Age of Transition. The unification of science from the nanoscale has brought with it the identification of new ethical areas: nanoethics, bioethics, infoethics, and neuroethics. NBIC poses a challenge to the legal system of today to take a proactive step to prepare anticipatory measures to better advance the future of tomorrow's sciences.

Convergence will accelerate our understanding of who we are and what our capabilities may be. Strategies for effective transformation must be developed across all disciplines and sectors of society. By forming unique and novel collaborations and partnerships, together, we ensure that science and technology will be developed for human benefit.

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## FIRST MULTIDISCIPLINARY BAR ASSOCIATION FORMED

The Converging Technologies Bar Association (“CTBA”) has been created, with headquarters in New York. The goal is to facilitate professional collaboration and foster public awareness, understanding and interest in emerging and converging technologies.

A specially bar association open for membership to attorneys as well as to non-attorneys, the CTBA was formed with the intention of serving and collaborating with the legal, scientific, medical, and engineering communities in the areas of (i) nanoscience and nanotechnology; (ii) biotechnology and biomedicine, including genetic engineering; (iii) information technology, including advanced computing and communications; (iv) cognitive science and neuroscience; and (v) other related sciences and technologies.

The stated purposes of the CTBA on its Certificate of Incorporation are multifold:

1. To facilitate innovative dialogue among various disciplines, professions, sectors of the economy, and the legal community;
2. To promote innovative educational programs that seek to bring expertise in convergent technologies and create reference information for the legal system;
3. To be a resource of information for those seeking to understand converging technologies and their broad implications;
4. To heighten public awareness of the rapid advancements and implications of converging technologies;
5. To advocate positions to law-making bodies and other branches of government as well as to the general public on proposed, pending, or needed policies, regulations and legislation; and
6. To advance, design, and prepare for the anticipatory measures in the legal system required from the ethical, societal, economic, educational, environmental, security, business and organizational implications of converging technologies.

The rapid advance of convergent technologies promises a previously unimagined enhancement of human performance and quality of life – both mental and physical, as well as proportional increases in the nation's productivity. However, with these advances, attention must be given early on to the broad implications such convergence carries. The CTBA will be the first bar association specifically devoted to tackling, addressing, and proactively determining, advancing, and attempting to resolve those issues.