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ARIZONA STATE UNIVERSITY

Technology Convergence:
Emerging Patterns, Disruptions and Opportunities

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San Francisco, CA
March 14, 2007

Seeking Security in an Insecure World

CENTRAL INTELLIGENCE AGENCY

ANALYZE POTENTIAL THREATS WITHIN THIS GEOMETRIC PARAMETER.

Biological. Chemical. Nuclear. Conventional. Threats to American security come in all shapes and sizes. As an analyst working at the Directorate of Intelligence, you will analyze security issues such as foreign weapons development and proliferation, information warfare and emerging technologies. More importantly, you'll ensure the safety of our nation. Professionals with diverse skills are needed:

• Weapons Analysis • Technology Analysis • Signals Analysis • Information Operations Analysis • Geospatial Analysis • Proliferation Analysis • Denial and Deception Analysis • Counterintelligence Threat Analysis • Energy Security Analysis • Arms Control Verification • Strategic Assessments Analysis

Staff and student positions available. Apply online at **www.cia.gov**

Applicants must have US citizenship and the ability to successfully complete medical examinations and security procedures including a polygraph interview. EOE

THE WORK OF A NATION. THE CENTER OF INTELLIGENCE.

We Must Meet Diverse (and Widening) Military and Intelligence Responsibilities

We Face More Demands Than Forces Available…

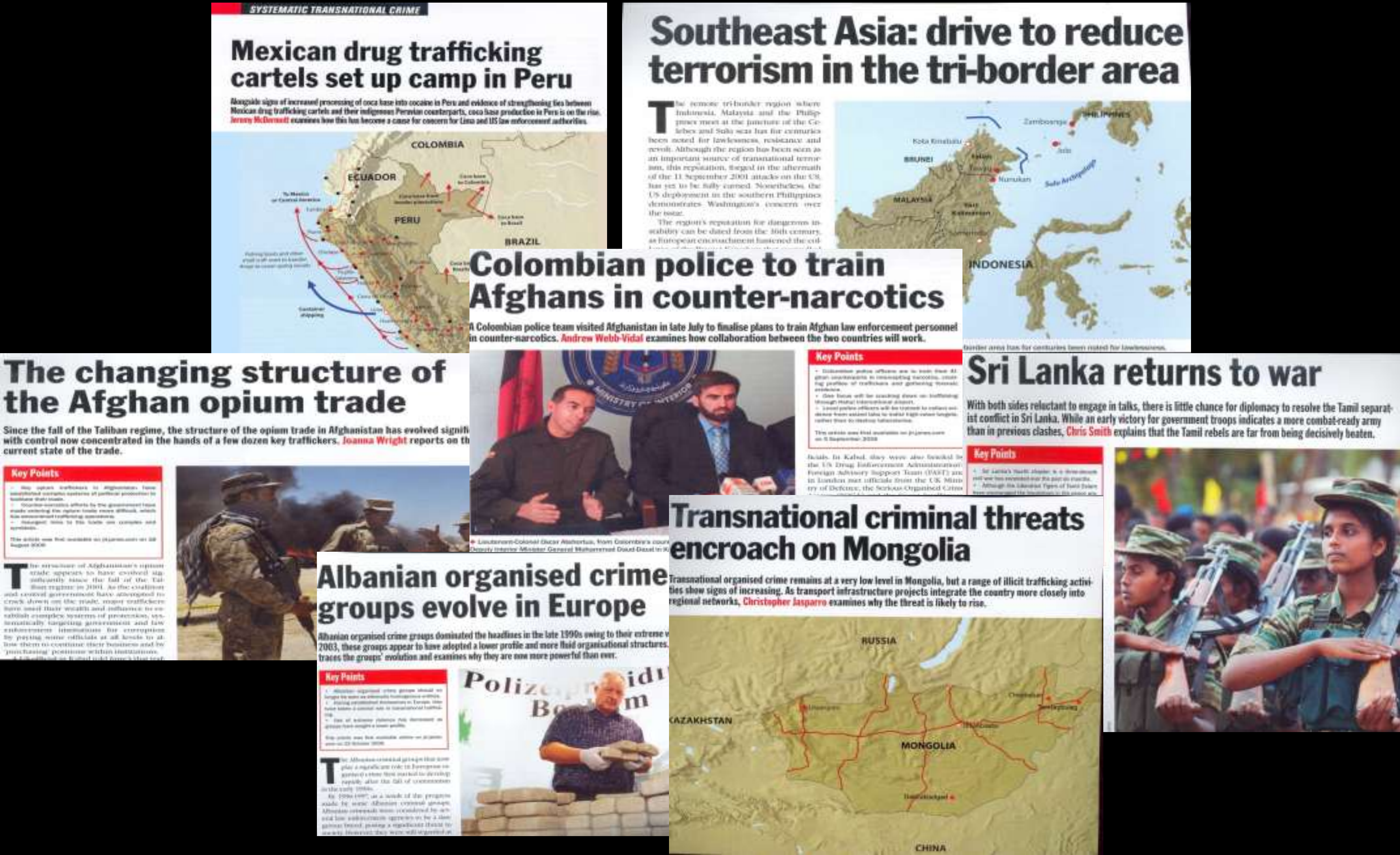
- insufficient capacity for multi-front conventional warfare…
  - Taiwan and China
  - North and South Korea
  - Iranian hegemony
- insufficient capacity to help others defeat Unconventional Warfare…
  - the "Stans"
  - the Philippines
  - Indonesia
  - Southwest Asia
- insufficient capacity to deal with atrocities and humanitarian crises

Where our adversaries are intelligent, ruthless, and dedicated to our destruction

Where there are clear and present dangers

- terrorism
  - sponsored and unsponsored…
  - led and self directed…
  - gaining combat experience every day…

Where Organized Crime is Sophisticated and Increasingly Transnational



SYSTEMATIC TRANSNATIONAL CRIME

Mexican drug trafficking cartels set up camp in Peru

Alongside signs of increased processing of coca base into cocaine in Peru and evidence of strengthening ties between Mexican drug trafficking cartels and their indigenous Peruvian counterparts, coca base production in Peru is on the rise. Jeremy McDermott examines how this has become a cause for concern for Lima and US law enforcement authorities.

Southeast Asia: drive to reduce terrorism in the tri-border area

Colombian police to train Afghans in counter-narcotics

A Colombian police team visited Afghanistan in late July to finalise plans to train Afghan law enforcement personnel in counter-narcotics. Andrew Webb-Vidal examines how collaboration between the two countries will work.

The changing structure of the Afghan opium trade

Since the fall of the Taliban regime, the structure of the opium trade in Afghanistan has evolved signifi[cantly] with control now concentrated in the hands of a few dozen key traffickers. Joanna Wright reports on th[e] current state of the trade.

Sri Lanka returns to war

With both sides reluctant to engage in talks, there is little chance for diplomacy to resolve the Tamil separatist conflict in Sri Lanka. While an early victory for government troops indicates a more combat-ready army than in previous clashes, Chris Smith explains that the Tamil rebels are far from being decisively beaten.

Albanian organised crime groups evolve in Europe

Albanian organised crime groups dominated the headlines in the late 1990s owing to their extreme v[iolence] ... 2003, these groups appear to have adopted a lower profile and more fluid organisational structures ... traces the groups' evolution and examines why they are now more powerful than ever.

Transnational criminal threats encroach on Mongolia

Transnational organised crime remains at a very low level in Mongolia, but a range of illicit trafficking activities show signs of increasing. As transport infrastructure projects integrate the country more closely into regional networks, Christopher Jasparro examines why the threat is likely to rise.

Where critical infrastructure is difficult to protect

“For most of us design is invisible.
Until it fails” Bruce Mau. Massive Change. 2004

Where there are growing polar divisions: rich and poor – young and old

Where perceptions of the value of life are highly variable…









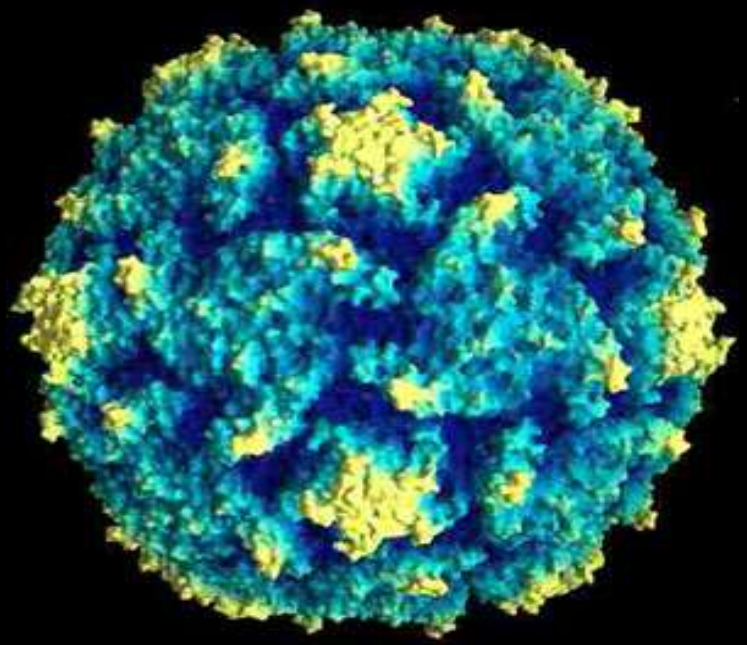

Where diseases have no borders….

Where environmental pressures and ecoshifts are creating formidable challenges…

Where the velocity of technology proliferation is constantly increasing…

Where norms associated with the responsible use of technology are not shared….

Where the custodians of radical innovation must take on new levels of responsibility…

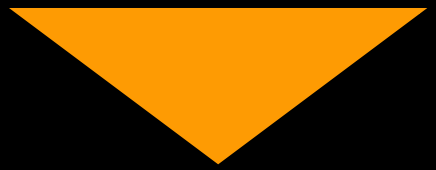


“The technique used to create the first synthetic polio virus, revealed last week, could be also used to recreate Ebola or the 1918 flu strain that killed up to 40 million people...”

New Scientist, July 2002

Asymmetric Warfare: Terrorism and Insurgency

- radical shift in the size/capability/cost of adversarial power
- power of individuals/small groups to cause catastrophic havoc
- ‘trojan horse everything’
- ‘miniaturize, disperse and merge everything’



- low cost offense
- high cost defense
  +
  persistent major vulnerabilities
- new strategies for new threats

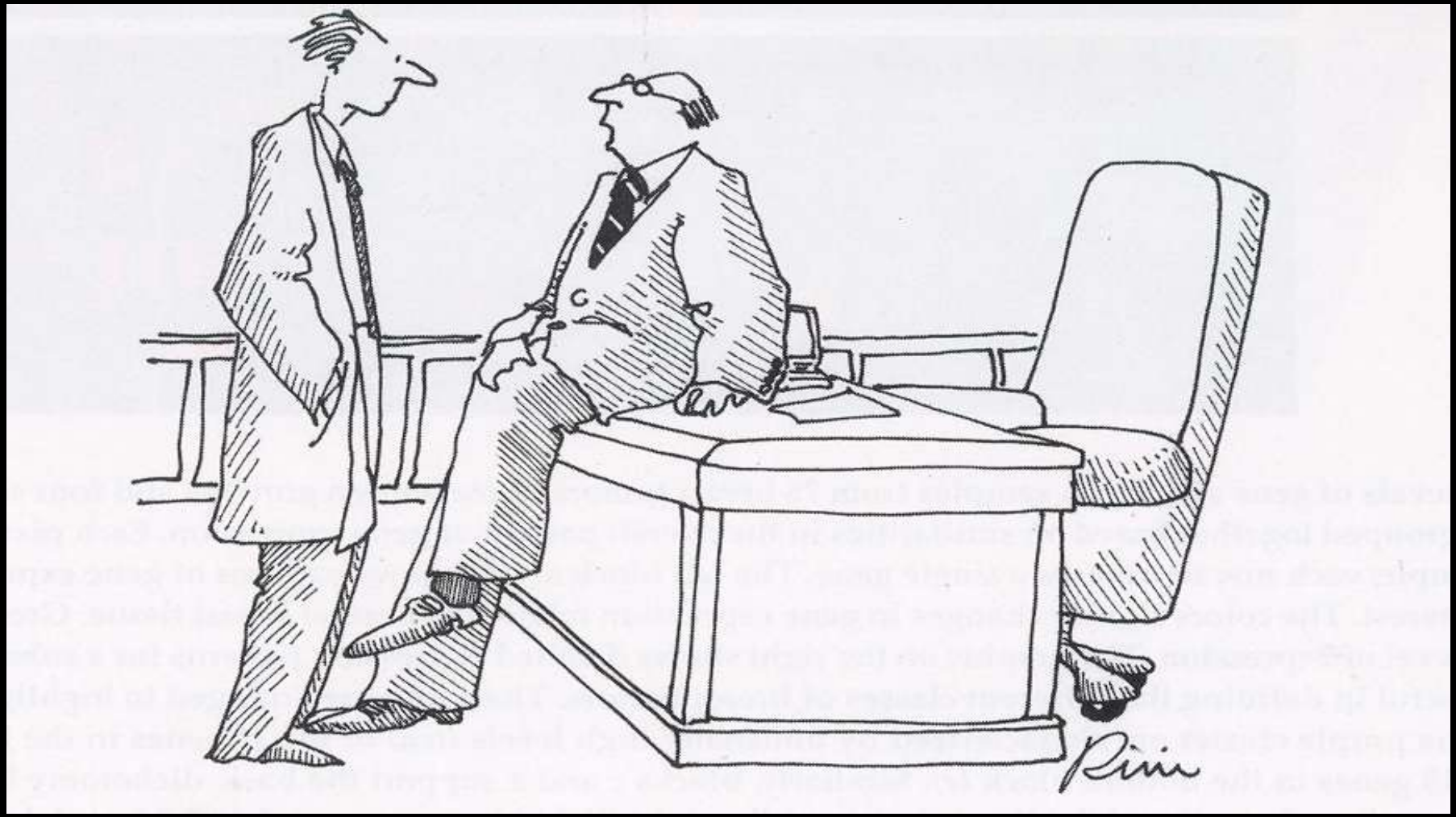
- strategic primacy of
  methods for identification (ID), tagging, tracking and locating (TTL)
  - people
  - materials
  - activities

- ubiquitous embedded sensor networks
- everything is a potential sensor
- smart IT systems for proactive threat detection and interdiction

Finding and Engaging the Enemy in Complex Environments

- non-traditional targets
- small signals in massive cluster/noise
- new methods for deep penetration/ pre-emptive covert operations
- MOUT
- SOF-centric

Ars Longa, Vita Brevis



“As for a Research Department, the Board feels you should try to find whatever you’re looking for the first time you search for it.”

Enduring Themes in the History of Technology
The Poverty of Imagination

- the recurrent myopia of individuals and companies in recognizing new disruptive technologies
  - complacency, risk aversion
- disruptive technologies are created disproportionately by individuals/companies operating at the mainstream margins
  - risky topics, investor timidity, claustrophobic corporate hierarchies/cultures

None Dare Call it Hubris: The Limits of Knowledge

"We have the illusion of understanding
and are not humbled by the fact
that we do not understand.
We refuse even to consider the possibility"

Michael M. Crow
President, Arizona State University
Issues in Science and Technology
Nat. Acad. Press, Winter 2007, 1.

“Transcending the Limits of Us”

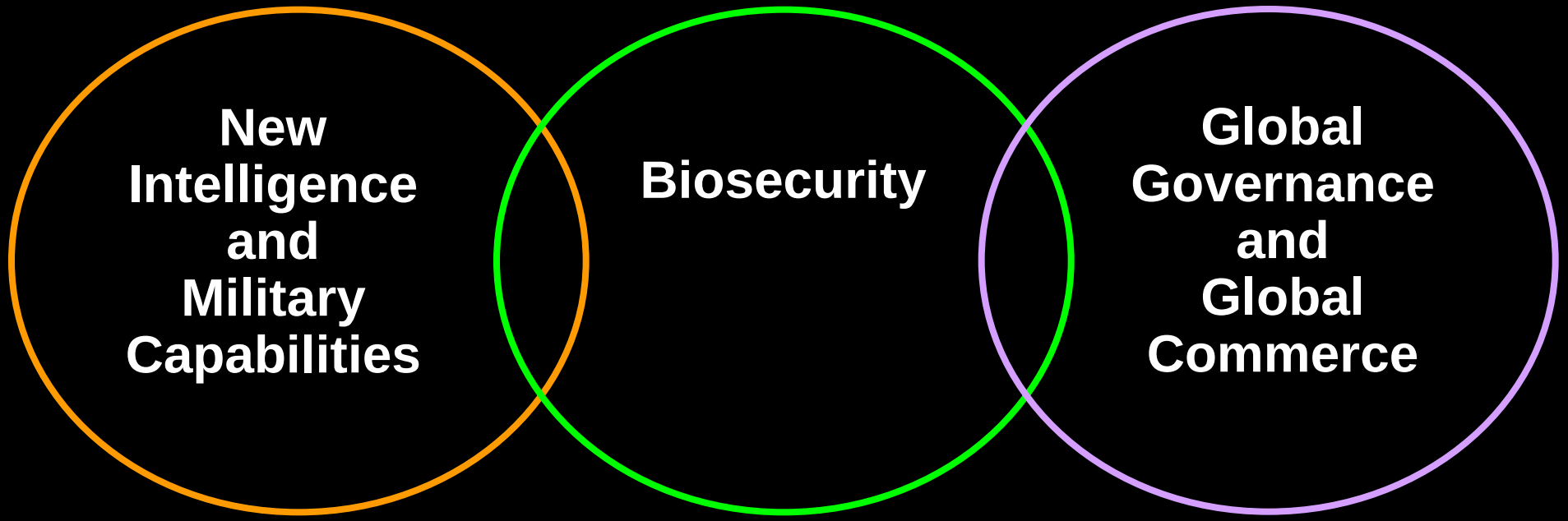
Michael M. Crow (2007) Issues in Science and Technology, Winter p 1

- imperative for new approaches to comprehend and manage complex systems
- better understand the limits of collective ability to acquire, integrate and apply knowledge
- current educational system and institutional structures lack the flexibility, resilence and responsiveness to assess large-scale and long-term consequences
- affluence, comfort and complacency promote individualism over civic engagement
- increasing insulation from implications technology-driven complex change(s)
- pervasive and dangerous scientific illiteracy among policy makers and socio-economic elites

Great Expectations

- expectations for both tactical and strategic intelligence
- new tradecraft
- new sources
- new ways to validate sources
- new technical competencies
- new knowledge integration tools
- new behaviors
  - systems versus stovepipes
  - open source knowledge
  - new relationships

The Principal Determinants of Global Order in the Early 21st Century



Asymmetric warfare and counter-terrorism

Mitigation of natural and malevolent risks to populations and the environment

Mitigation of economic, social and political instabilities


DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA


U.S. DEPARTMENT OF HOMELAND SECURITY


SEAL OF THE PRESIDENT OF THE UNITED STATES


UNITED STATES SPECIAL OPERATIONS COMMAND


UNITED STATES SECRET SERVICE


DEPARTMENT OF THE ARMY
UNITED STATES OF AMERICA
1775


DEPARTMENT OF THE NAVY
UNITED STATES MARINE CORPS


DEPARTMENT OF JUSTICE
FEDERAL BUREAU OF INVESTIGATION


CENTRAL INTELLIGENCE AGENCY
UNITED STATES OF AMERICA


DEFENSE INTELLIGENCE AGENCY
UNITED STATES OF AMERICA


UNITED STATES NAVY


DEPARTMENT OF THE AIR FORCE
UNITED STATES OF AMERICA


DEPARTMENT OF STATE
UNITED STATES OF AMERICA


NATIONAL RECONNAISSANCE OFFICE
UNITED STATES OF AMERICA


DEPARTMENT OF HEALTH & HUMAN SERVICES · USA


DARPA


UNITED STATES COAST GUARD
1790


USDA


UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY


DEPARTMENT OF JUSTICE


DEPARTMENT OF ENERGY
UNITED STATES OF AMERICA

“After two years in Washington, I often long for the realism and sincerity of Hollywood.”

— Fred Thompson

April 2006: Jordanian intelligence identify Sheik Abdul Rahman as a primary contact in al-Zarqawi's group - 'al-Qaida in Iraq'

7 June - 6.15pm: F-16 warplane attacks safe house with two 500lb bombs

May 2006: RAF Nimrod intercepts satellite cell phone used by Rahma

7 June - 6.00pm: Central Command orders air strike

TASK FORCE 77 - HOW THE INTELLIGENCE LED TO AL-ZARQAWI

May 2006: Surveillance begins on several key targets

May/June: Predators used to track movements of Rahman and note colleagues

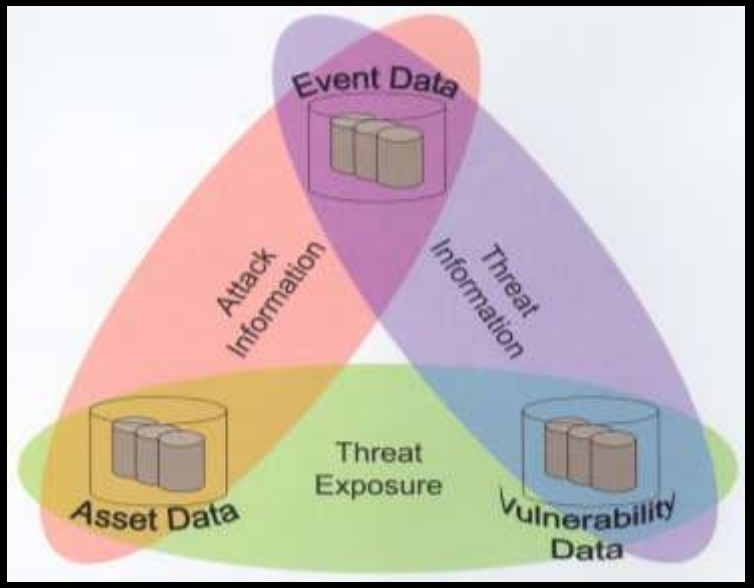
7 June: Predator tracks Rahman's vehicle as he makes his way to Hibhib

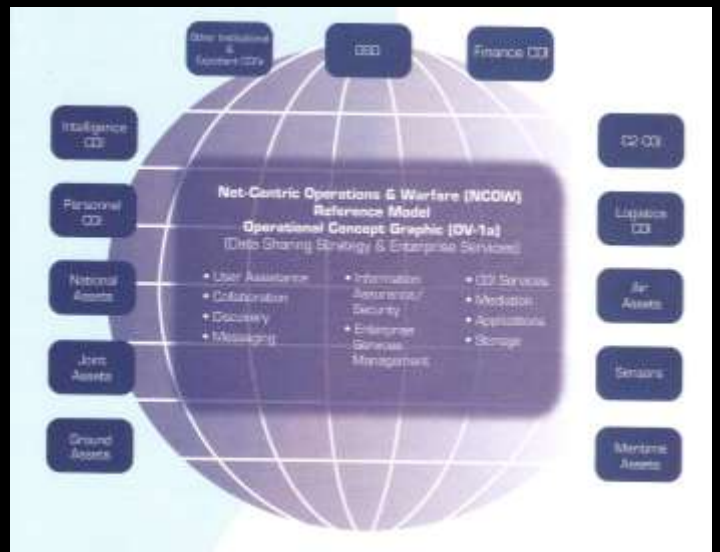
7 June: Surveillance teams in Hibhib confirm Rahman and al-Zarqawi together in safe house

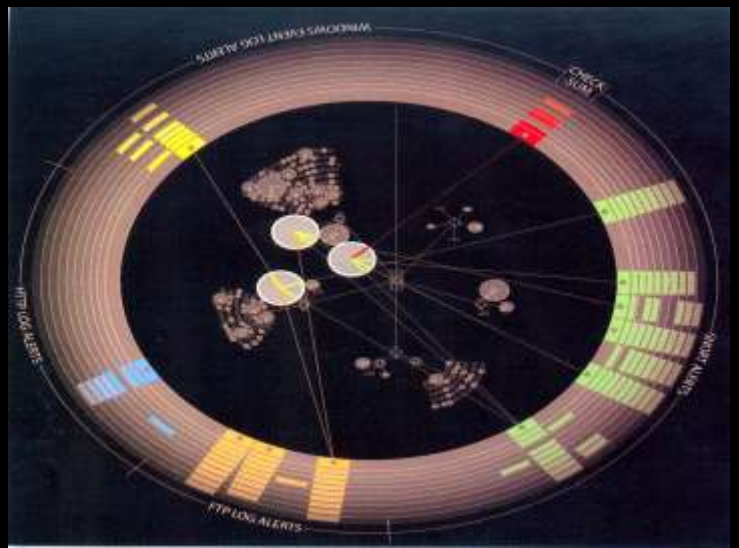
Seeking Security in an Insecure World

- security is indivisible
  - integration of intelligence, defense, homeland security, public health
- connectivity, complexity and unintended consequences (blowback)
  - acceleration of dual-use technologies
  - technology convergence
- new threats, and new counter-measures
  - new skills and organizational frameworks to address hitherto largely ignored ‘security’ dimensions

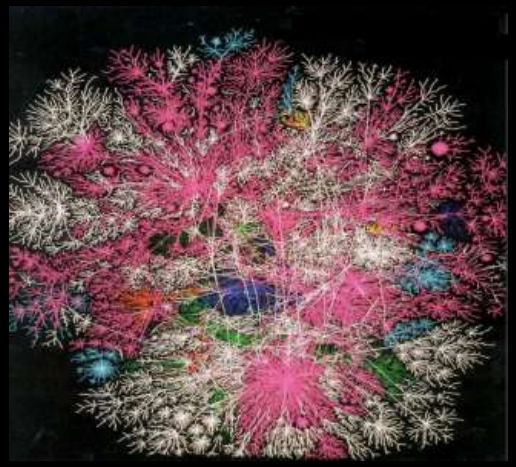
Information Superiority: A Critical Success Factor for Security and Competitiveness in the 21st Century



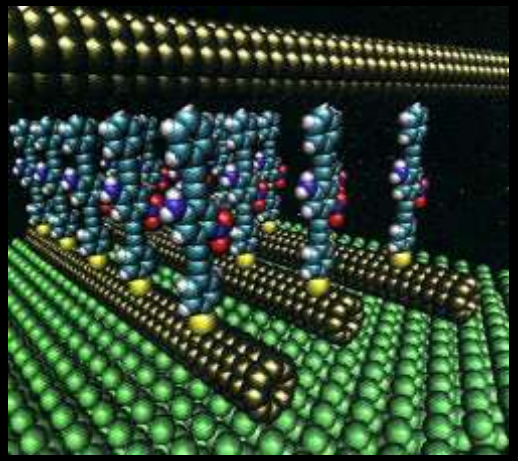




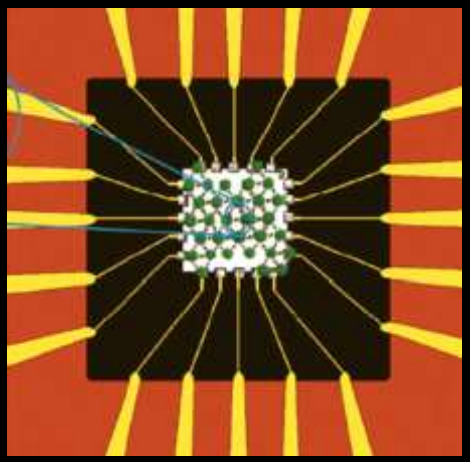
Technological Convergence and National Security



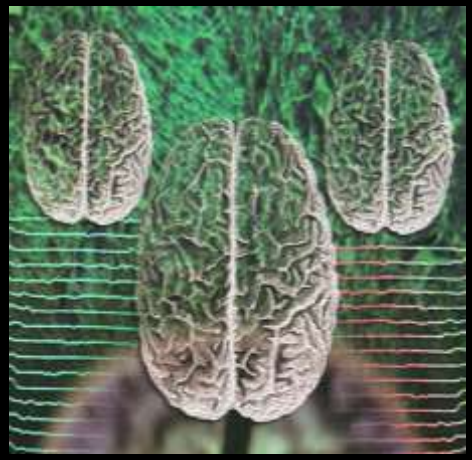
Biotechnology, Systems Biology and Synthetic Biology



Nanotechnology and Miniaturization Engineering



Computing



Neurobiology and Brain: Machine Interactions

speed and diversification of new "dual-use" applications

- lack of historical precedents for new technologies that redress military inferiority not being developed

The World of Molecular Engineering and Ubiquitous Sensing: Using Very Small Things to Solve Big Problems

Healthcare

Public Health

Sustainability and Stability

National Security

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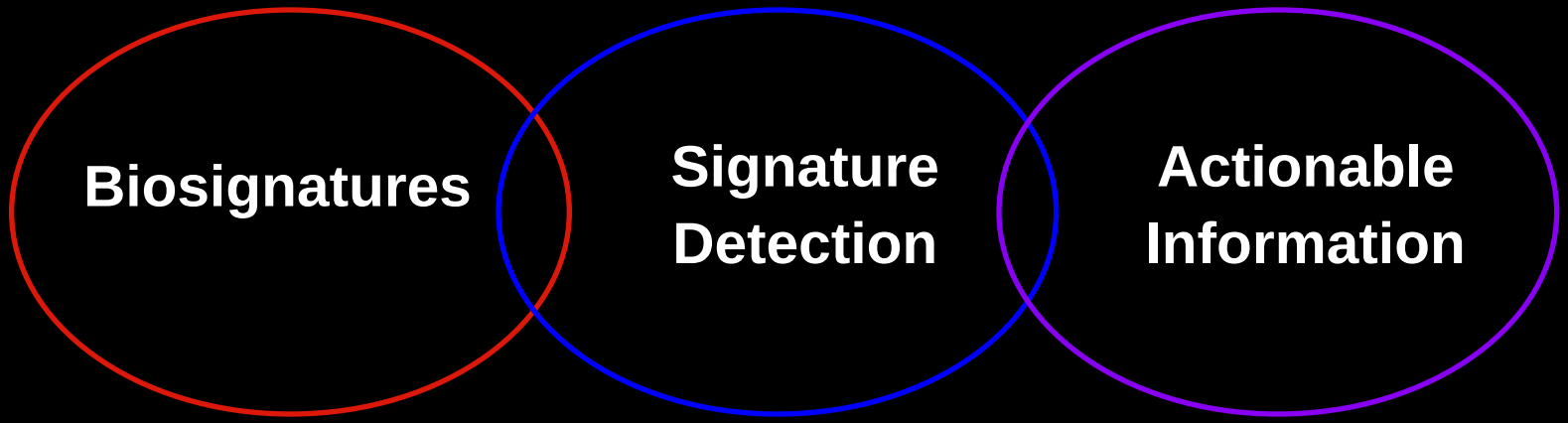
Innovative Solutions for Major Global Challenges




Unifying Technology Platforms



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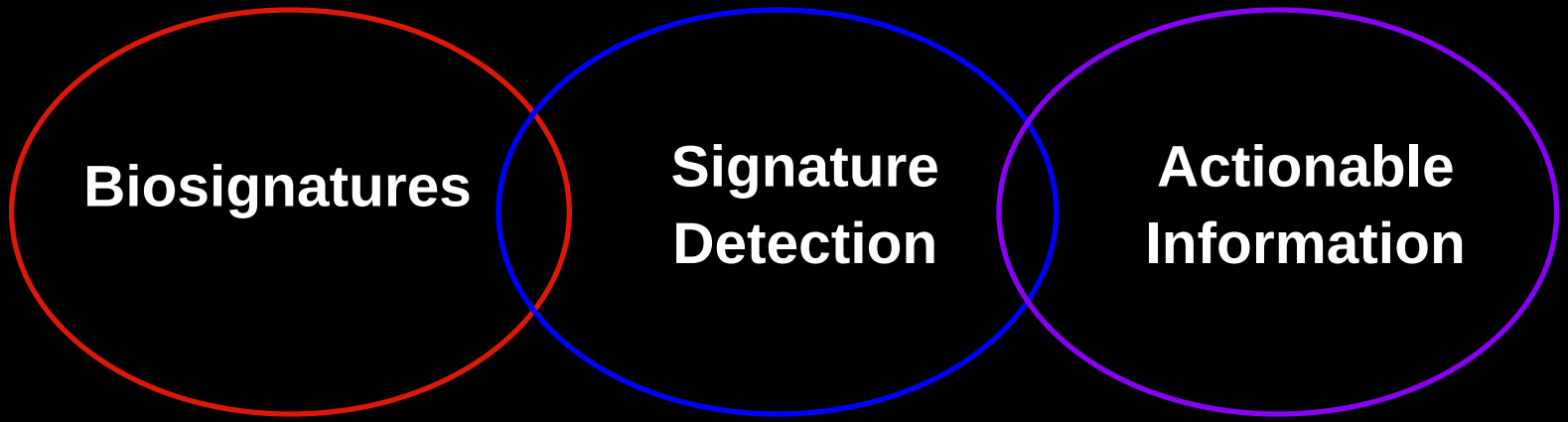
Innovative Solutions for Major Global Challenges




Unifying Technology Platforms



Profile | **Sense** | **Act**

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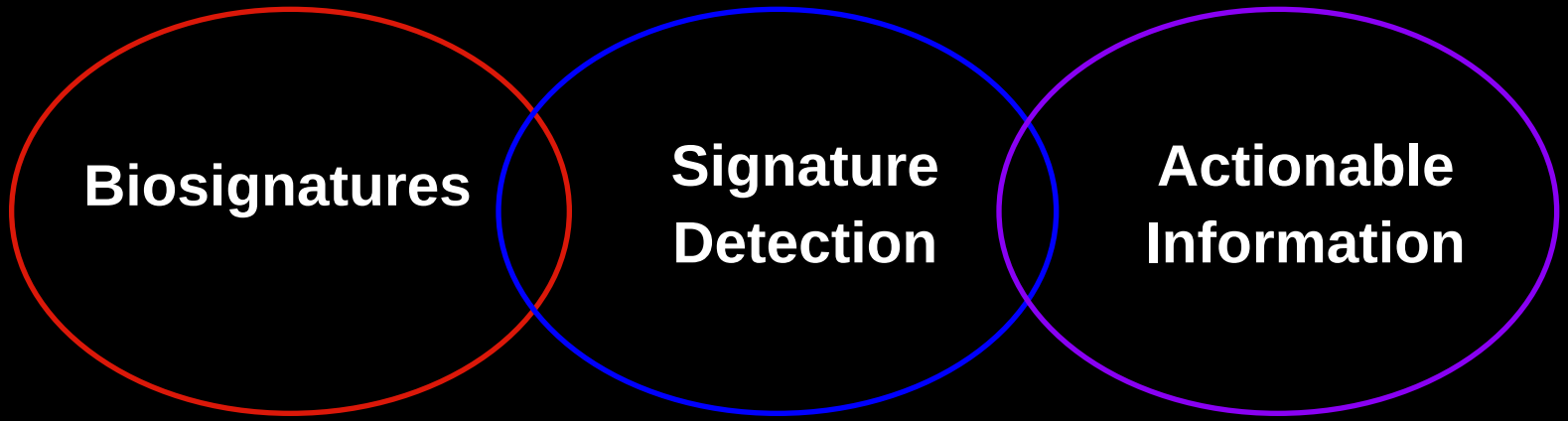
Innovative Solutions for Major Global Challenges




Unifying Technology Platforms



Profile	Sense	Act

"Sensor World": Ubiquitous Sensing and Ambient Intelligence

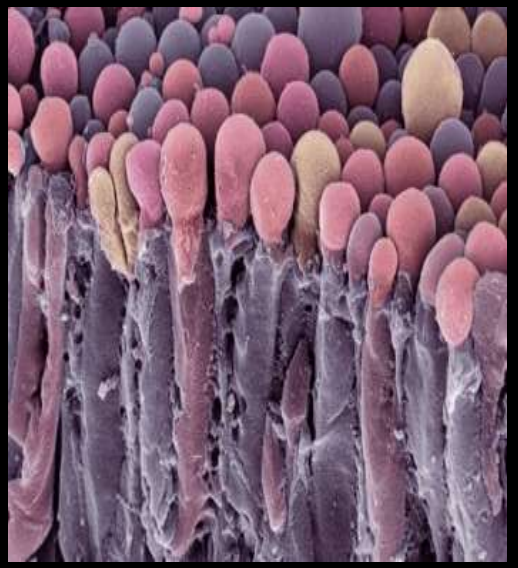
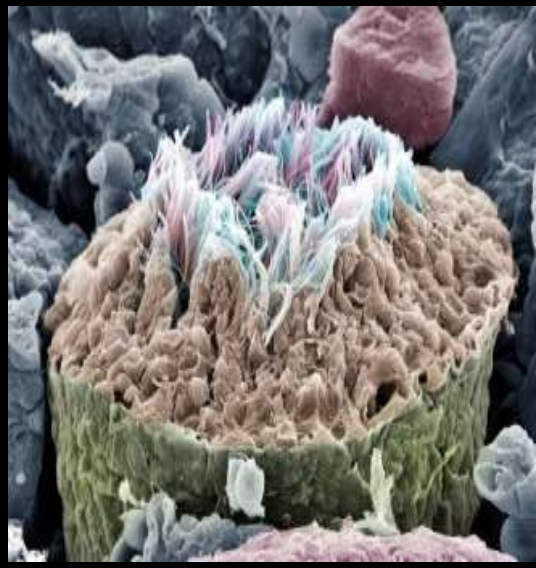
Ubiquitous Sensing: (Ambient Intelligence)
Instant Information: Anything, Anywhere, Anytime

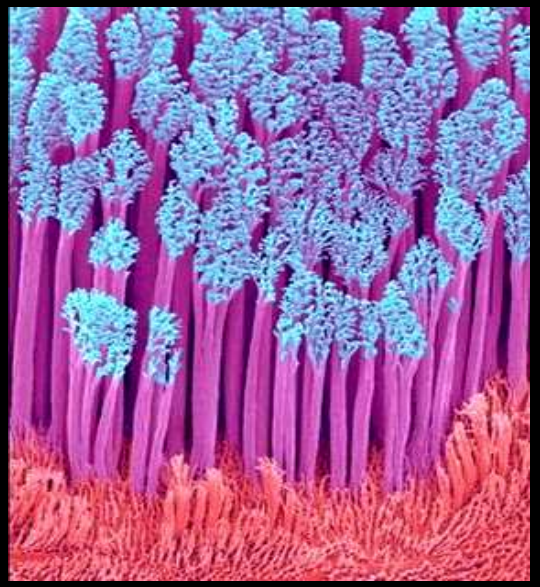
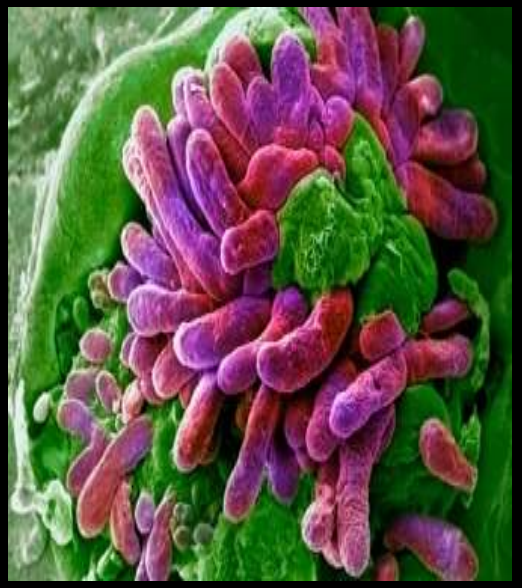
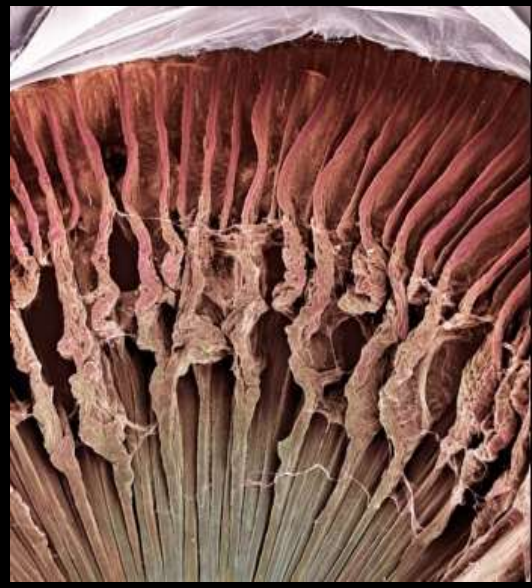
- linking the molecular world to the internet
- miniaturized sensors and a monitored world
  - infrastructure, agriculture, health, ecosystems, security
- from deep blue to deep space to inner space
- “intelligent” adaptive sensor networks (swarms)
- global connectivity and network information architecture(s)
- large scale simulation capabilities for modeling potential major instabilities/perturbations
- complex legal, ethical and social implications

A New Era of Materials Science

- nanoscale directed molecular assembly
- biomimetic materials
- abiotic : biotic materials
- dynamic ‘smart’ materials
- shape-memory materials
- metamaterials
- molecular motors, hydraulic systems and actuators



Bio-Inspired Novel Materials

- self-assembly
- template-directed assembly
- replication and repair
- compatible interface with non-biological materials
- biomolecular motors for microscale power and actuation
- “cognitive” sense-and-respond materials
- adaptive capabilities for structure/function plasticity in changing environments

Technology Convergence

Engineering Design

- "heat and beat"

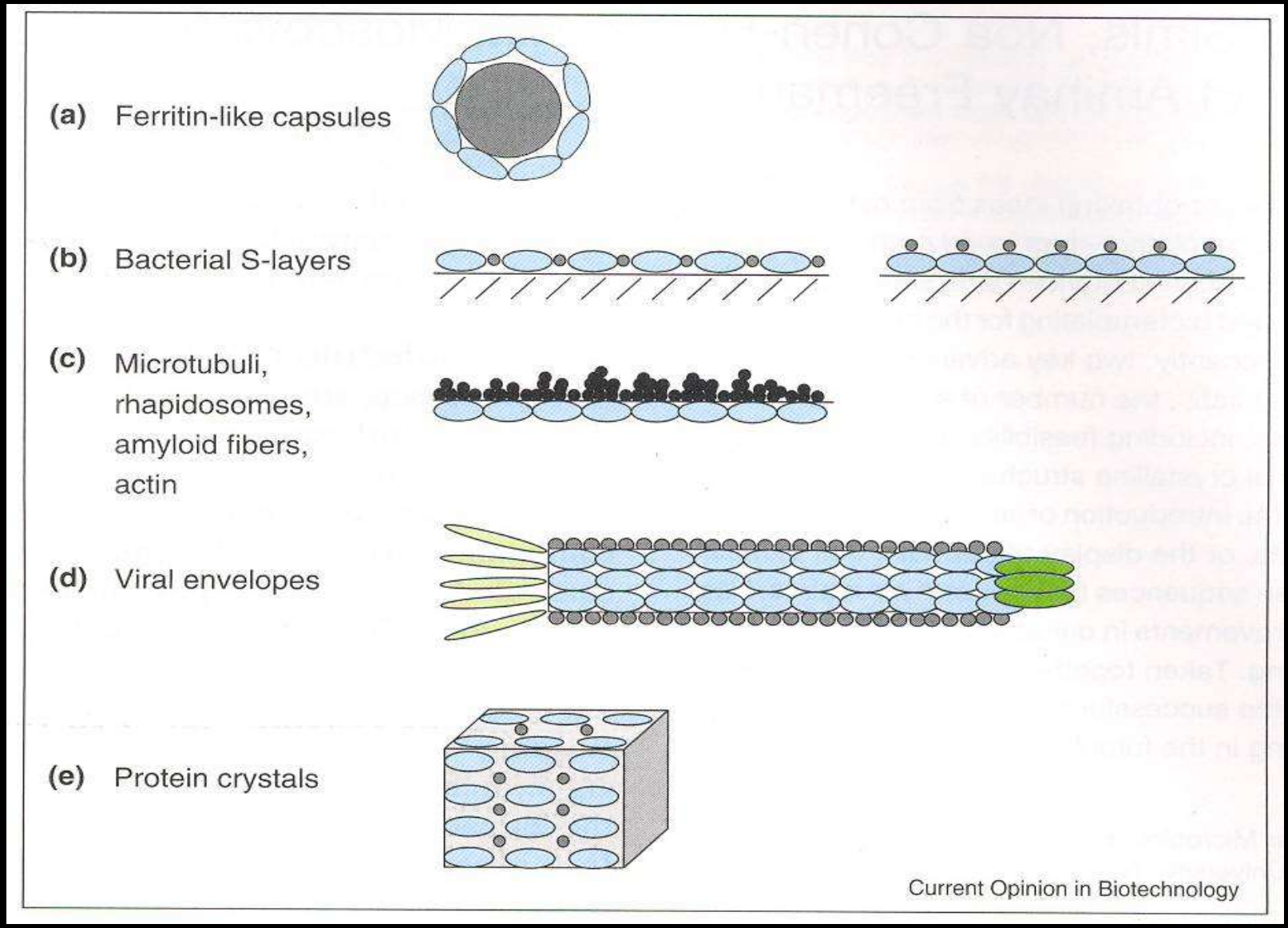
Biological Design

- "nucleation and self-assembly"

Bio-inspired Design: Biomimetic Engineering

- high precision nanoscale assembly of unique hybrid materials using biological structural templates and self-assembly reactions
- convergence of biological chemistry and nanoscale fabrication technologies
- synthetic biology and expansion of available inventory of biological 'building blocks'
- programmed design of unprecedented heterofunctional materials, structures, devices combining biotic: abiotic components/functions

Protein-Mediated Nanoscale Biotemplating

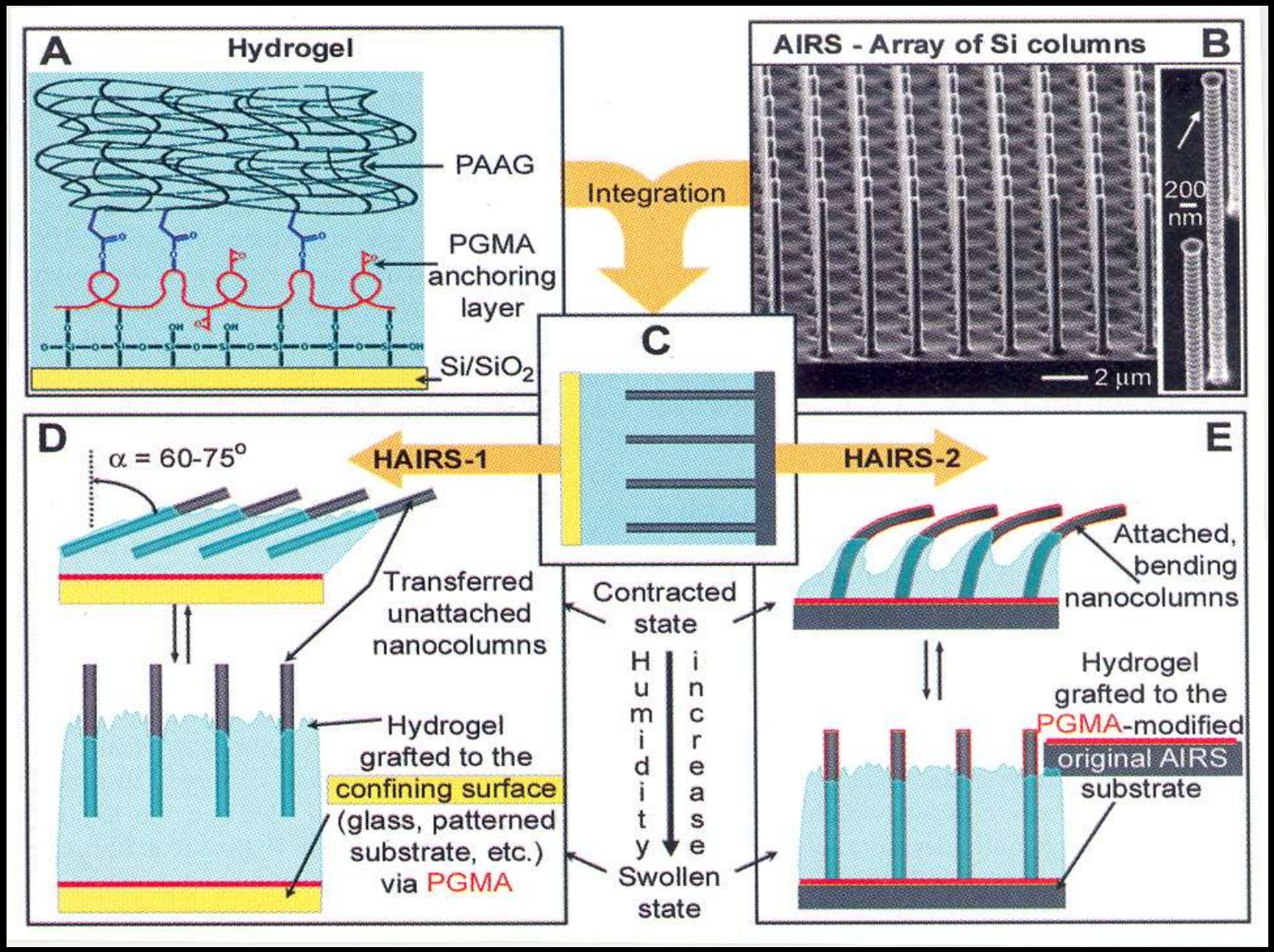


From: S. Lagziel-Simis et al (2006) Curr. Op. Biotechnol. 17, 569

‘Molecular Erector Sets’ for Programmed Self-Assembly of Hybrid Inorganic: Protein Nanostructures

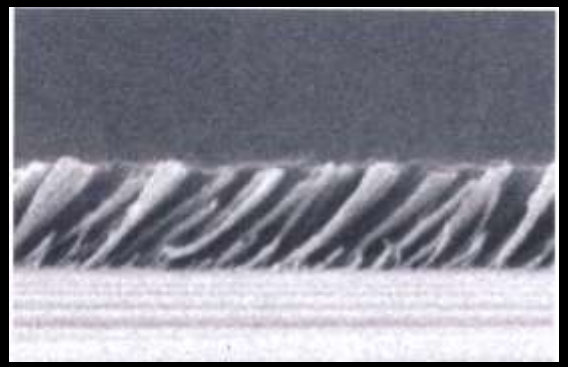
- current limits on prediction of folding and surface binding chemistries of proteins
- combinatorial synthesis and screening of peptides/proteins for desired binding and structural parameters
- directed evolution optimization methods
- incorporate ‘inorganic affinity’ sequences/domains into other proteins with additional desired scaffold/functional traits

Reversible Switching of Hydrogel-Actuated Nanostructures into Complex Micropatterns



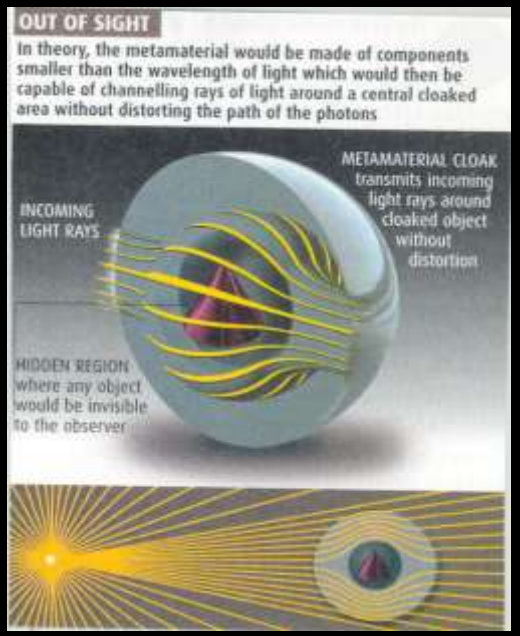
From: A. Sidorenko et al (2007) Science 315, 487

Optical Thin-Film Materials with Low Refractive Index (1.05) for Broadband Elimination of Fresnel Reflection



- J.Q. Xi et al (2007) Nature Photonics 1, 176
- light reflection from aluminum, silicon, aluminum nitride and aluminum coated with TiO_2 and SiO_2 graded index films using top layer oblique angle deposition (450) of SiO_2 nanoroads
- anti-reflection coatings
- black body materials

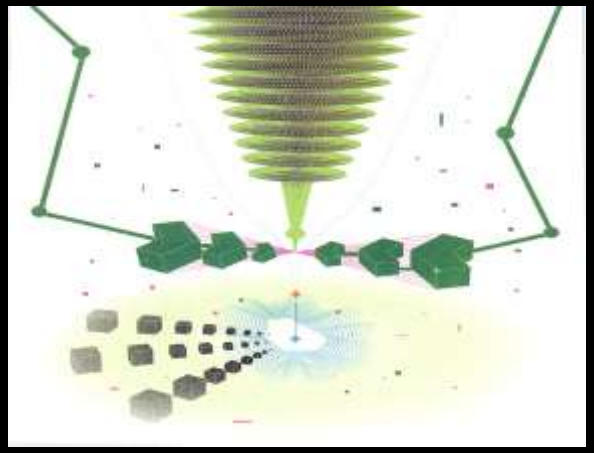
Now You See Me, Now You Don't: "The Invisibility Cloak", Metamaterials and the Quest for Negative Refractive Index Materials



- future challenges
  - 3D versus 2D 'cloaking'
  - control of permeability and permittivity in visible light

Adapted from New Sci. 2007 17 Feb. 38

Breaking the Diffraction Limit: Engineering Nanoscale Antennas
K. Crozier and F. Capasso, Harvard



- intrinsic limitations of diffraction limit
  - lenses cannot focus light into area with diameter less than half light's wavelength
- design of nanoscale 'optical antennas' to focus light to 40 nm wide spot
  - 1/20 of lights wavelength
- potential for DVD with 3.6 terabytes (= 750 todays 4.7 gigabyte DVDs)
- new applications in photolithography, superhigh resolution optical microscopes

Cephalopod Camouflage

- color-blend to match their environment
- dramatic multifunctionality combination of shape, malleability and optical transformations
- surface texture alteration
- photonic crystal dimension changes (structural color change)
- pigment cloaking
- ‘reflectins’: proteins that self-assemble into diffraction gratings with spacing (and thus color) that is tunable and responsive

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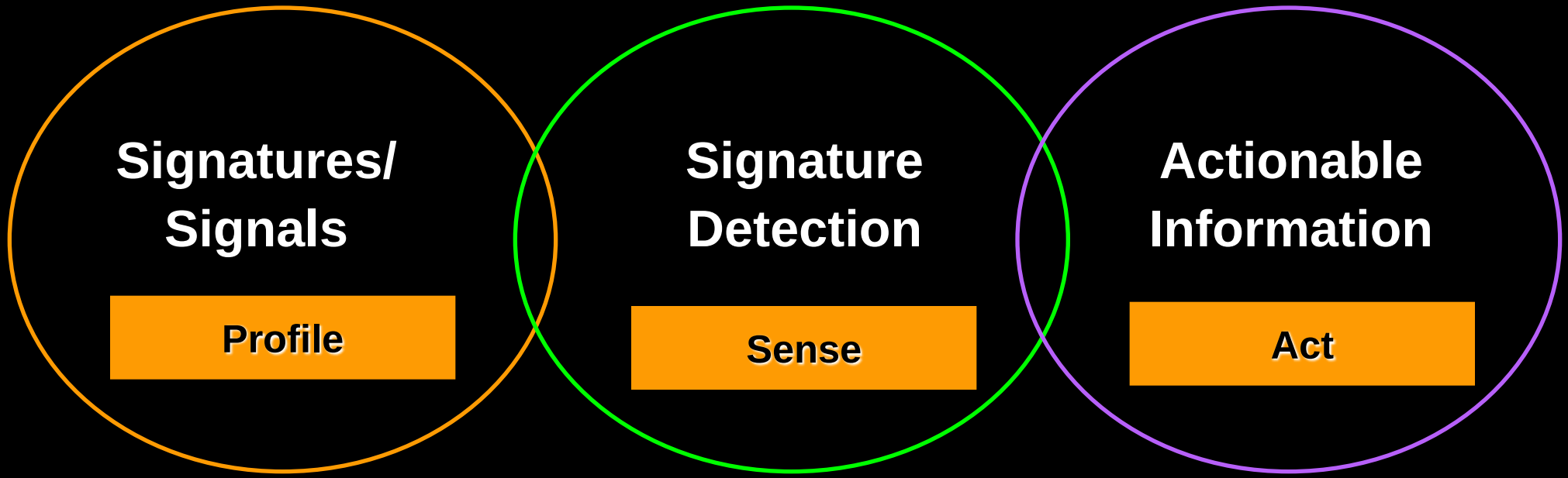
Intelligent Monitoring Systems for National Security



- threat identification
  - people
  - materials
  - location(s)

- tag, track and locate (TTL)
  - overt
  - covert
  - in-body to outer space
- global reach

- real-time threat awareness
- threat pre-emption
- in-theater superiority
- WMD incident management
- forensic attribution

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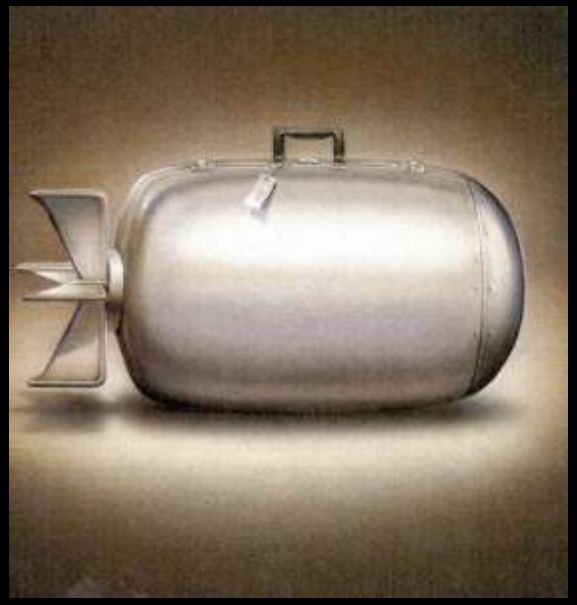
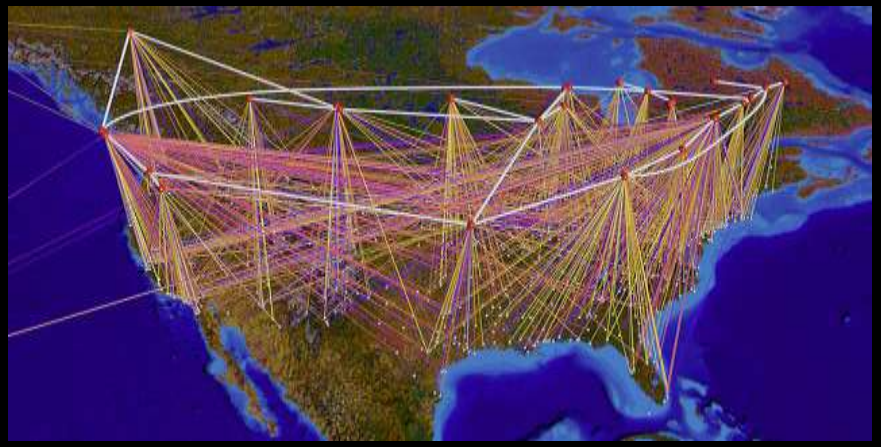
Intelligent Sensor Networks for Monitoring WMD Catastrophic Terrorism Risks





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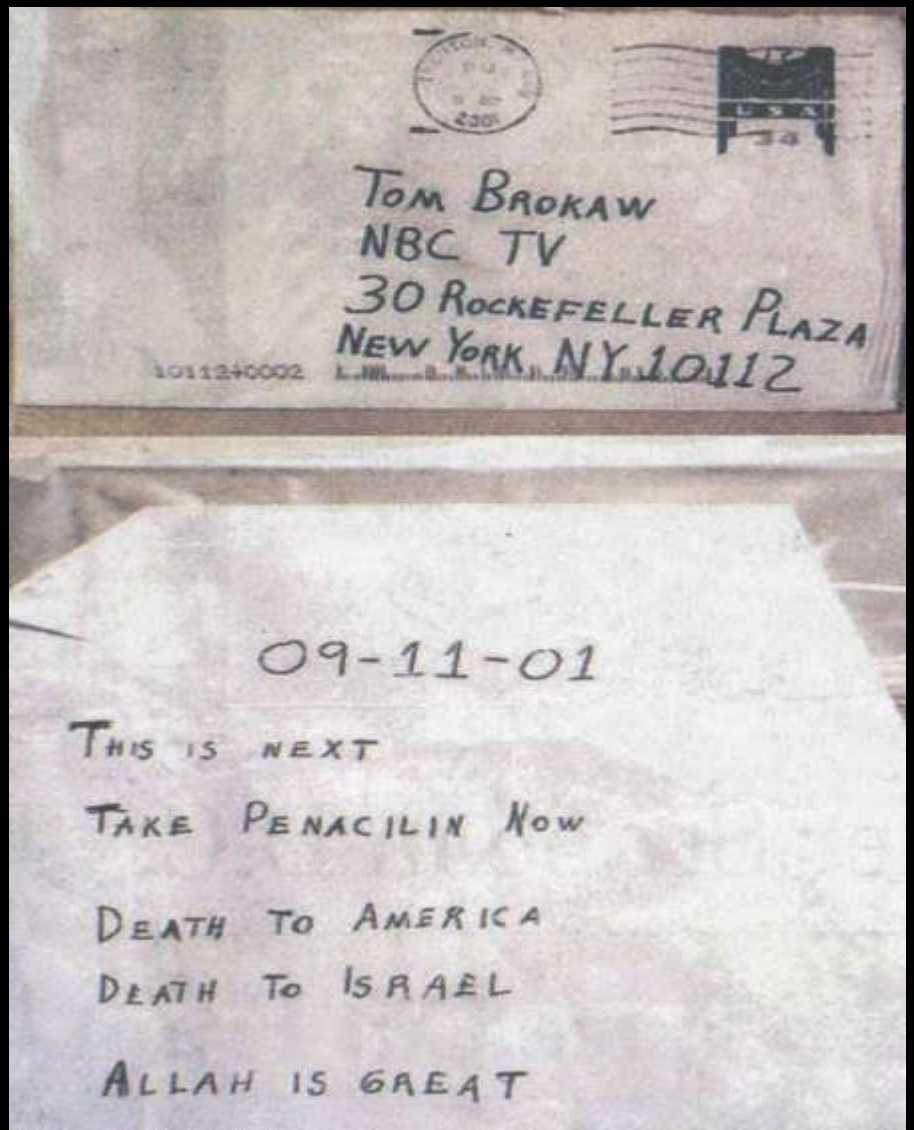
Biosecurity

Bioterrorism

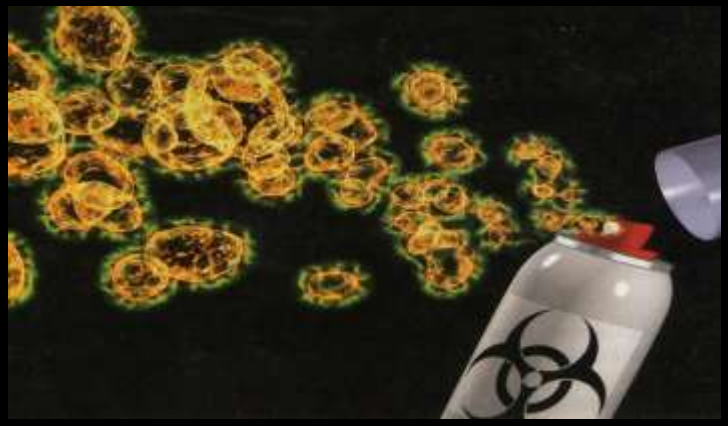
Infectious Diseases of Natural Origin

Environmental Sustainability

Bioterrorism : Overhyped or Ignore at Our Peril?



"I will show you fear
in a handful of dust"
T.S. Elliot



Dual-Use Knowledge

The Molecular Basis of Microbial Virulence

- pathogen genomes (virulent vs avirulent strains)
- specific virulence determinants and methods for experimental modulation
- evasion of host immune responses
- directed evolution methods and genesis of novel variants
  - virulence, host range, tropism, Rx resistance
- de novo synthesis/genetic reassortment in major pathogens

Assessing the Threat from Infectious Diseases

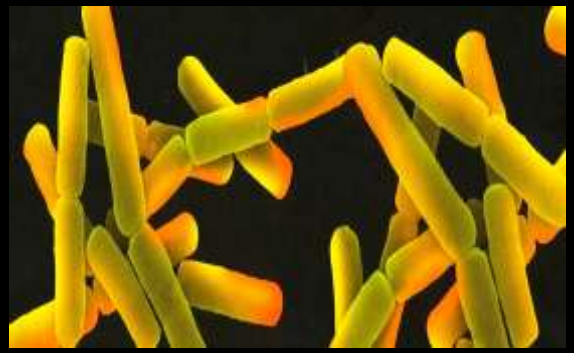
Bioterrorism

- low probability, high consequence

Natural Epidemics and Pandemics

- high probability, high consequence

HIV



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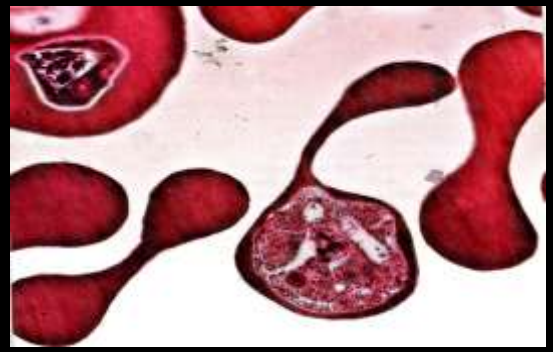
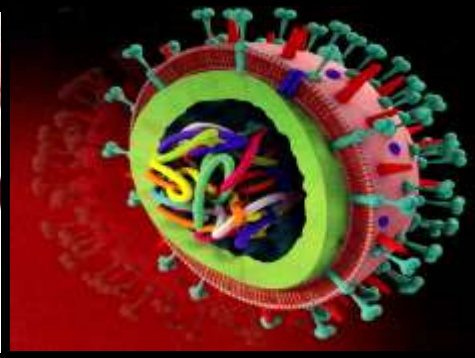


Malaria



Influenza

EIDs

Urbanization

Rx Resistance

Incentives

Misperceptions and Flawed Policies

The Delusional Value of Quick-Fixes: The Curse of Contemporary Governance

"Of course, every complex problem

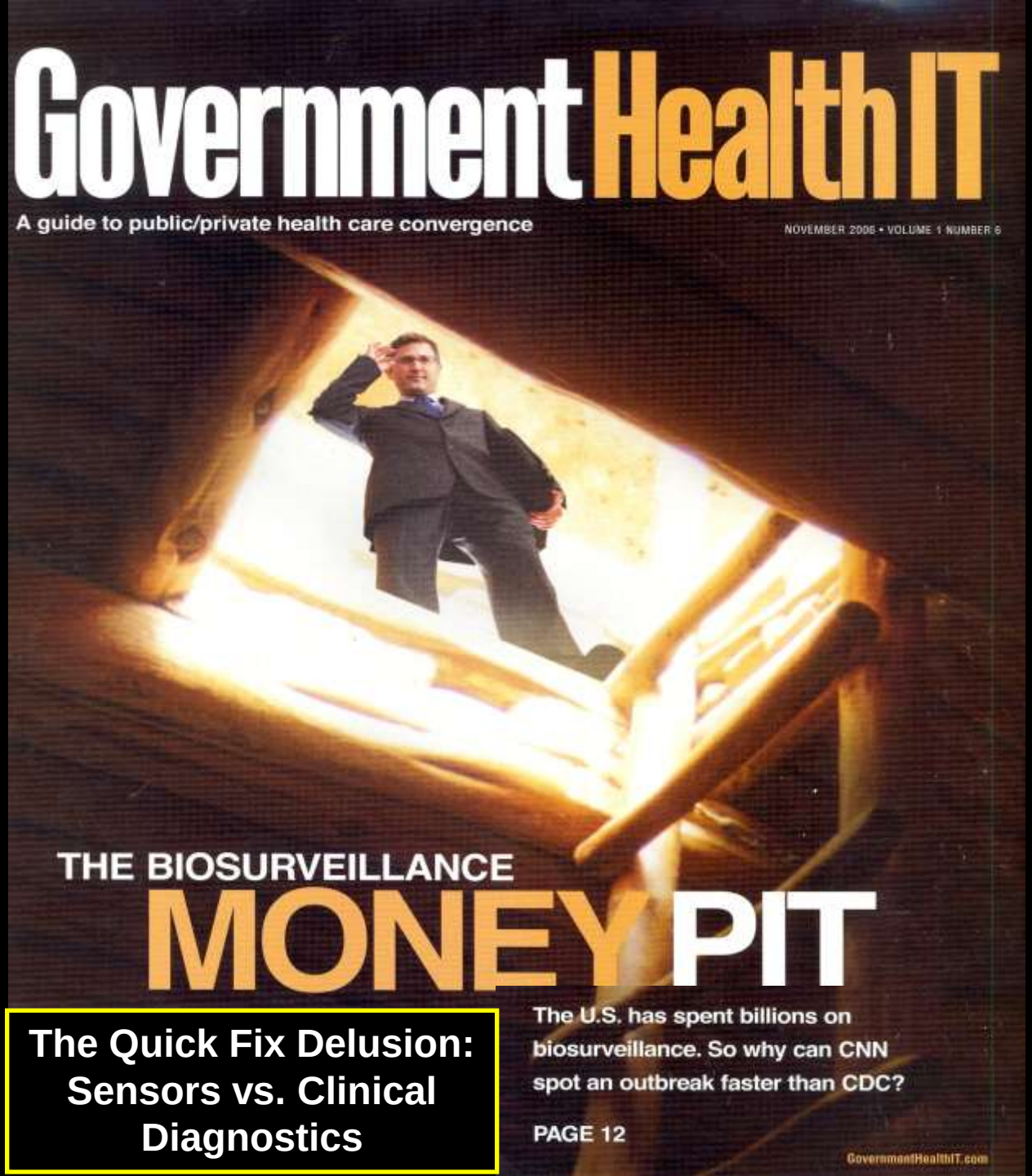
has an instant solution;

and it's always wrong!"

H.L. Mencken (1935)

"It is not realistic to undertake a nationwide
blanket deployment of biosensors.
The most important component of a biodetection architecture
in the event of an attack
will be stricken Americans, not sensors"

JASONS
Biodetection Architectures
Report #JSR-02-330 (Feb. 2003)

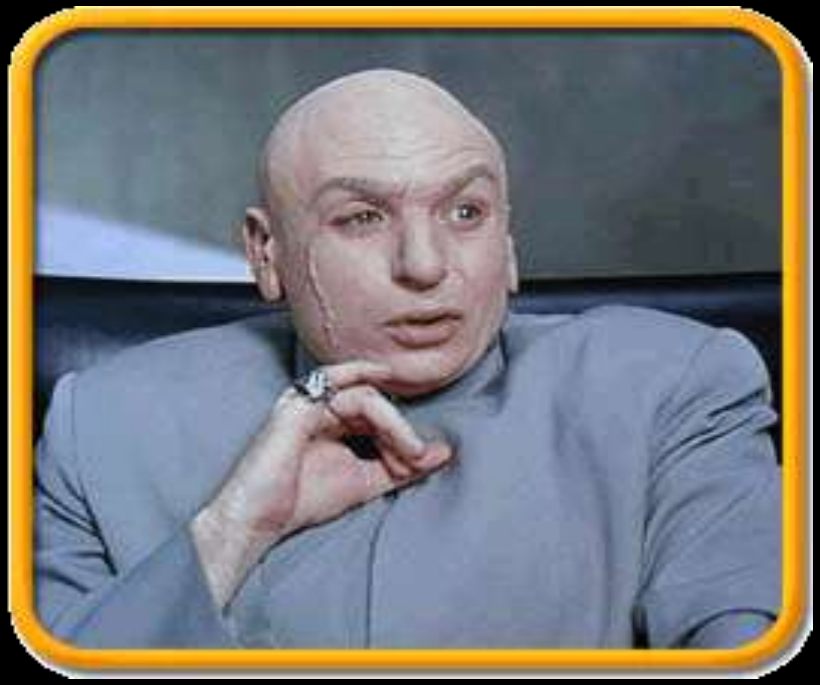


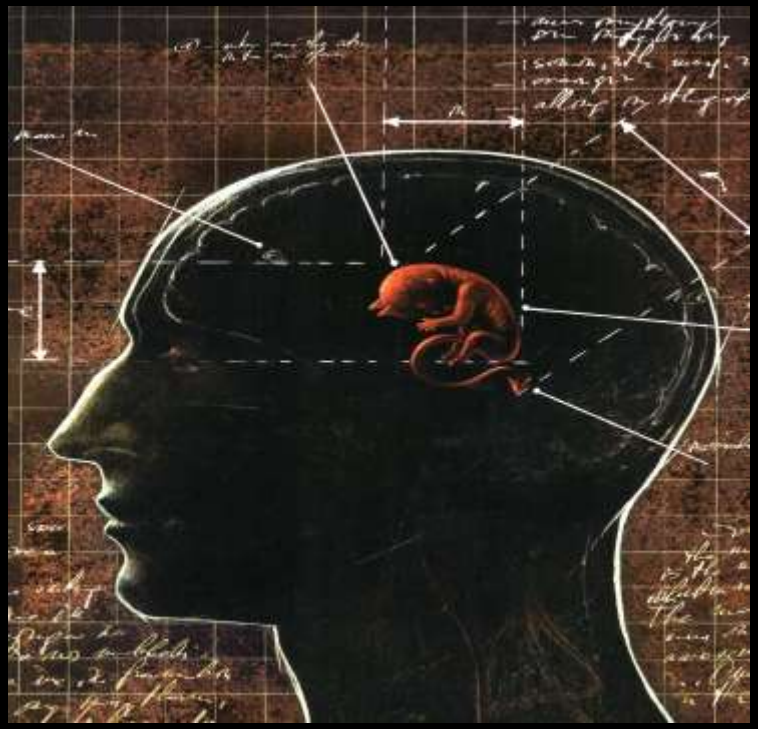
The Quick Fix Delusion: Sensors vs. Clinical Diagnostics

Biodefense: Not Hazmat or Wide Area Sensor Nets

New Clinical Diagnostics: The Single Most Important Leverage Point for Amplified Biodefence Capabilities

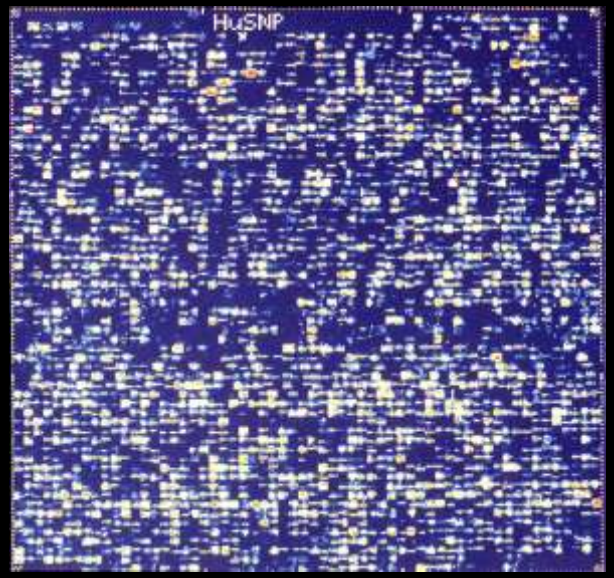
The Future Trajectory of Biotechnology

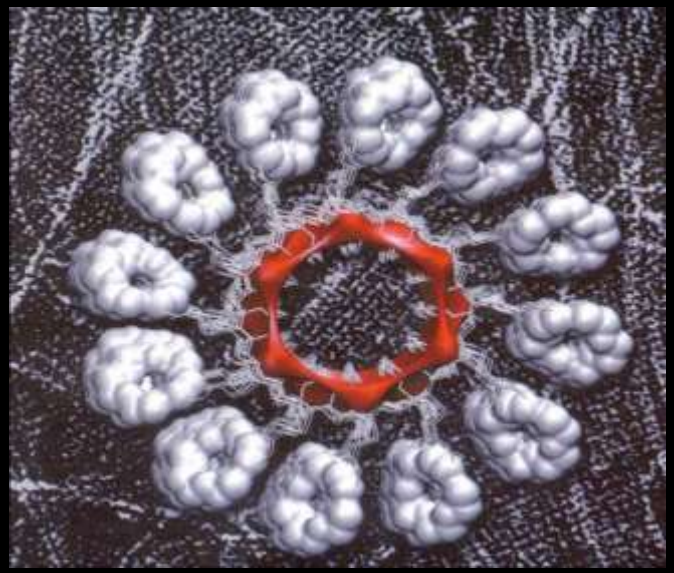


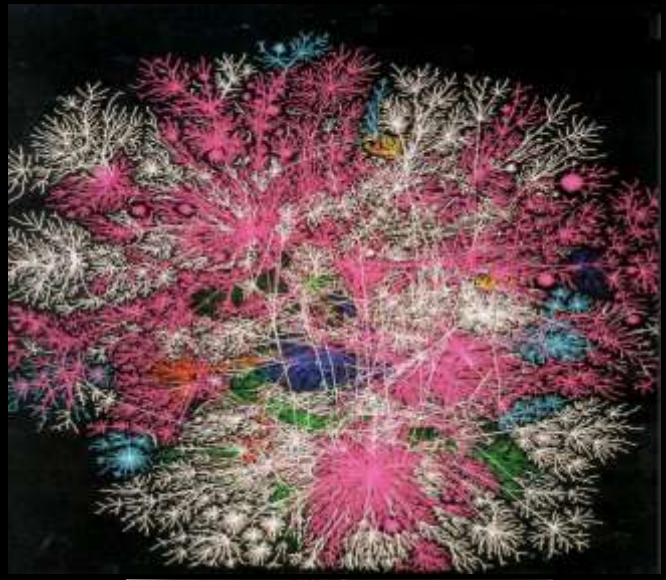


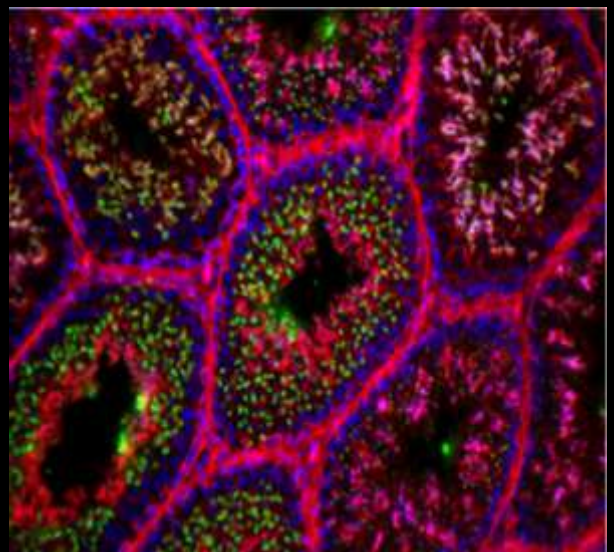
New ‘Dual-Use’ Technologies
with
Applications in Biowarfare and Bioterrorism

Comprehending Biological Design: The Design of Complex, Adaptive Networks of Increasingly Higher Structural Order

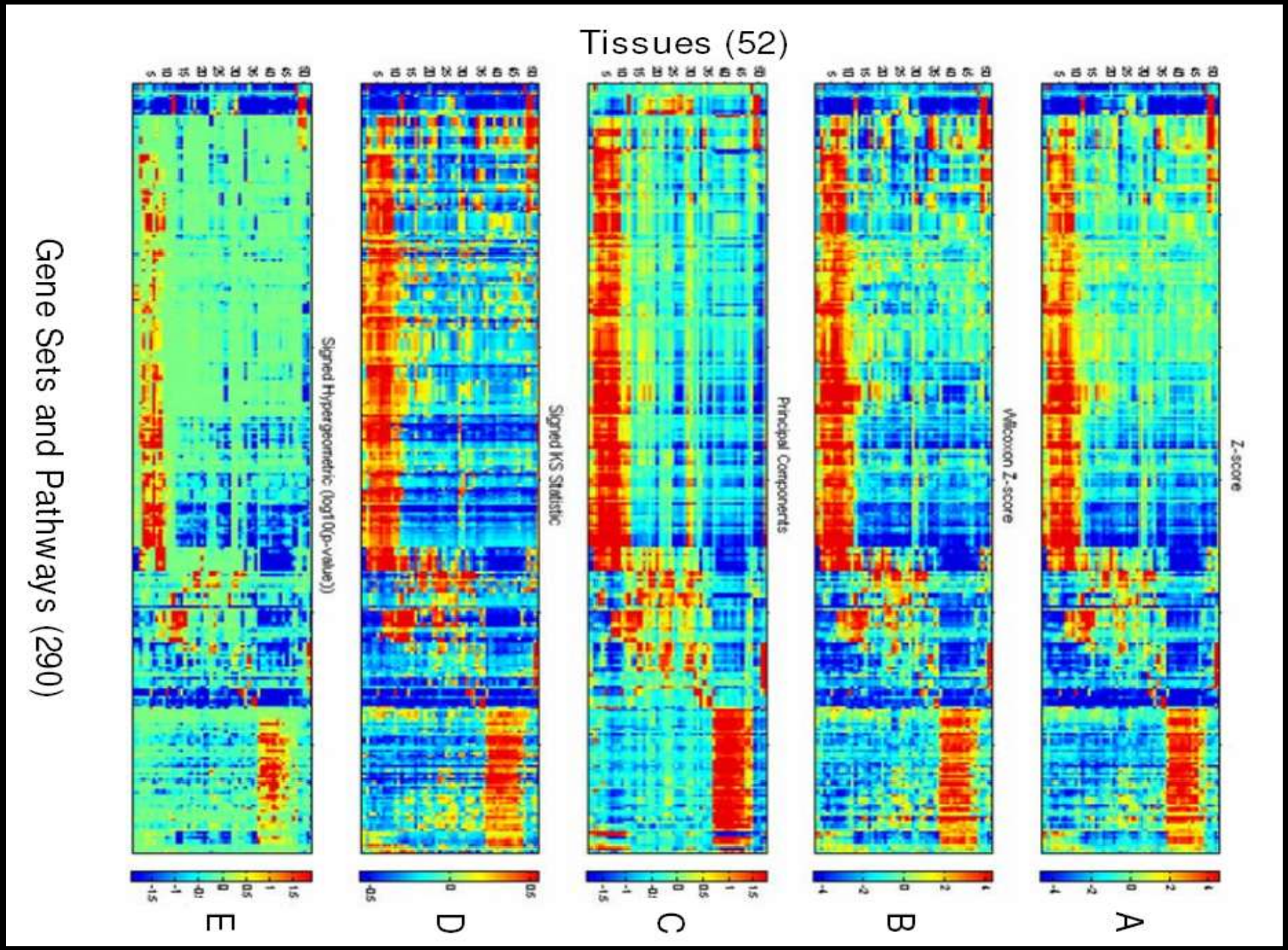






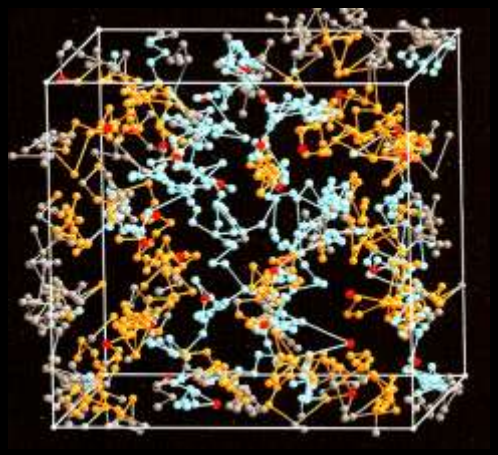


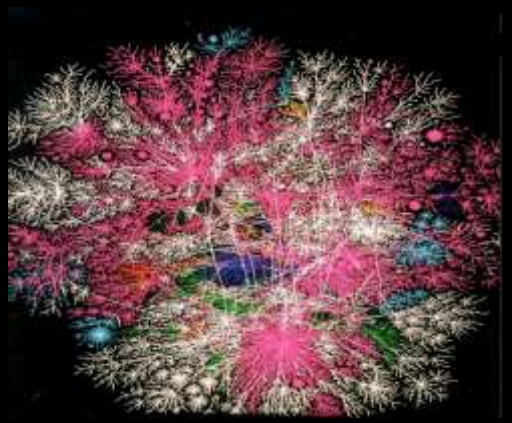
Comparison Plot of Human Body Atlas Pathway Expression Computed by Five Different Metrics



From: D. M. Levine et al. (2006) Genome Biology 7, R93

The Dual Use Dilemma in Life Sciences R&D





- future biothreats will not be limited to microorganisms
- mapping of genetic control circuits/networks for key homeostatic functions
  - major advances in medicine
  - simultaneous ID of “nodes” for perturbation
- creation of biological circuit disrupters (BCDs) will be easier than microbial modification
  - screening of large combinatorial chemical libraries
  - small molecule BCDs

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NIH Roadmap ACCELERATING MEDICAL DISCOVERY TO IMPROVE HEALTH

Chemo-Genomics

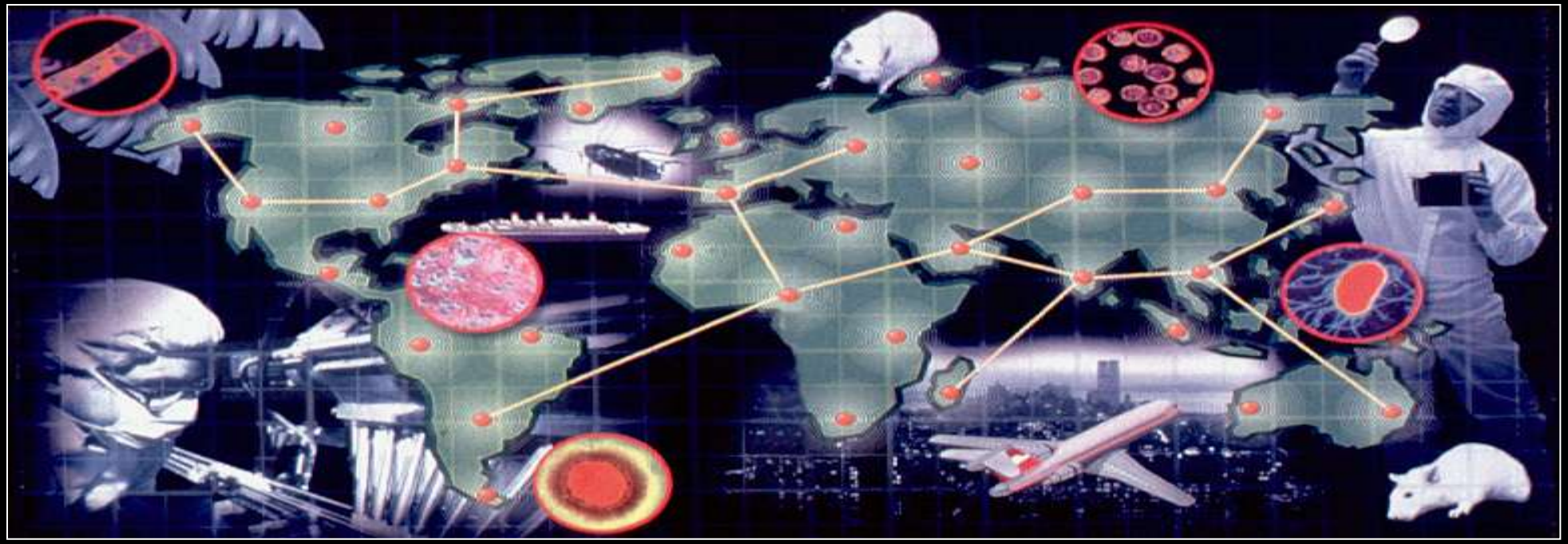
- identification of chemical structure (or series) that interacts with every human gene product
- new repertoire of research tools for perturbation of specific proteins, pathways, and networks
- lead identification for Rx structure-activity optimization (?)

Instructive Template for New Generation of Chem-Bio Weapons: Biological Circuit Disrupters (BCDs)?

A Shared Global Risk :
The Growing Threat from Microorganisms and Parasites

Comfort and Complacency

EIDs: Global Reach and Global Consequences



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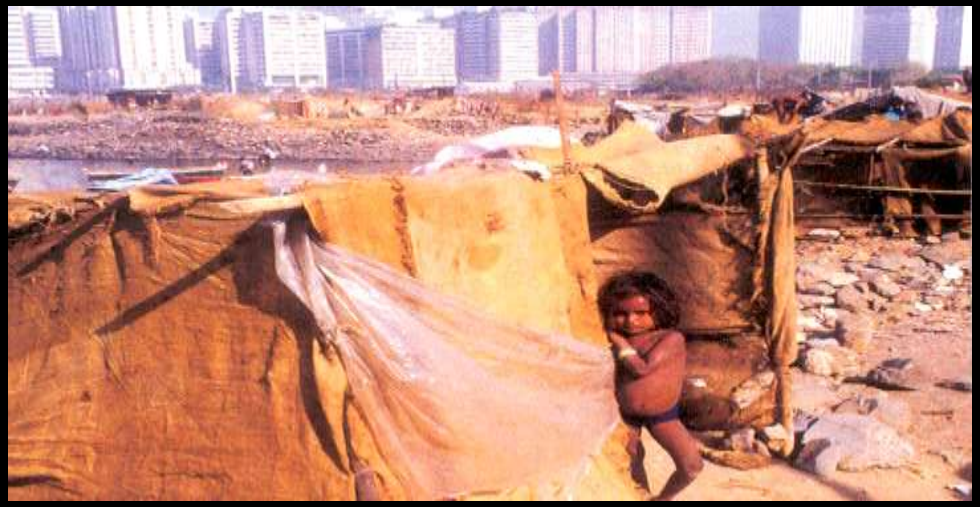
The Lack of Public Health Infrastructure in Developing Countries: Urbanization and New Zoonoses



Strengthening International Capacity for Surveillance of Infectious and Parasitic Diseases

- faster detection and ID of EIDs
- ecoshifts in host spectrum
- vector-borne diseases and emergence of novel vectors
- zoonotic diseases carried by food animals
- sentinel surveillance for food- and water borne diseases
- emergence of Rx resistance

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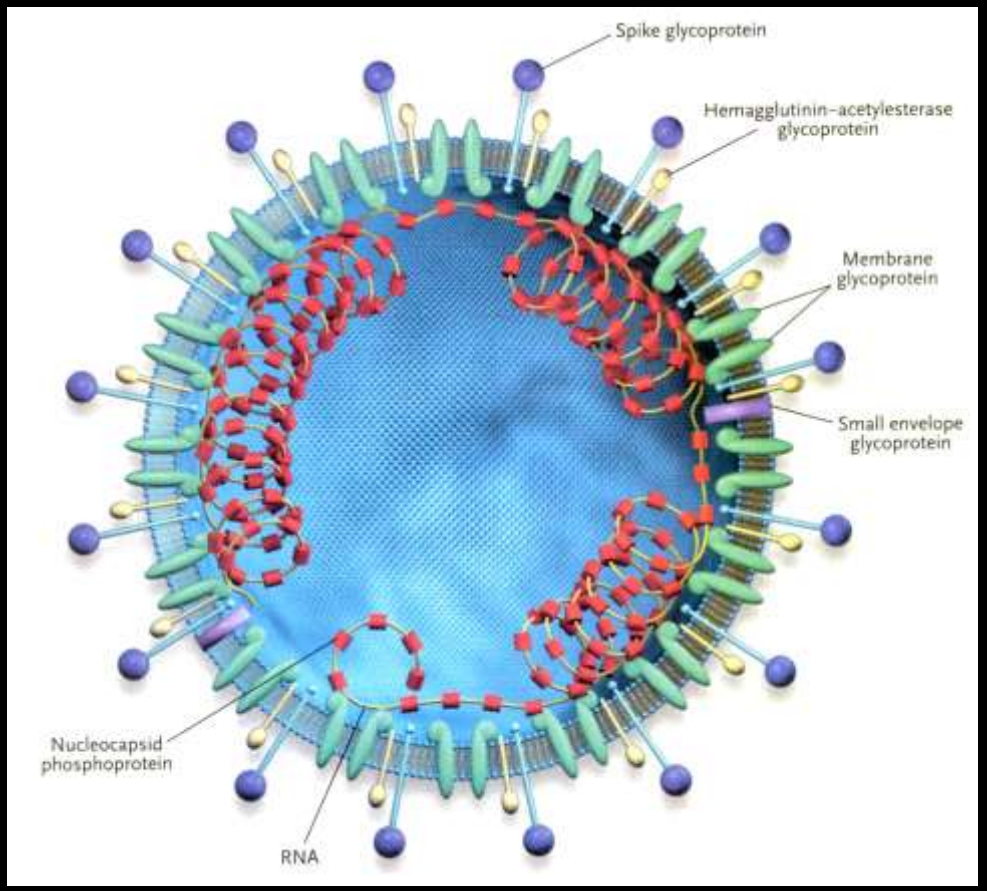
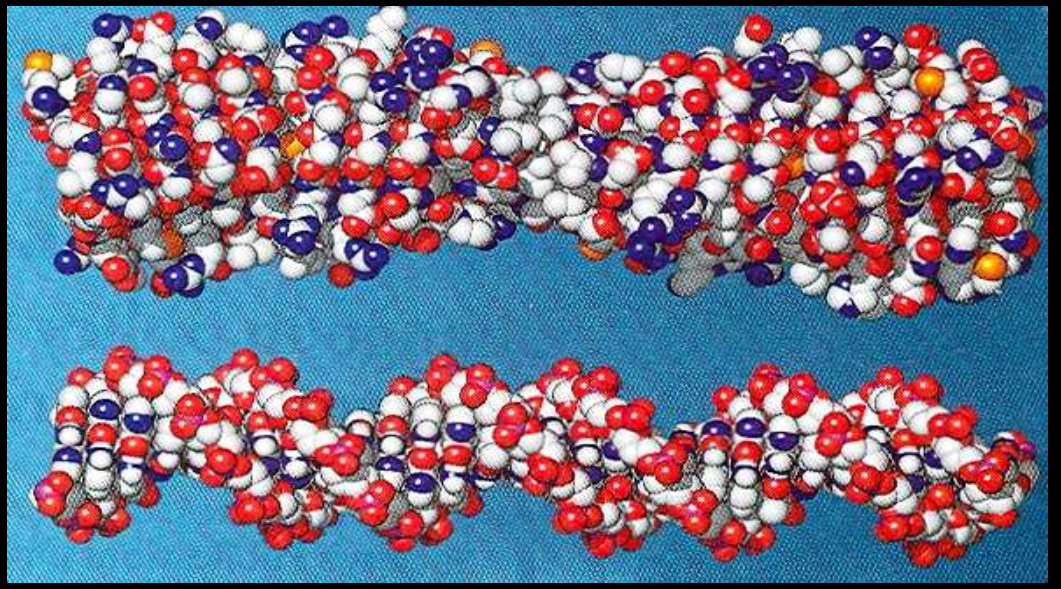
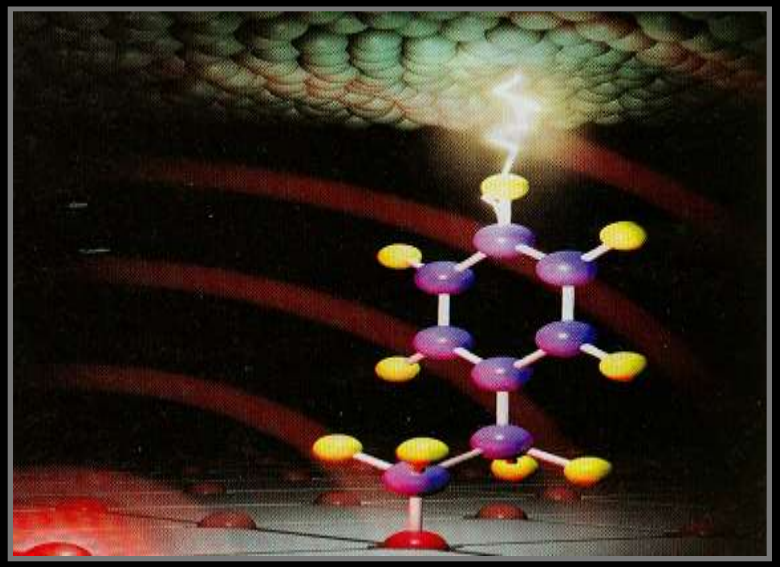
Combating Threat-X

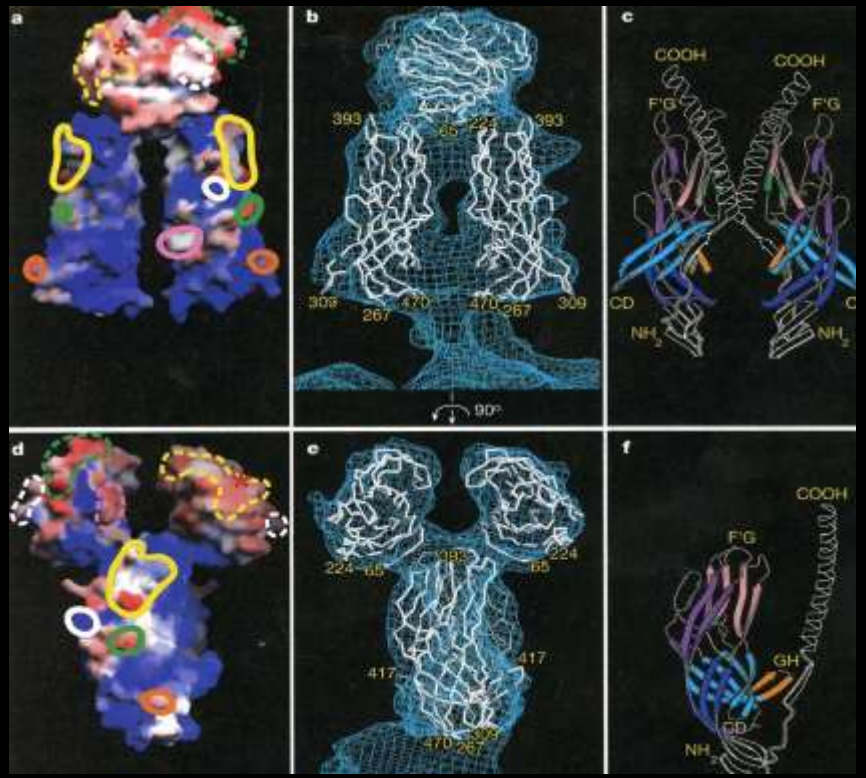




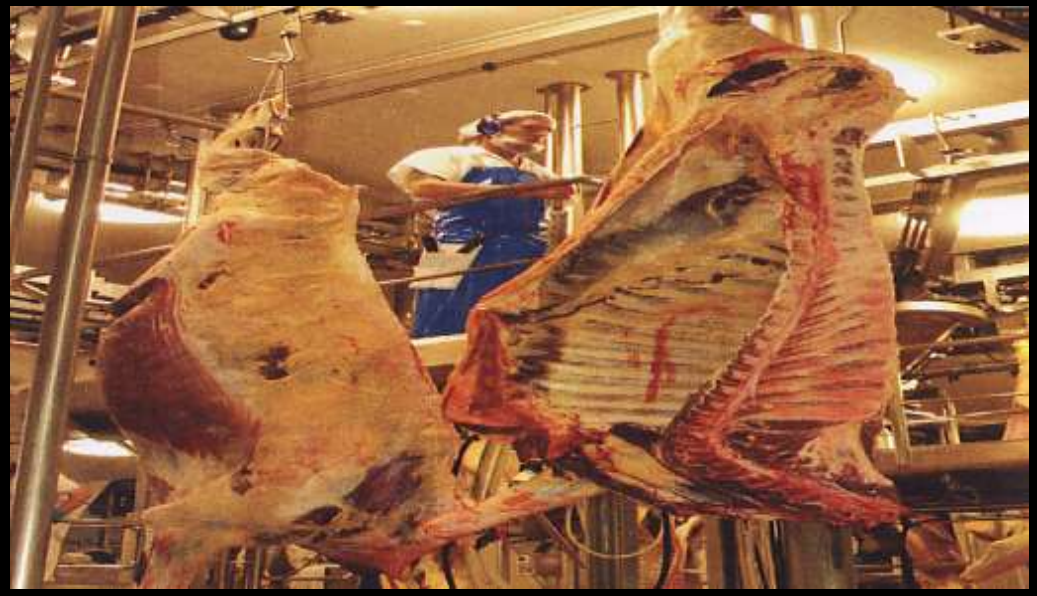


Accelerated Manufacture of Biologics

Protein Therapeutics, Vaccines and Immune Modifiers



Molecular Diagnostics and Protection of the Food Supply



Be More Than You Can Be:
Human Peak Performance Optimization

Human Performance Optimization and Military Missions

May 2005

Human Performance Optimization
Final Report

Written by:
Dr. Adam Russell
Bartlett Bulkley
Christine Grafton

Completed for:
Director, Office of Net Assessment

SAIC Project No. 01-1536-04-2520
Contract No. GS-10F-0297K

Human Performance Optimization and Military Missions

October 2004

Human Performance Enhancement
Cultural Models
A Collection of Four Country Reports

Written by:
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Bioengineering and Enhanced Warfighter Performance

- enhanced physiological traits
- cognitive superiority
- soldier self-care and mitigation of acute injury
- regenerative and rehabilitation medicine
- brain: device coupling

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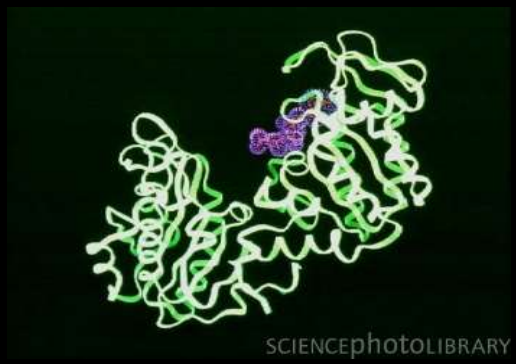
Enhancing Extreme Performance

Novel Materials

"Hassle-free" Sensors

Optimizing Physiological Performance

Total System Monitoring

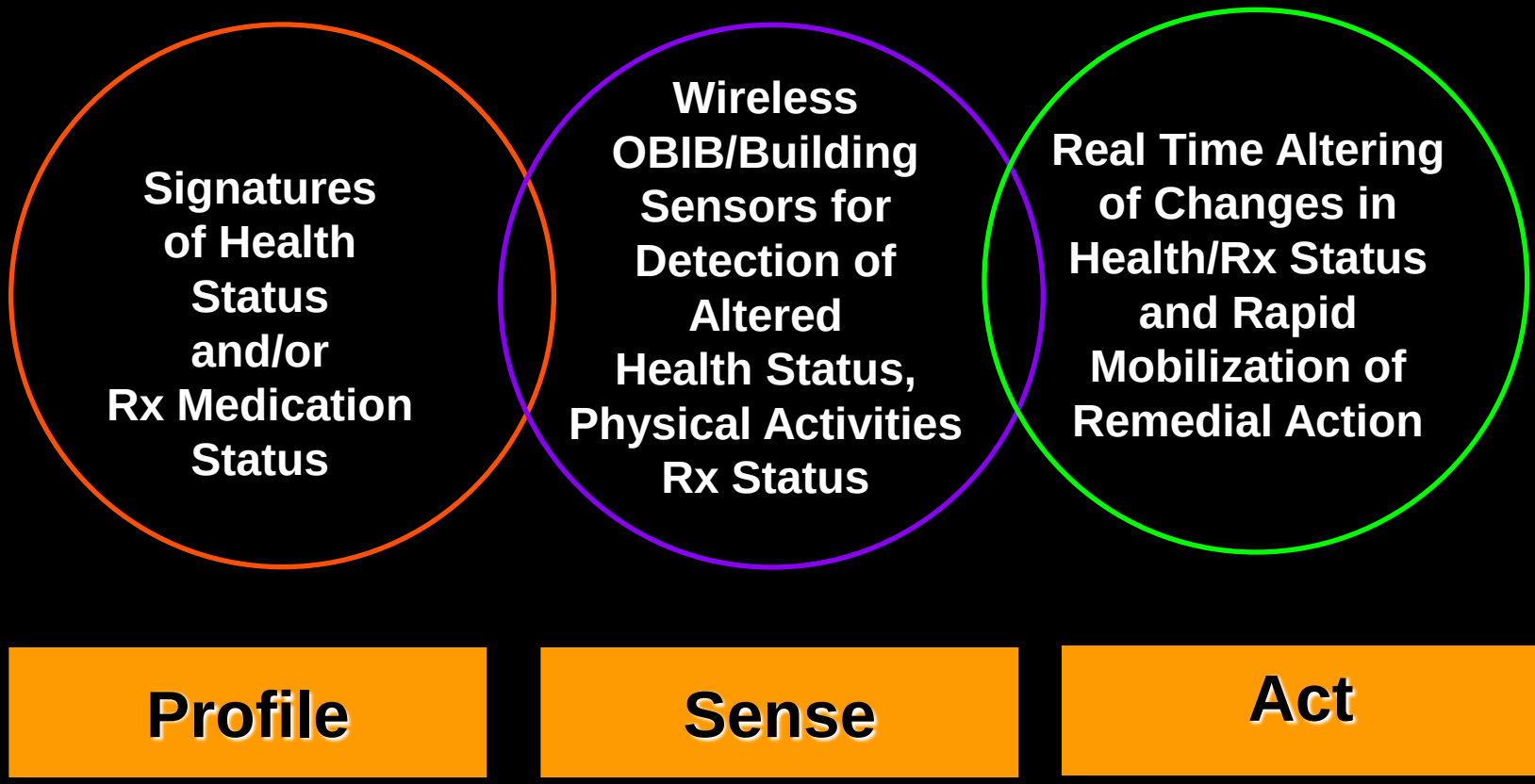


Bioenergetics

Full Spectrum Performance

Novel Integration of performance enhancing tools

Remote Monitoring of Health Status and Treatment Compliance with On Body: In Body (OBIB) and/or Environmental Sensors



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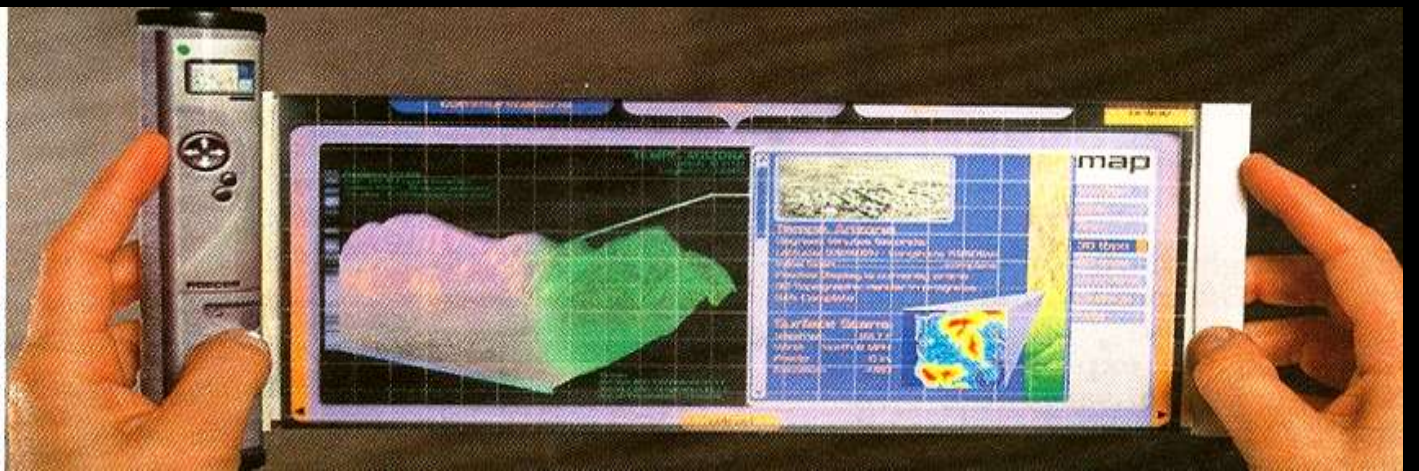
Peak Soldier Performance In Theater and Other Austere Environments

- strength, endurance and mental acuity
- optimize metabolic performance via improved energy substrate mobilization/metabolic waste stream management
- biomarkers for fatigue, stress, fear and presymptomatic infection
  - OBIB sensors to identify ‘at risk’ personnel
- “learning from nature”
  - systems biology of extreme physical performance
  - acute fight/flight responses
  - long range animal migration

Sustaining Cognition During Extended Periods of Sleep Deprivation and the Fog of War

Pallbearers carry the casket of a Canadian soldier who was mistakenly bombed by American pilots in Afghanistan (gun camera views of the incident are below). The pilots' attorneys subsequently alleged that the fliers had been taking the "go pill" to stay alert and that this was common military practice.

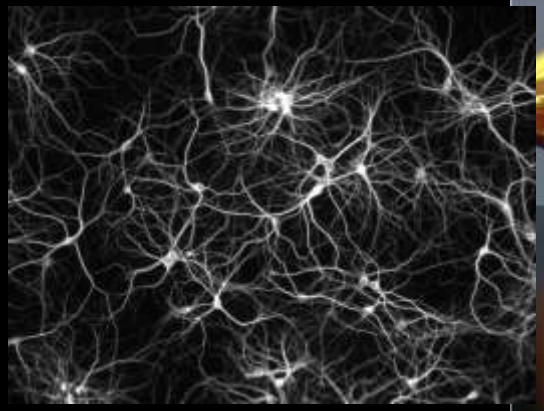
Novel Materials for Warfighter Protection and Performance Enhancement

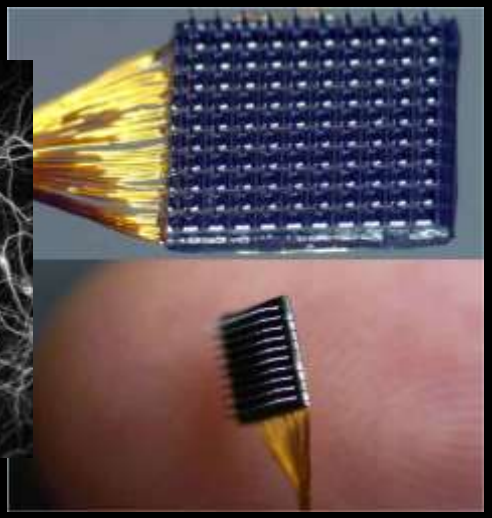


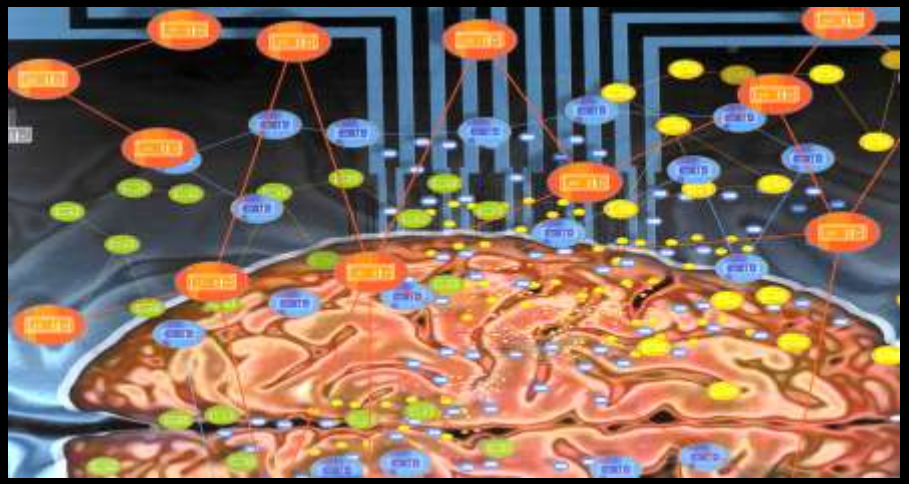
Novel Materials for Warfighter Protection and Performance Enhancement

- novel nano- and meso-composites
- ultra-strong, light weight energy-absorbing materials to limit ballistic/blast injury
- sustain physiological homeostasis in austere environments
- diverse sensor modalities for rapid detection of chem-bio agents
- medical management capabilities
- tag signatures for blue force location and coordination in MOUT

Intelligent Adaptive Neural Systems and Devices for Circumventing Disability

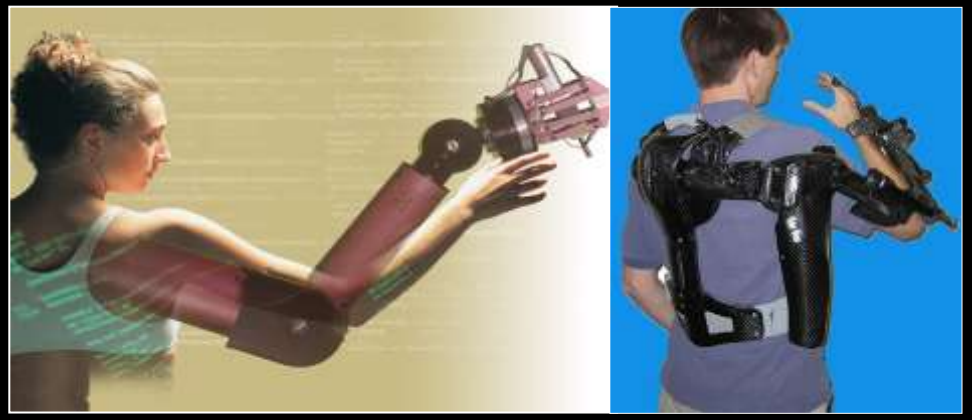






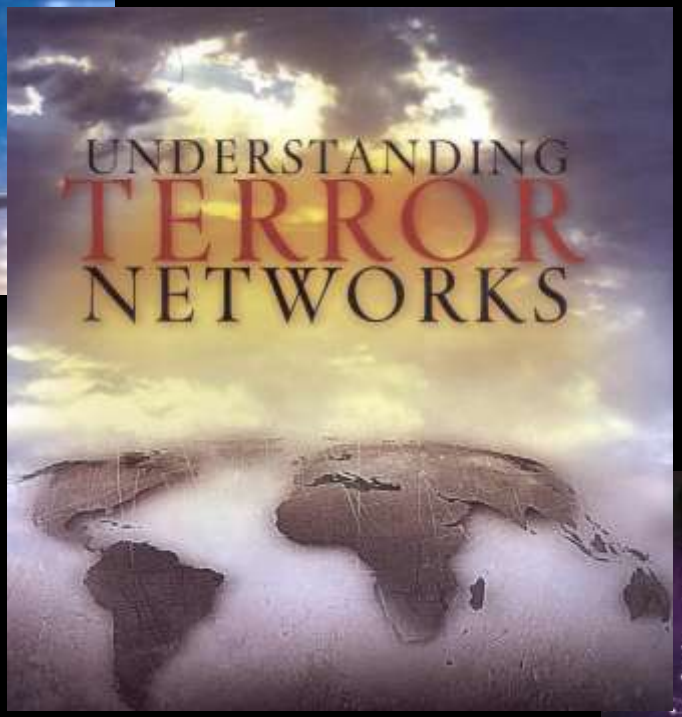
Neural Signatures of Motor and Cognitive Functions

Neuro-Controlled Robotics

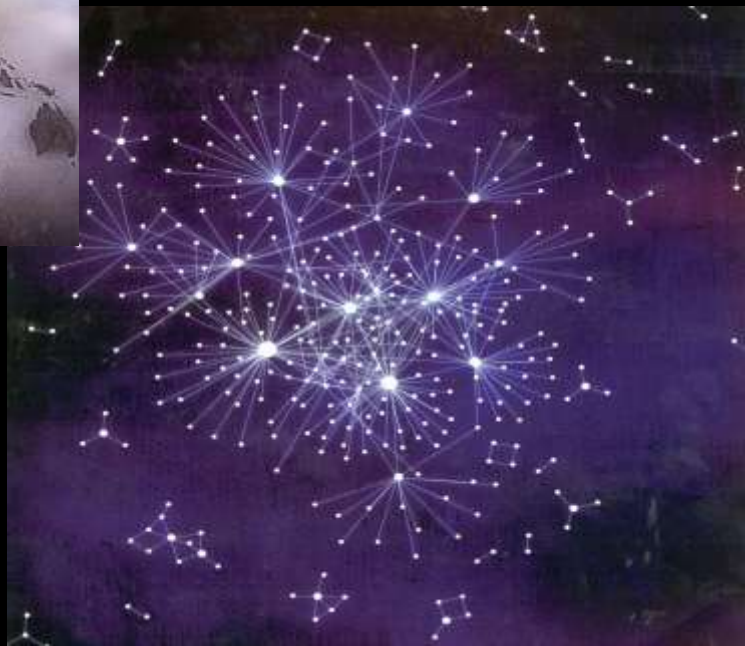


Intelligent Prosthetics

The TTL Challenge



- Tag
- Track
- Locate



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Its all about signatures…

Who's been using explosives?

Who's sick with a contagious disease?

Who's lying?

Who's been inoculated against an agent?

Is this someone I'm looking for?

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…and the systems required to collect them

Contact

Close-in

Proximate

Space

Terrestrial

Airborne

Novel Tags

Invasive

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Tagging, Tracking and Locating (TTL): New Platforms for National Security Needs in Surveillance and Interdiction

- TTL
  - stand-off detection of adversaries
  - detect interactions between tagged individuals
  - tracking of material and supply chains
  - forensic analysis and attribution
- complex ethical and legal frameworks
  - covert tagging
  - covert surveillance/screening of large bystander populations
  - remote activation of tags with injurious intent

Principal Technology Platforms for TTL

Biometrics	Tags	Object Recognition
• fingerprint/palm print	• RFID	• visual
• hand geometry	• “smart dust”	• acoustic
• face, voice, odor, gait recognition	• biochromophores	• infrared
• DNA profile	• nano-tags	• radio-frequency
• novel molecular markers	• retro-reflectors	• multi-spectral
• commensal microflora and immune history	• chemical	• nuclear, chemical, biological “signatures”

Natural Signatures Research

- what signatures (or combinations of signatures) are individually unique?
  - can they be read at distance?
  - can they be amplified or modulated?
  - can novel signatures be induced?

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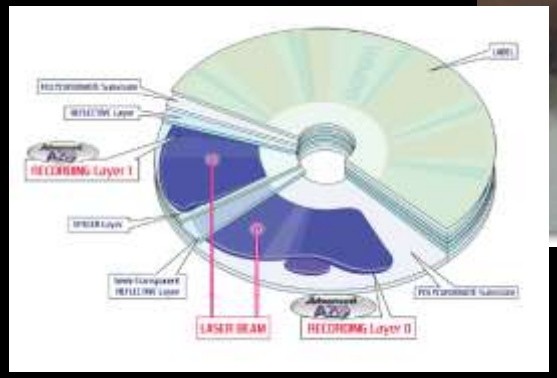
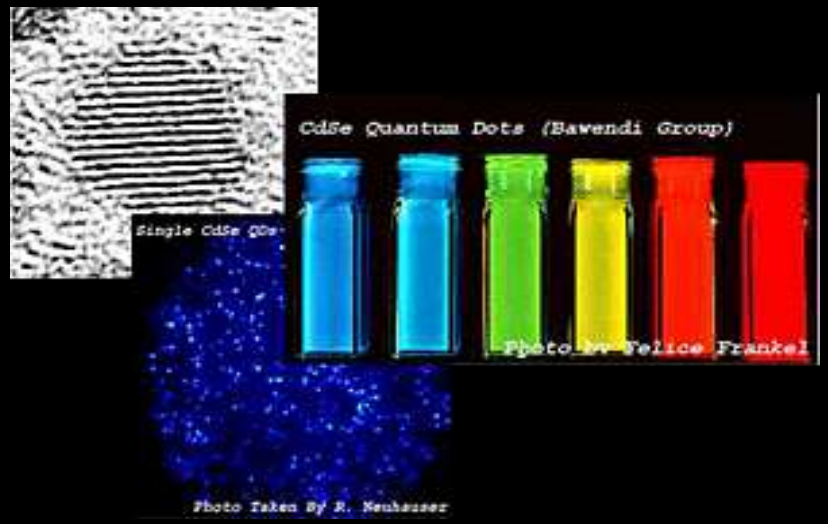
Untraditional Tags and Sensors

ASU Proprietary



Signal Transmitting DVD



New Families of Quantum Dots

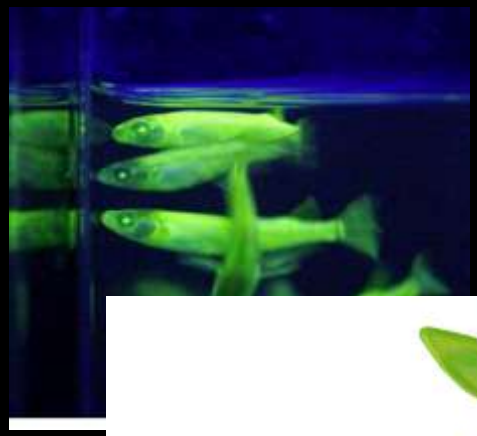
Embedded Sensors and Detectors

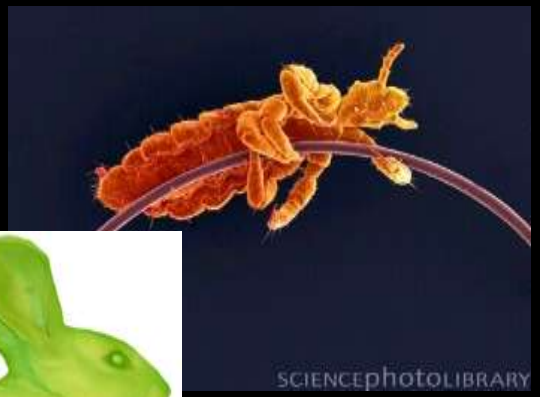
ASU Proprietary

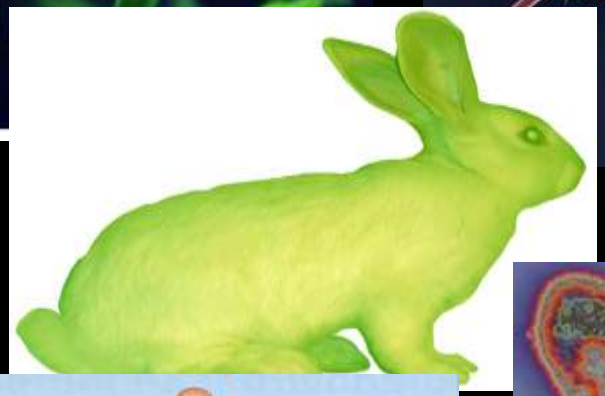
TTL: No Man (or Beast) Walks Alone

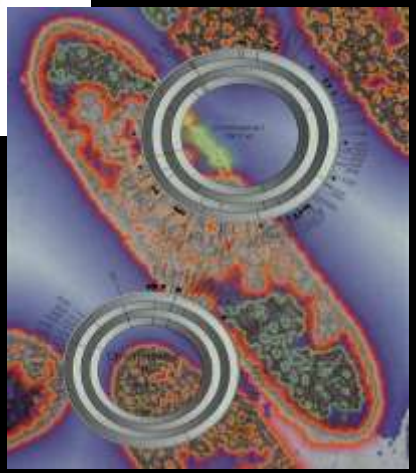
- every adult human carries two pounds of bacteria
  - 100 trillion non-human cells
- microorganisms as key substrates for therapeutic/diagnostic interventions
  - in-body sensors
  - regulated production of biomediators
  - gene-centered implants, copies, upgrades
- genetics will be scaleable and upgradeable
- plug and play genetics : the “undo” button

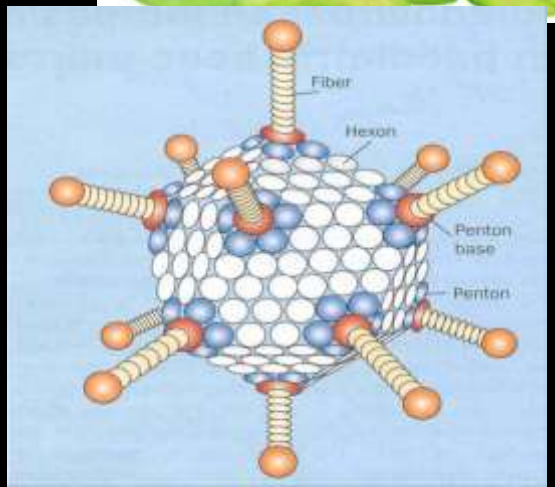
Commensal Microorganisms, Viruses and Parasites as Sensors and Taggants











- engineered tag insertion into carrier organism
  - constitutive or induced expression of tag
  - activatable tags
- standoff detection range unknown
  - magnetic, metallic, spectral tags
- induction of biomarkers by exposure as evidence of presence in red location

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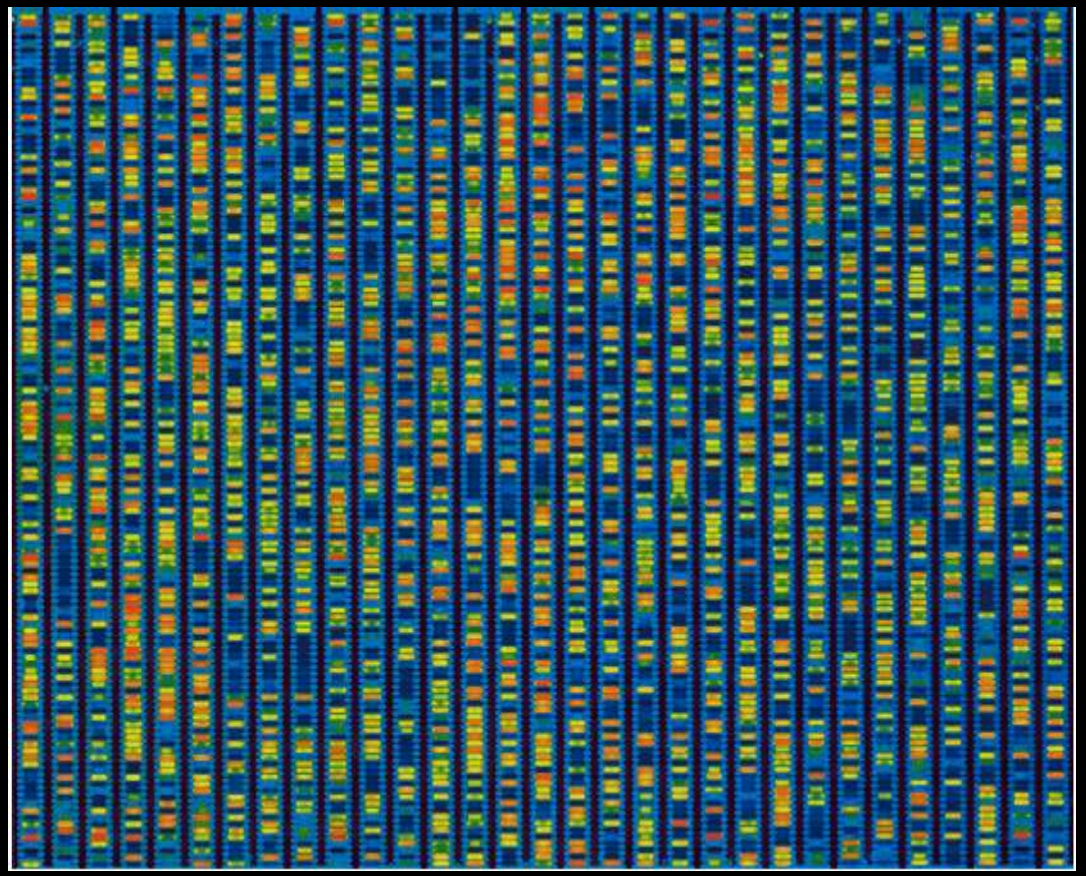
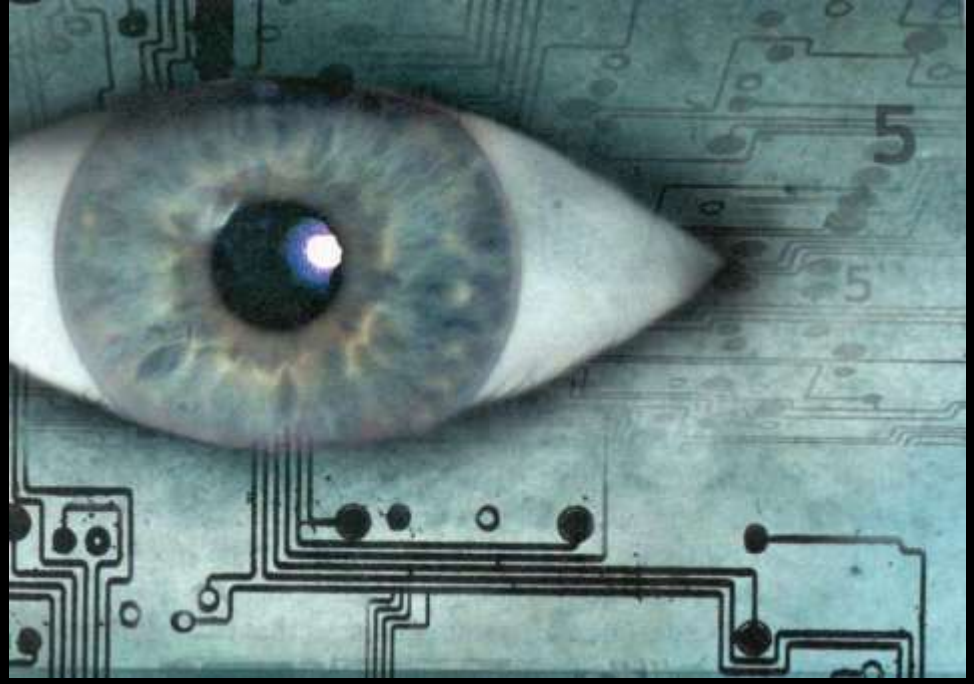
Securing a Safer World:
Immunosignatures as a Profiling Tool for Forensic Analysis

- immune responses to ‘local microflora’/seeded taggants as exposure signatures



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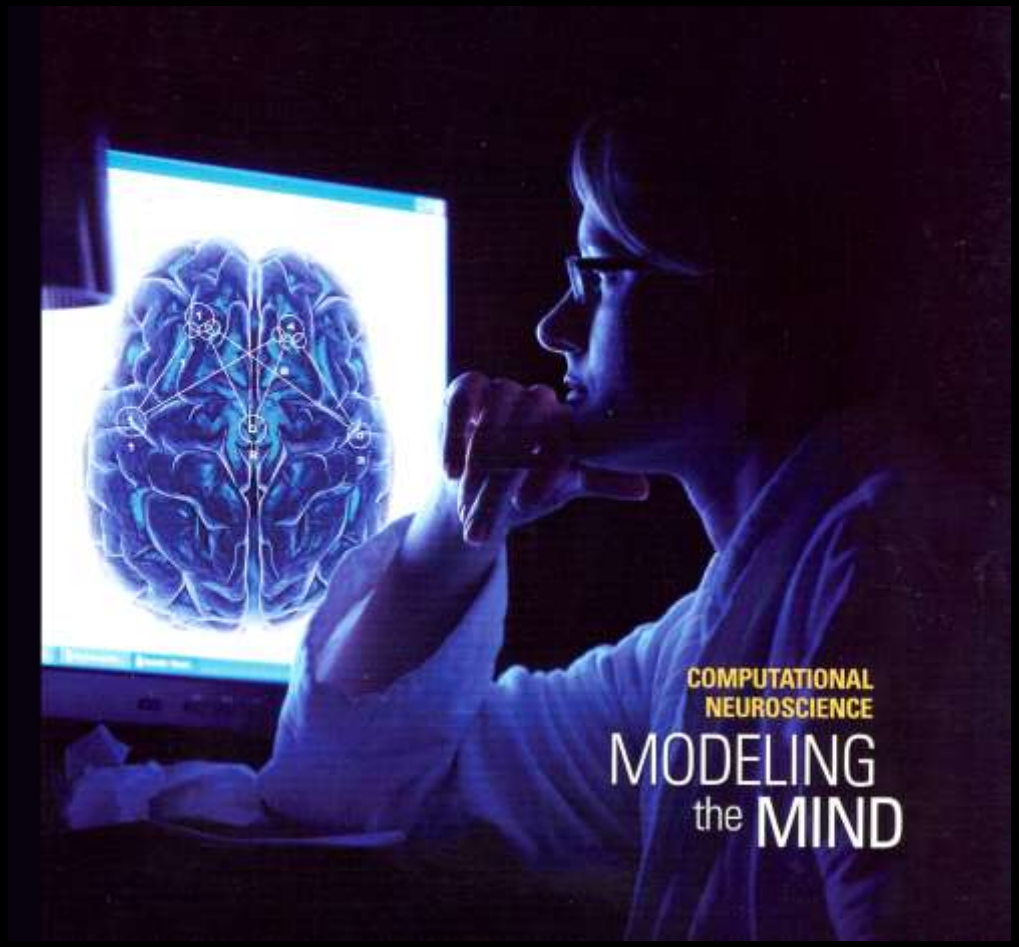
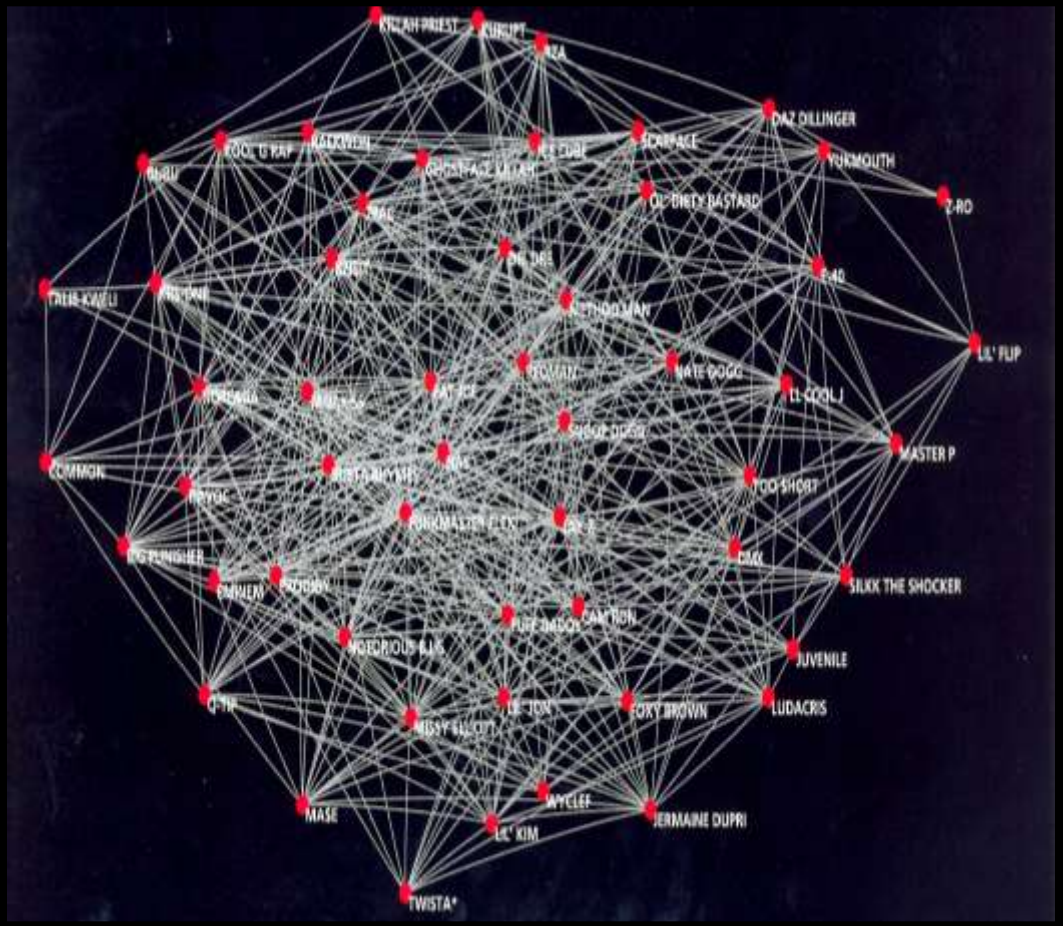
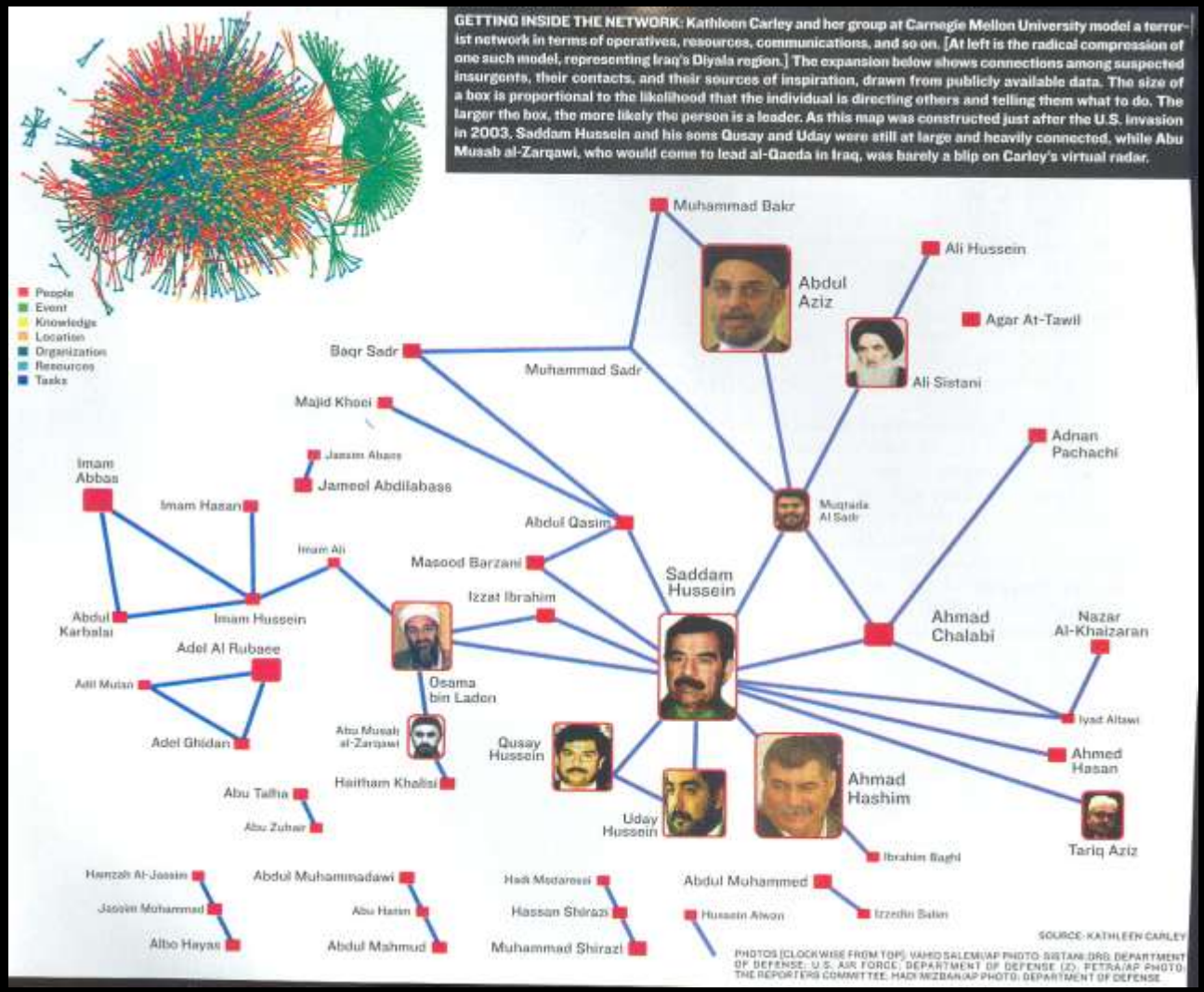
WITH LIBERTY
AND SURVEILLANCE
FOR ALL

Social Network Analysis and Predictive Behavioral Modeling





Network Analysis



IEEE Spectrum Sept. 2006 p32

Herd Behavior: 1.3 Million Bathers, Coney Island 1951

The changing nature of social interaction

The new “virtual” community

"No company today, no matter how large or how global, can innovate fast enough or big enough by itself. . . . *Wikinomics* reveals the next historic step—the art and science of mass collaboration where companies open up to the world. It is an important book."—A. G. Lafley, CEO, Procter & Gamble

WIKINOMICS

How Mass Collaboration Changes Everything

Don Tapscott
Bestselling Author of *The Digital Economy*
and Anthony D. Williams

Radical Islam:
The America I Have Seen by Sayyid Qutb (1951)

“Humanity makes the gravest of errors if it makes America its example”

Comprehending Terrorist Behavior

“A Jihadist terrorist
has a preferred state of the world.
He’s got standards
Its not game theory
Its people’s values”

Gary Ackerman
Director,
Center for Terrorism and Intelligence Studies
IEEE Spectrum Sept. 2006, p 26.

The Four R’s of Terrorism

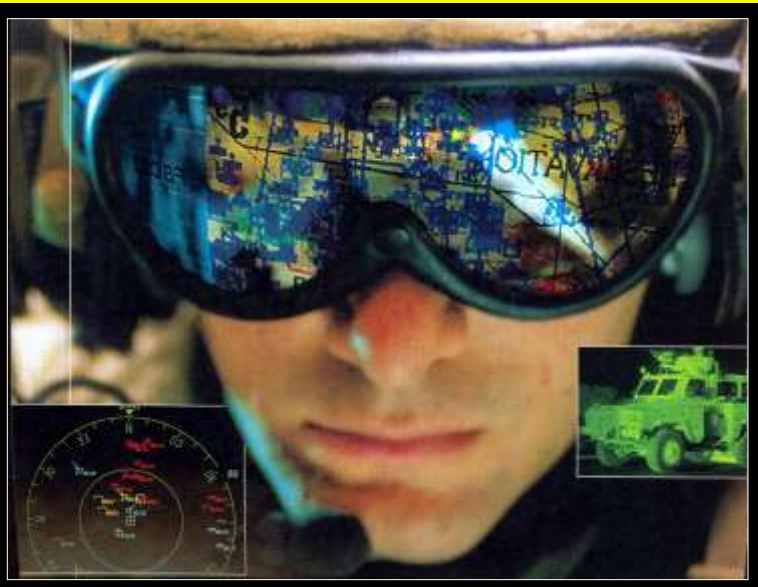
- righteousness
- revenge
- renown
- reaction

Enduring Vulnerabilities

- the war for the mind is constant
  - "perspective shaping" dominates the information sphere
    - fuels "quick fix" approaches
    - fuels spin control at the expense of sophisticated understanding
    - drives "say it first" at the expense of "get it right"
    - the real bad news… it influences scientific endeavors

“Tracking Expertise”

Ubiquitous, Embedded
Sensor Swarms and Networks
New Challenges in Information Architectures



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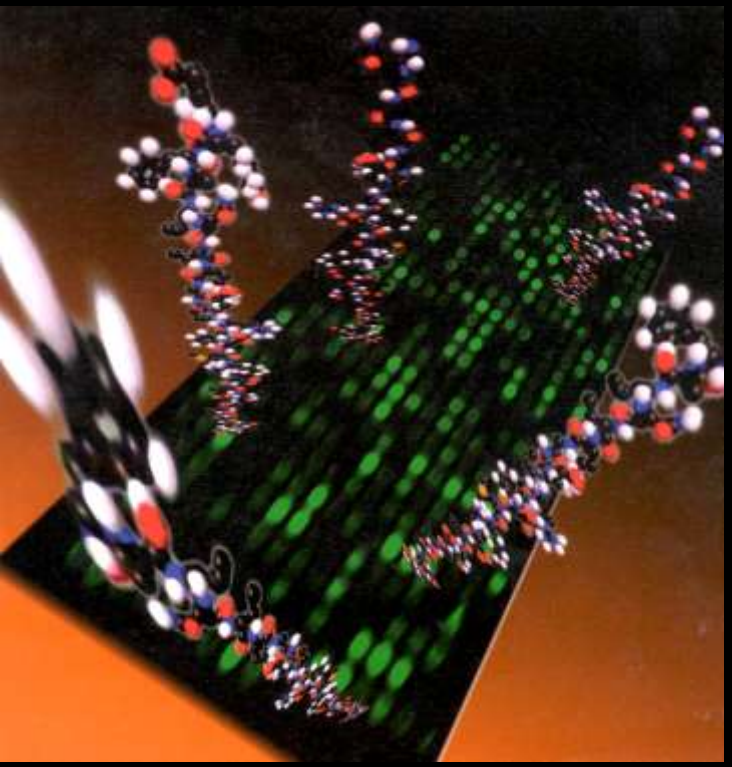
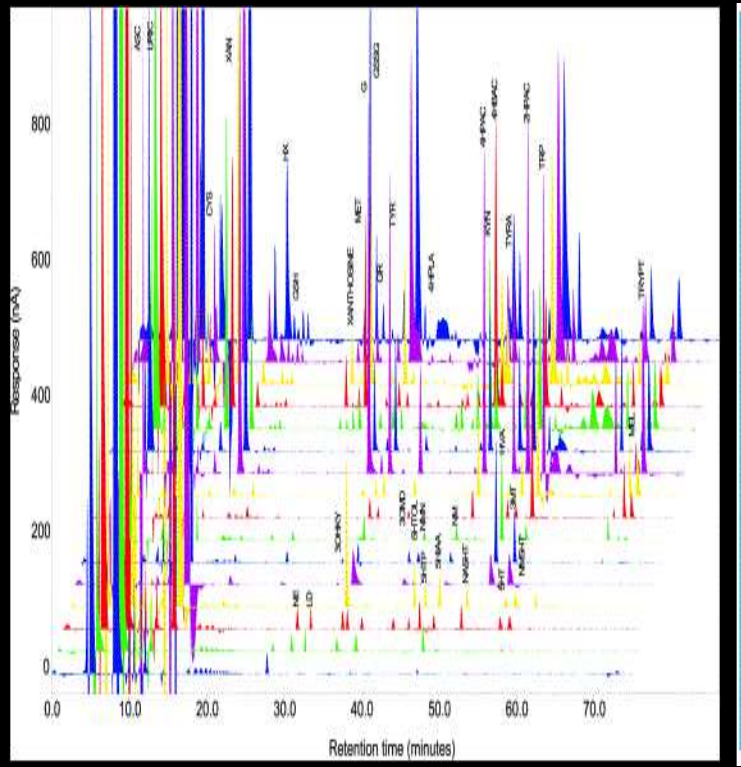
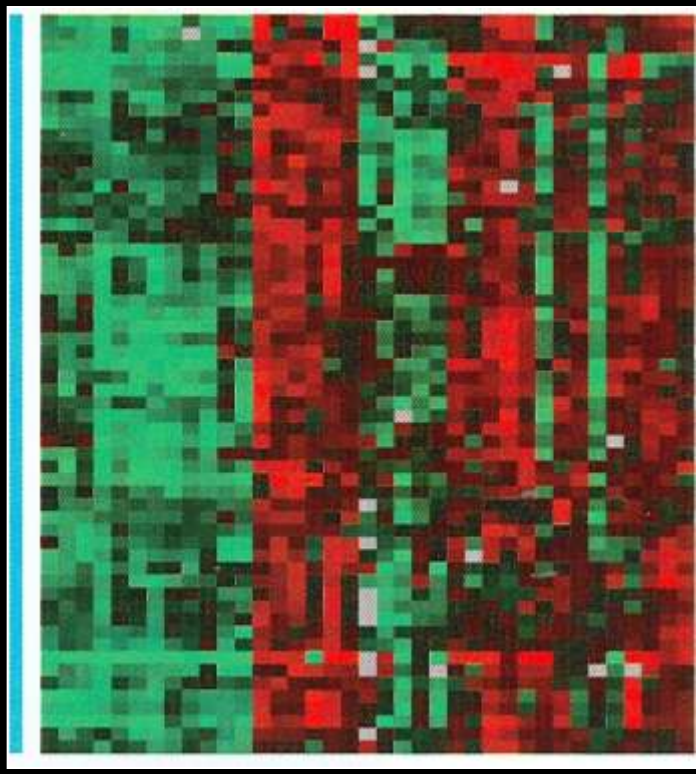
Analysis of Complex, Multiplex Signals







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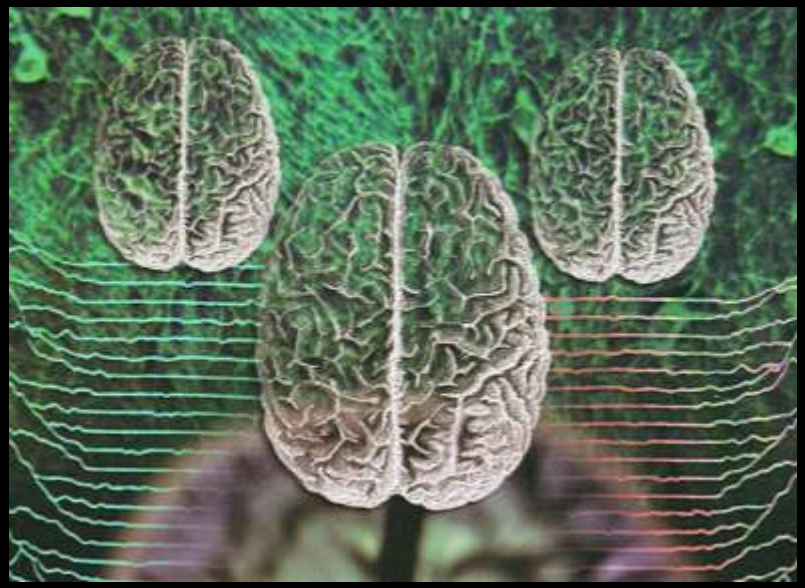
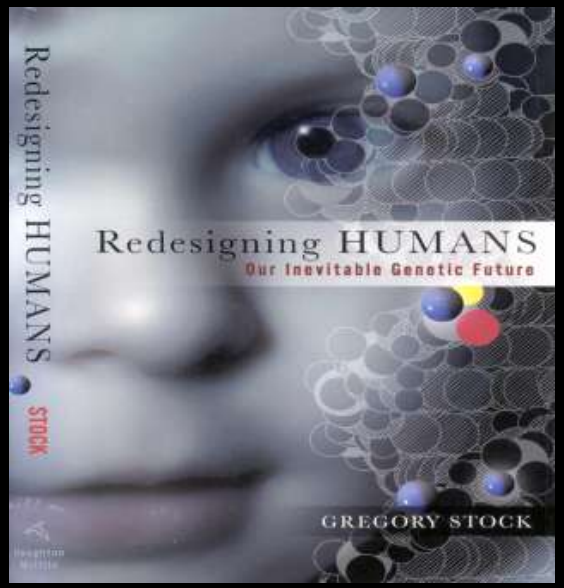
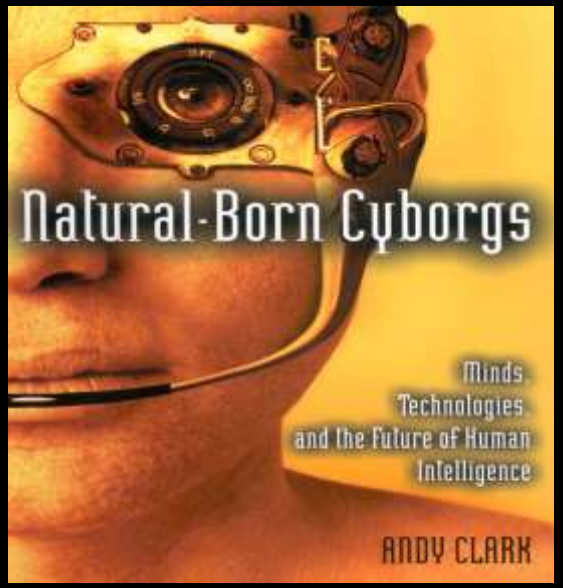
The Accelerating Union of Neurobiology with Advances In Engineering and Computing

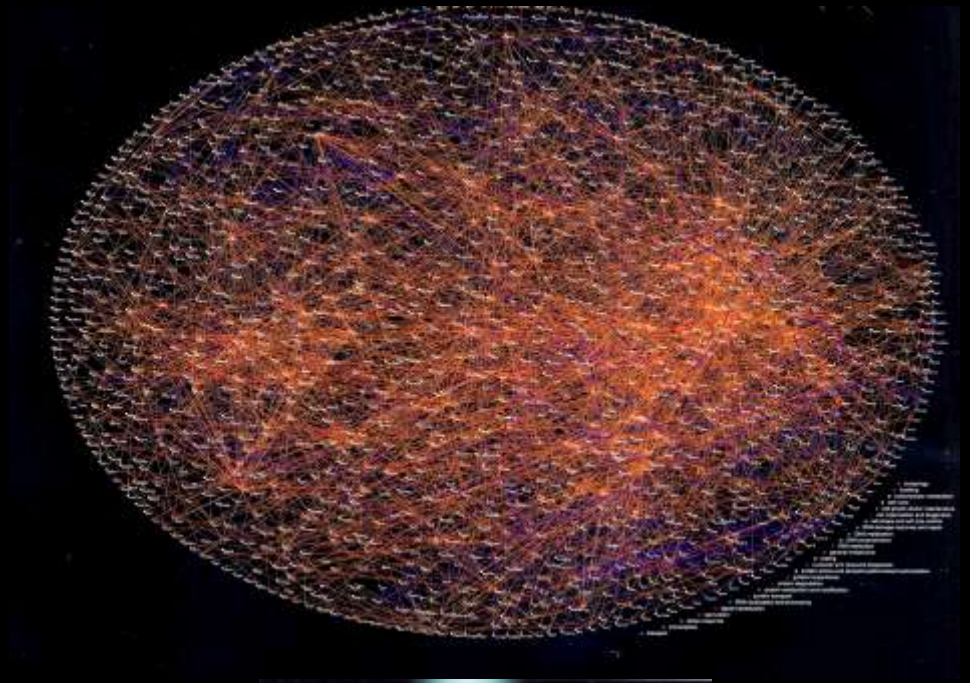


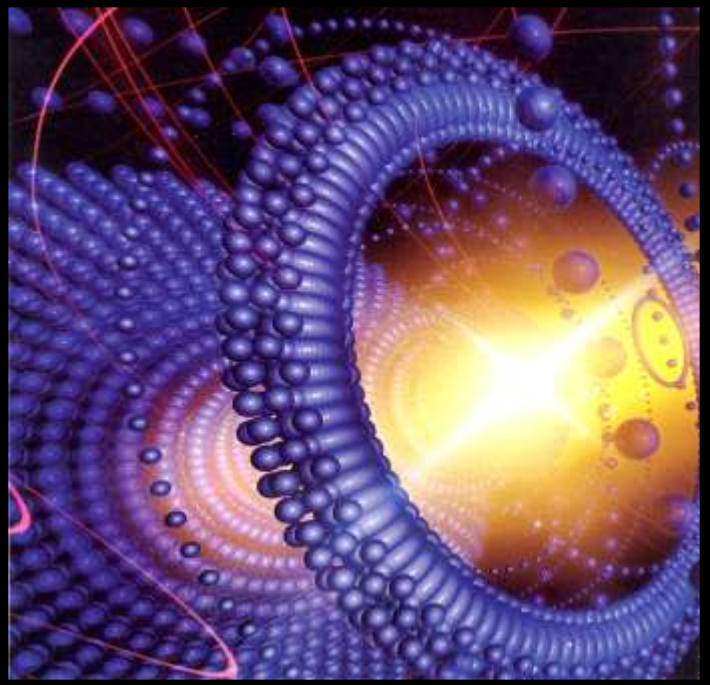


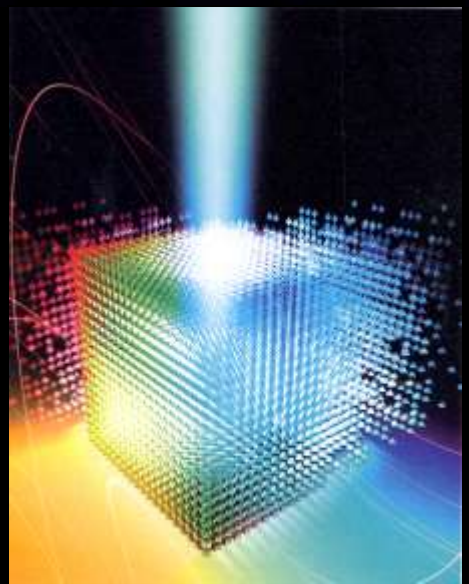


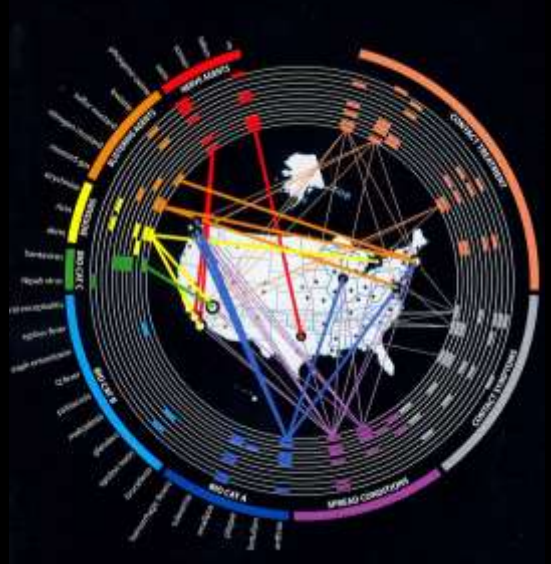
- "Brains on Target": Bio-Info-Cognitive (BIC) technologies
- "Borg Drift": On-Body/In-Body (OBIB) devices and brain: computer interface technologies

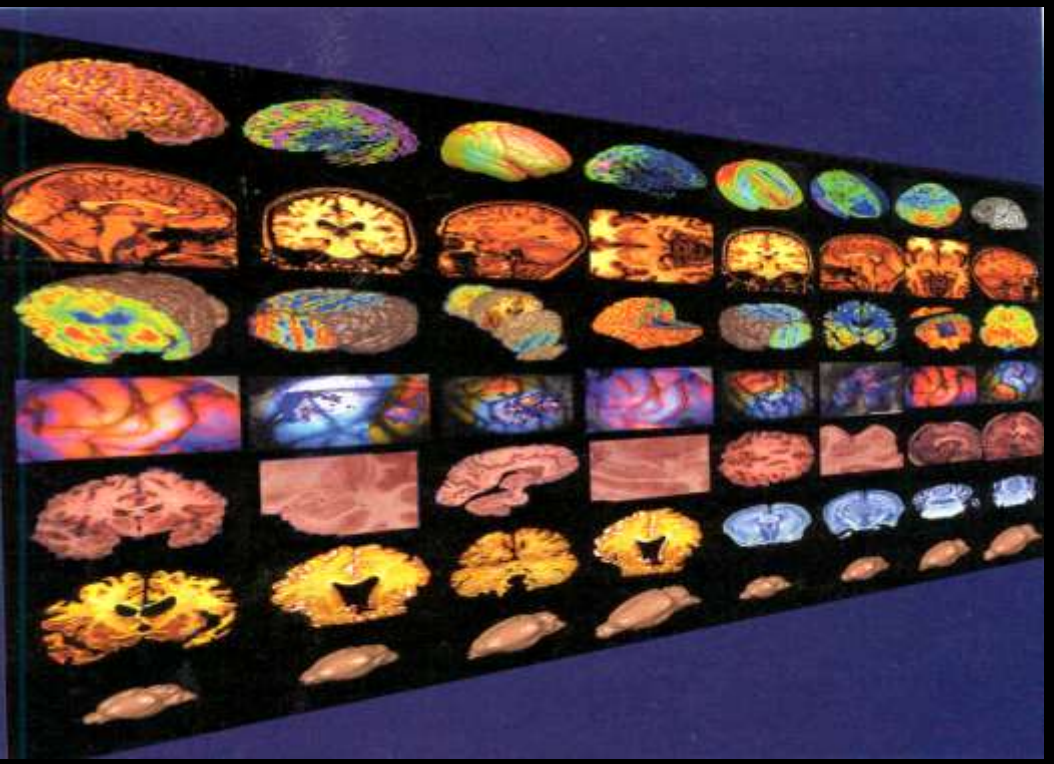
Managing the Data Deluge:
Data Standards, Ontologies and Data Visualization

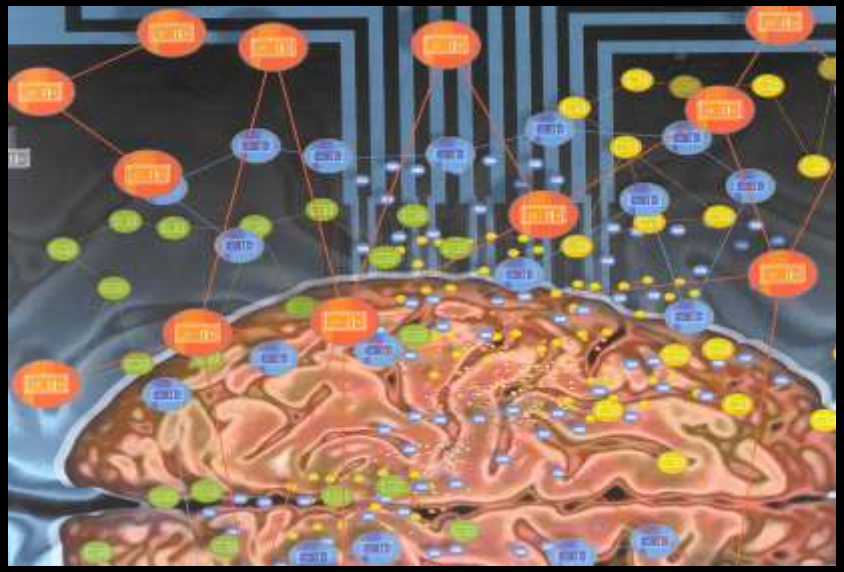




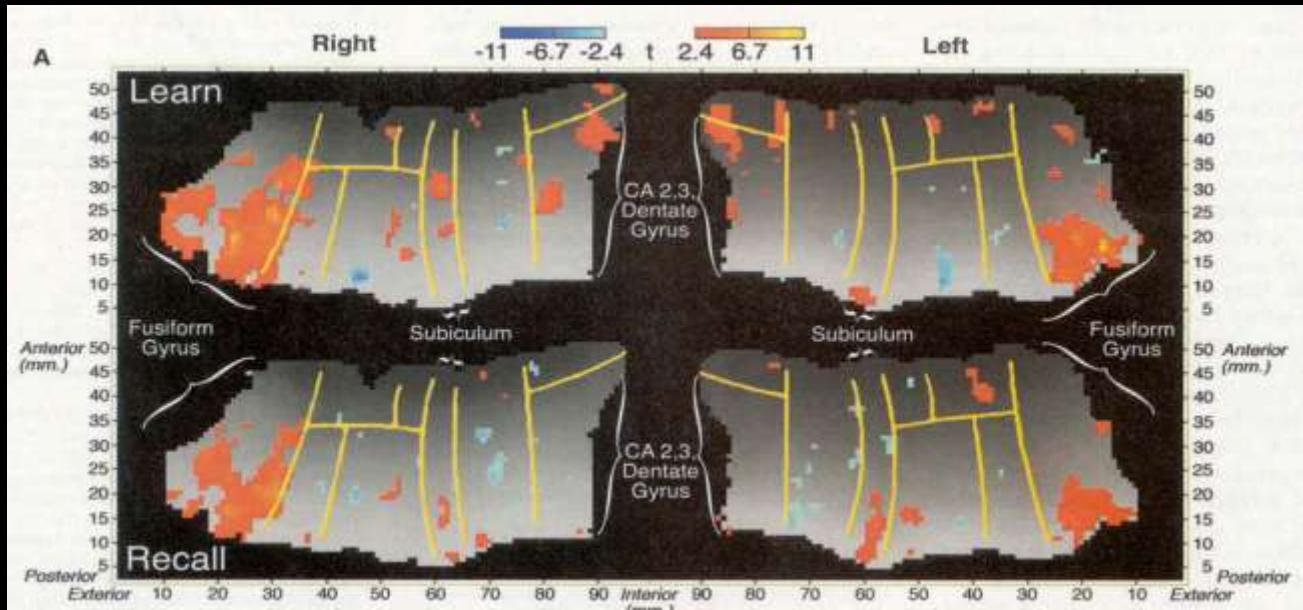








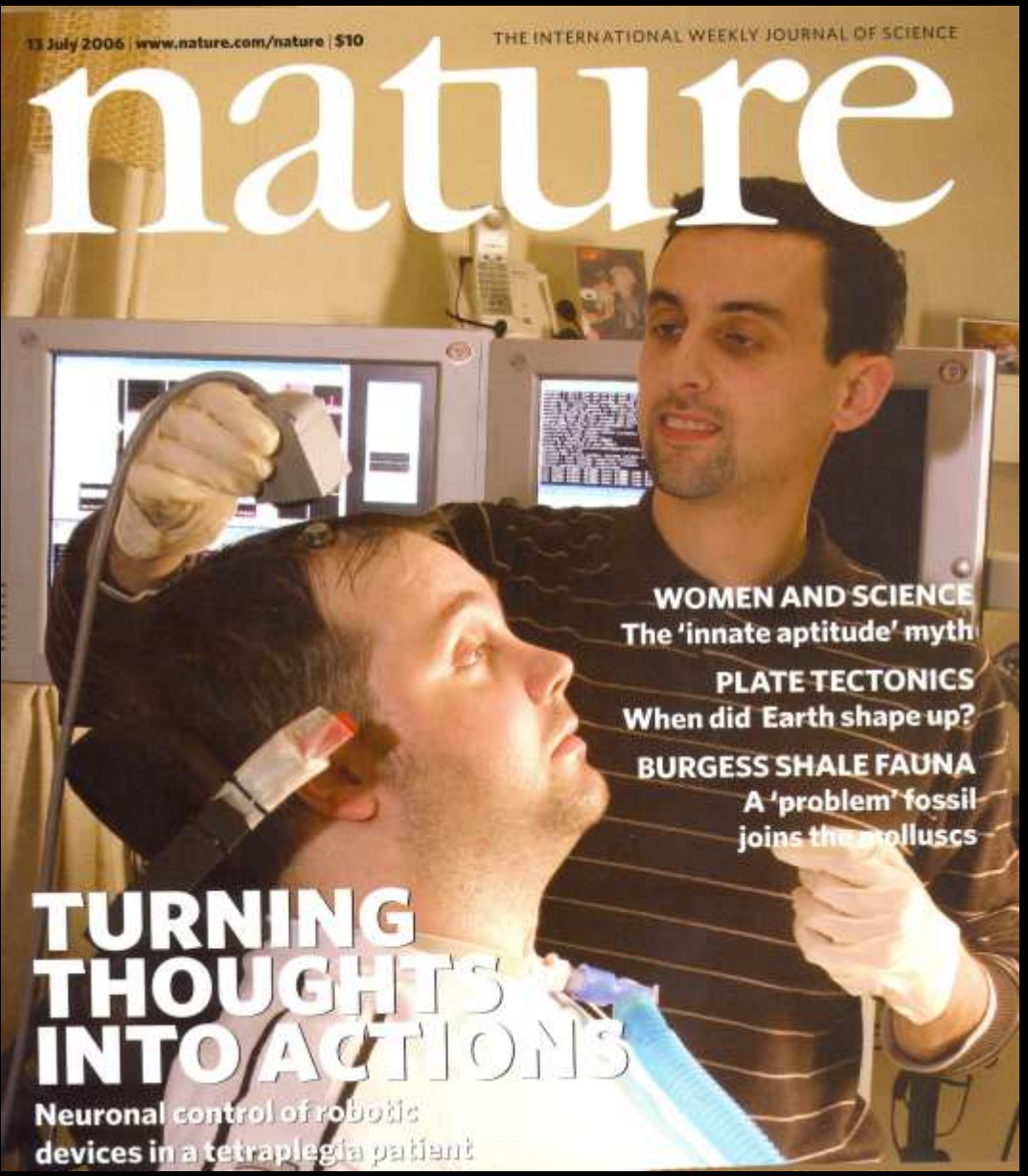
High Resolution MRI Imaging and Computational 'Unfolding' of the Hippocampus Medial Temporal Lobe During Encoding and Retrieval of Face-Name Pairs

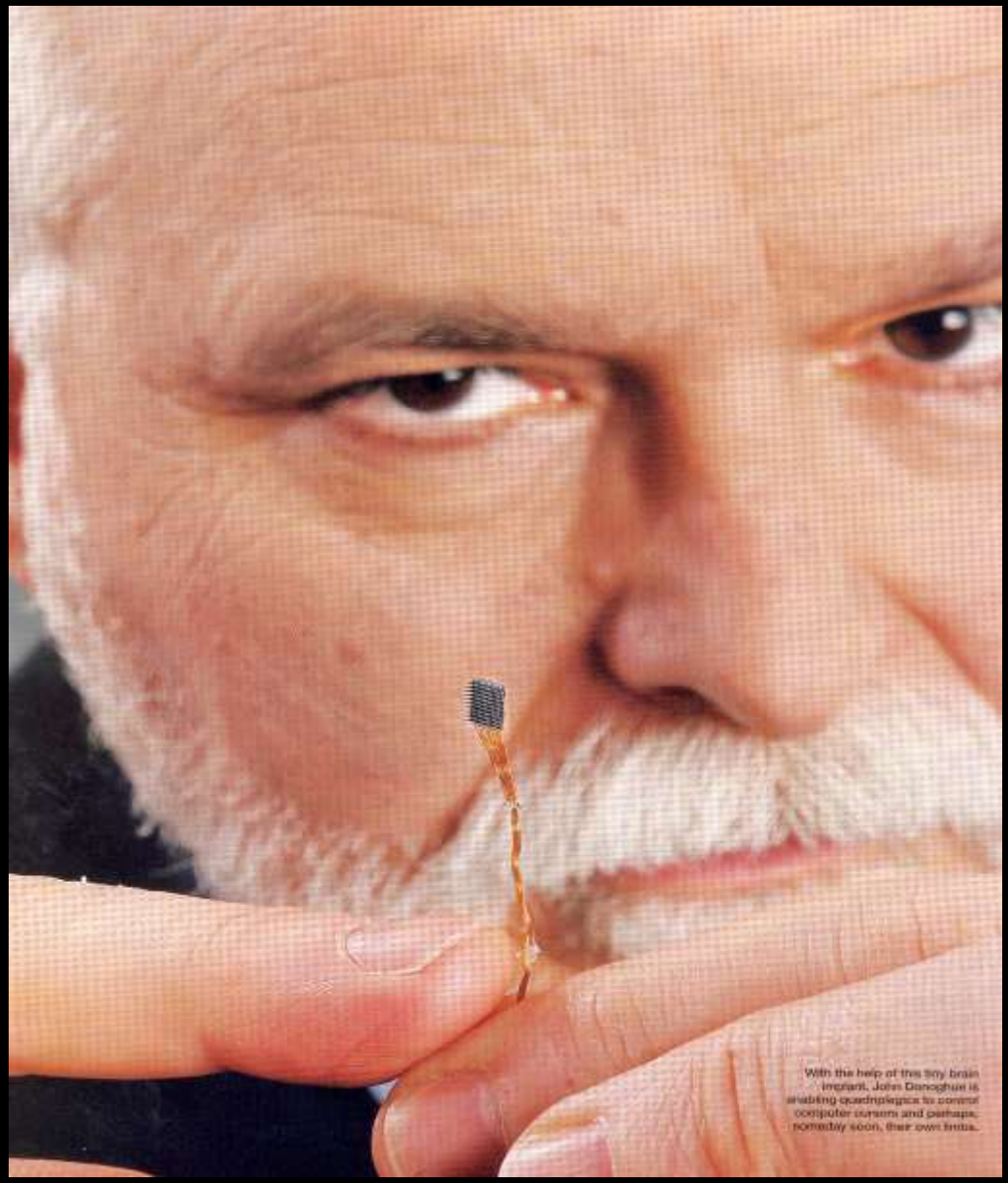


Defining the Neurobiology of Cognition and Mental States

- high resolution mapping of neurocircuitry to establish stimulus-response frameworks
  - cellular imaging in situ
  - SQUID, teraherz and other spatio-temporal localization methods
- real world biometrics for state evaluation and optimization of stimulus – response coupling
  - computational attentive interface devices
  - on-body : in-body sensors
- inter-memetic linguistics and context perceptualization engineering for human-computer interfaces
  - education, workface productivity in virtual environments
  - medical diagnosis and treatment outcome monitoring
  - new warfighter skills

Matt Nagle: First Tetraplegia Patient in the BrainGate Clinical Trial



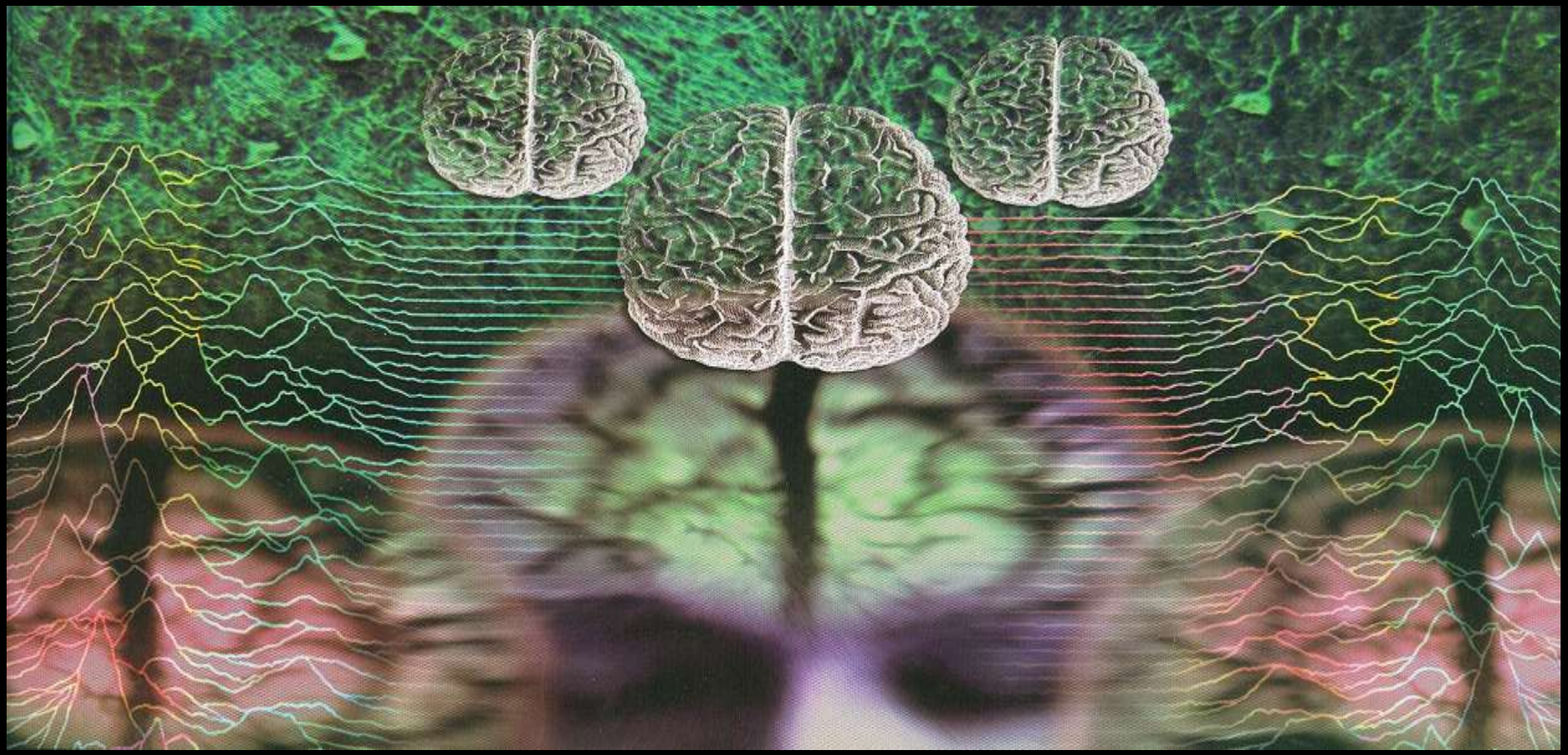


CyberKinetics and Brown University

Neural Control of Peripheral Devices

- ID of neural and force dynamic codes for complex motor/sensory activities
- non-invasive, real-time coupling of brain decision codes to control peripheral devices or systems
- novel materials for device design and responsiveness to neural code instructions
- brain-actuated control of remote devices

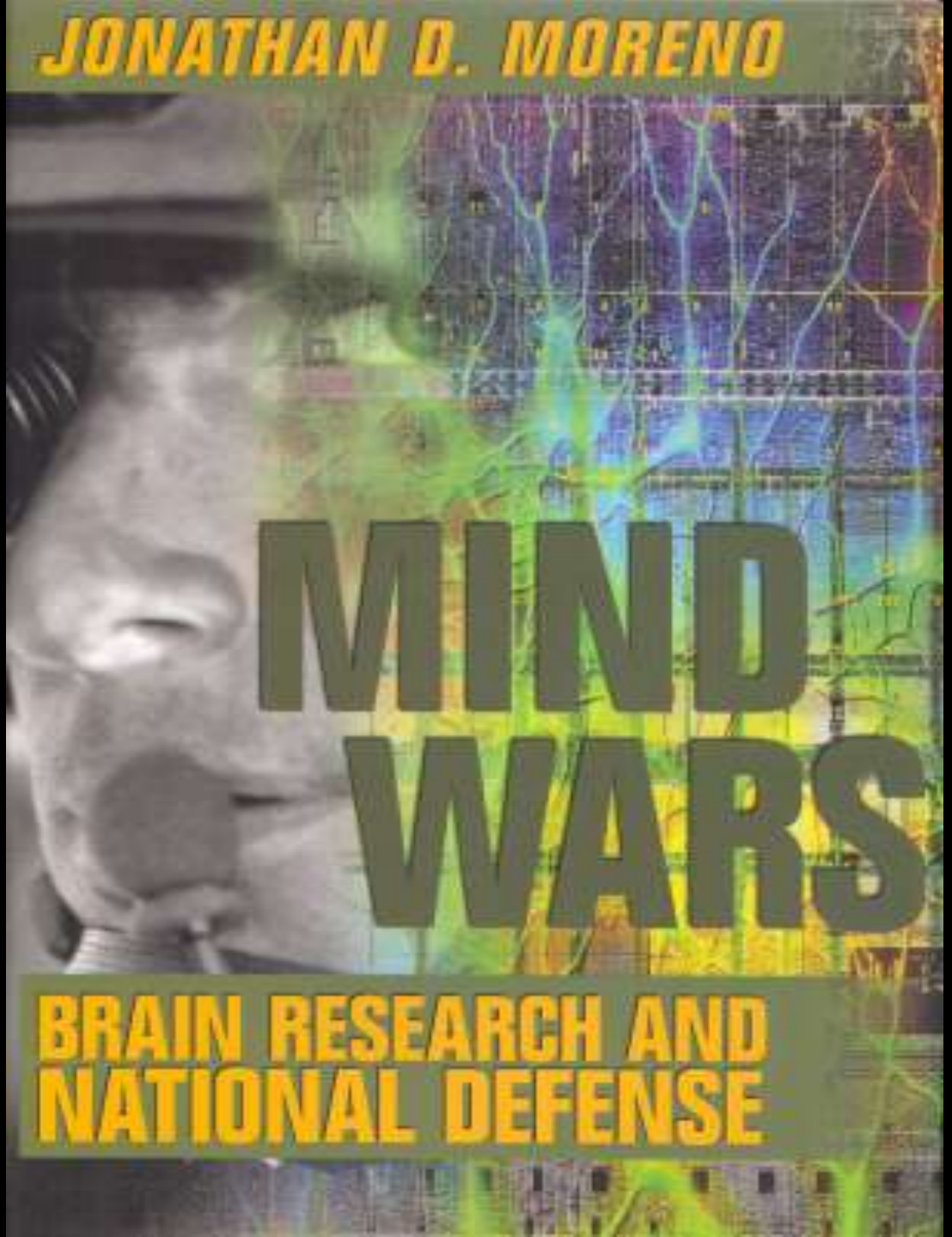
“COGINT”



The Neurobiology of Preference and Choice

- fMRI mapping of brain regions involved in cognitive behavior
  - analysis of short-versus long term-risk
  - reward
  - fear
  - deception

Psycho


JONATHAN D. MORENO
MIND WARS
BRAIN RESEARCH AND NATIONAL DEFENSE

Neuroenhancement

“Mental health is the ultimate competitive weapon.
Even if just a few people choose to use neuro-enhancements, their choice will change the basis of business competition for the rest of us”

Zack Lynch
Managing Director, NeuroInsights
AAS Symposium on Impact of Human Enhancement
www.aas.org/news/releases/2006/0609enhancement.shtml

Neuroenhancement

"Mental health is the ultimate competitive weapon.
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their choice will change the basis of business competition
for the rest of us"

and nations too . . . . . .?

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2006/0609enhancement.shtml

The New York Times Magazine
MARCH 11, 2007 / SECTION 6

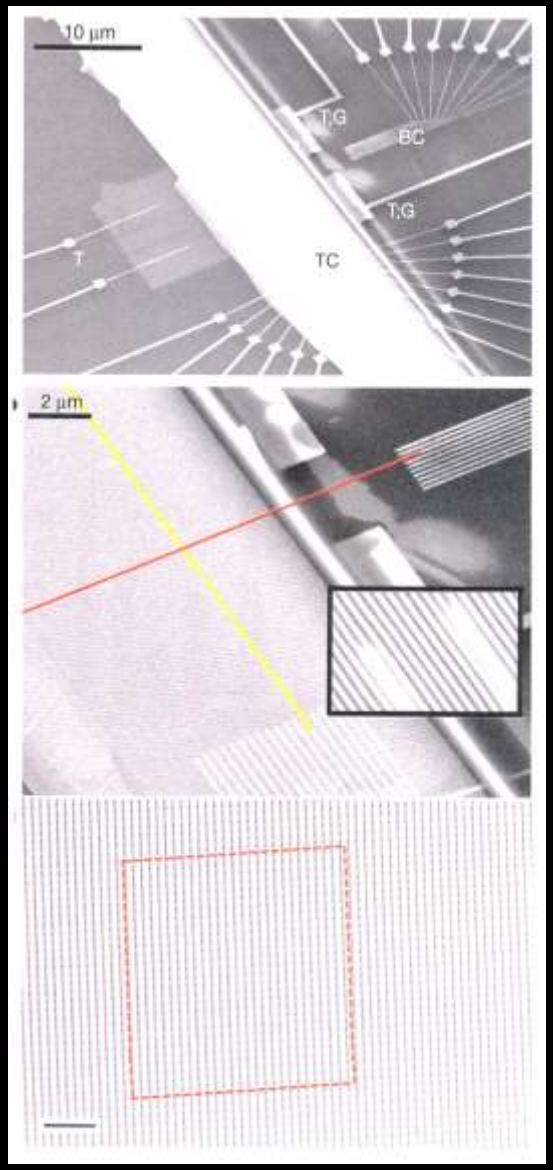
The Trials of

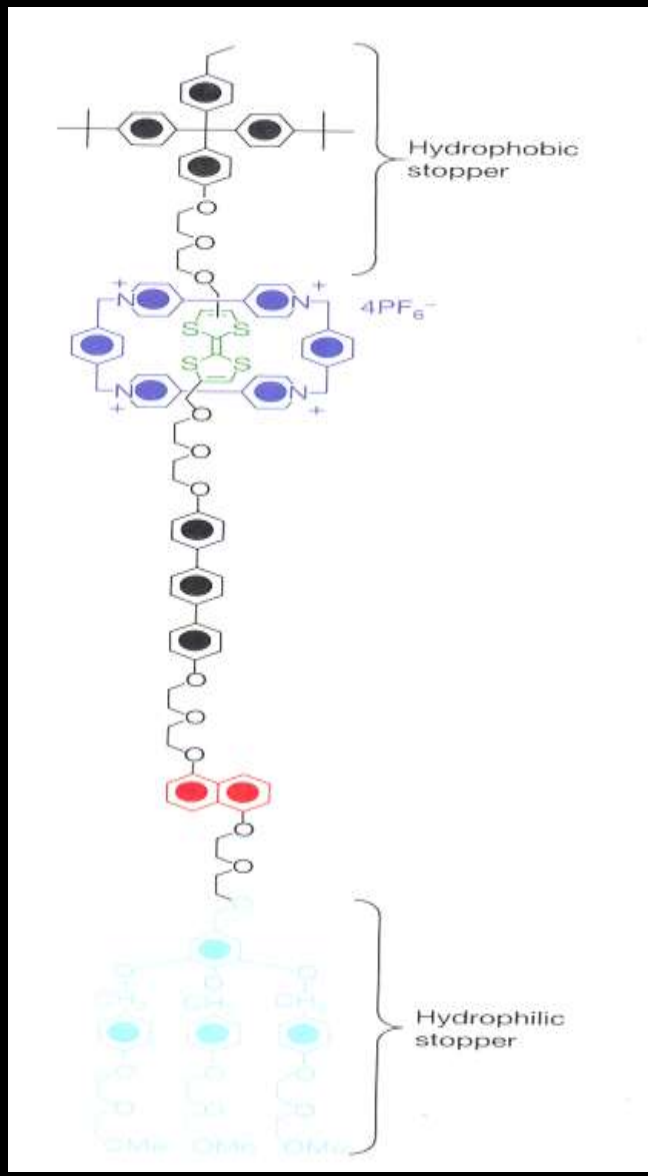
Neurolaw

How advances in brain science could transform our legal system.

By Jeffrey Rosen

The Continued Expansion of Computer Capacity, Storage and Speed





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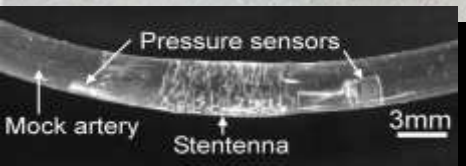
Robots of all shapes and sizes



UCAR

Unmanned Combat Armed Rotorcraft

Program Objective:
Affordably and effectively identify and prosecute masked ground targets at ranges that limit threat capability to engage friendly forces.

Operating Goals:
- 20% to 40% of proposed Comanche flyaway cost
- 50% to 80% reduction over Apache O&S

Program Status:
- Phase II Preliminary Design
- PDR/Downselect

Technical Challenges:
- Affordable and robust survivability solutions, low altitude autonomous flight
- Evolution of mission planning & execution to high level tasking / autonomous & collaborative execution
- Substantial improvement in target ID & target recognition ranges

HOME

CRW

Canard Rotor/Wing

Program Objective:
- High-speed rapid response from a vertical take-off and landing (VTOL) air vehicle with significant range and stealth improvements compared to other VTOL concepts
- Affordable, survivable, air vehicle to support dispersed units in littoral and urban areas.

Technical Challenges:
- Rotating center wing that stops and locks in place for forward flight
- Validate the stability, control system and aerodynamic performance required for vertical take-off, landing and hover.

Program Status:
- First flight conducted December 2003
- Preparing for second flight test.

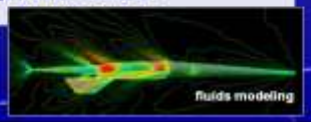
HOME

QSP

Quiet Supersonic Platform

Program Objective:
To develop and validate critical technology for a long-range advanced supersonic aircraft with substantially reduced sonic boom, reduced takeoff and landing noise, and increased efficiency relative to current-technology supersonic aircraft.

Technical Challenges:
Optimizing configuration shaping and preliminary design of laminar flow control technology to be integrated into the flight test vehicle.



Program Status:
- Flight test in August 2003
- Reduced sonic boom over-pressure by more than 30% on existing F-5 aircraft.

HOME

HELLADS

High Energy Liquid Laser Area Defense System

Program Objective:
Develop a high-energy laser weapon system (~150 kW) with an order of magnitude reduction in weight compared to existing laser systems.

Program Status:
Completed Laser Demonstration (Phase 2) – over 1 kW output with excellent beam quality

Technical Challenges:
System weight of less than 5kg/kW

HOME

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Sustainability Imperatives

Reduced GHG
and Carbon Footprint

Energy Independence
and Security

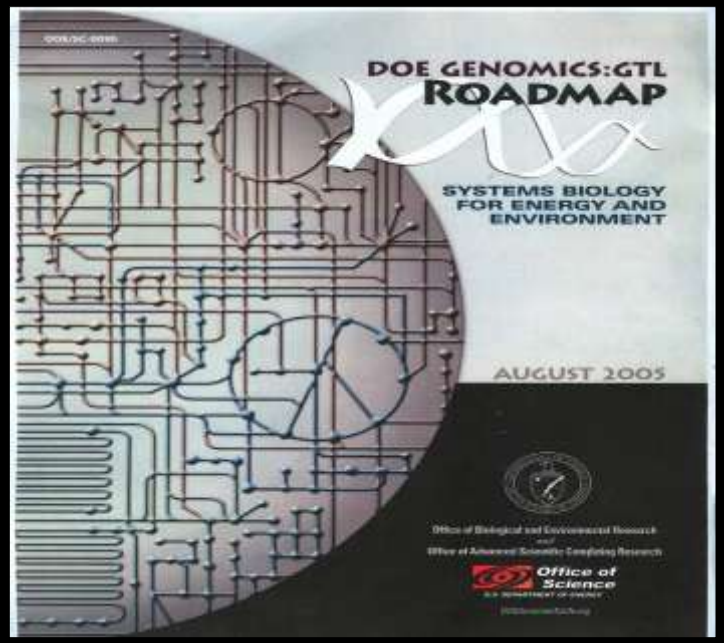
Reduced Depletion
of Non-Renewable Resources

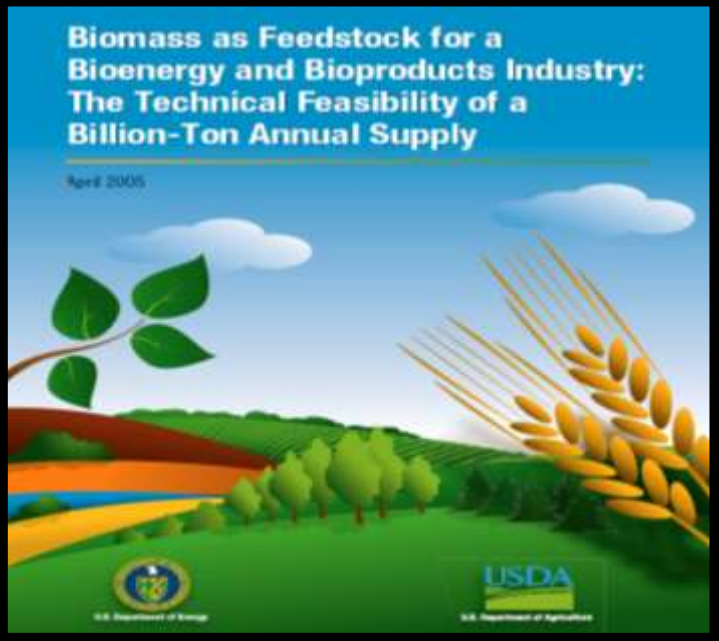
Urbanization and Global Public Health

Safe Water Supplies and Health

Toxic Waste and Bioremediation

Bio-Inspired Systems for Energy Production





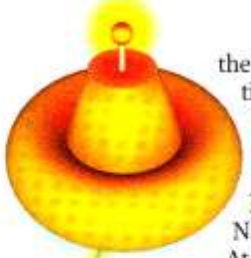
The Tiniest Power Plants

Scientists are seeing a host of possibilities in electricity produced by microbes

BY JOHN CAREY

LEONARD M. TENDER HAD A little demo in his office at the Naval Research Laboratory in Washington that could wow visitors. His computer screen showed air and water temperature data transmitted from a buoy in the nearby Potomac River. The surprise was the power source: "the microbes are starved for a place to put the electrons." When scientists bury an electrode in sediment and connect it in a circuit, the bugs glom on to it and happily supply electricity. The result is one of the world's most unlikely power plants.

Tender hopes to turn these microbes into power supplies for sensors and instruments in lakes and oceans. That will be a boon for researchers and military sleuths

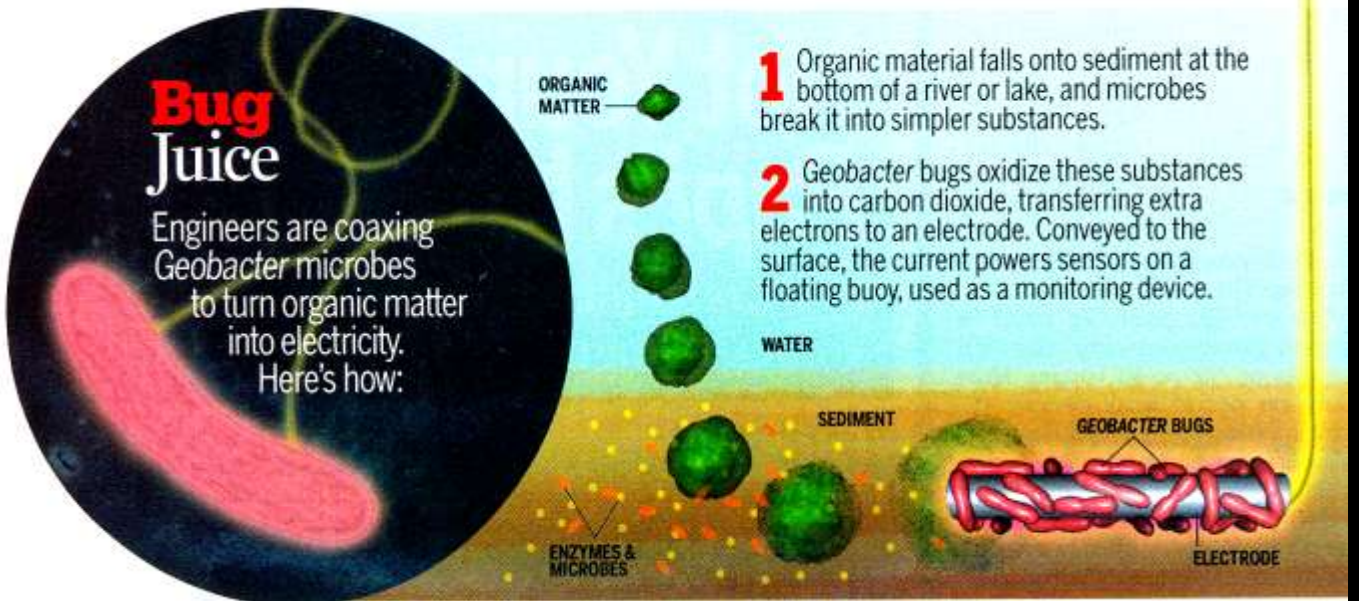


the grip of oil-producing nations by providing alternatives. The research "is at a very, very early stage, but the potential is huge," says Patrick L. Brezonik of the National Science Foundation. At the University of Massachusetts at Amherst, microbiologist Derek R. Lovley has figured out how these bugs work. To prove their potential, he has designed microbial cells powerful enough to drive toy SUVs and other devices.

FILAMENT FLOW

LOVLEY RECENTLY made an important discovery. Some species of electricity-producing microbes, such as *Geobacter*, have long, wispy filaments extending out from their cells. At one of his son's soccer games, Lovley broached the "crackpot" idea with another dad that the filaments could be natural wires. The talk led to experiments proving that electrical current flowed down the filaments. "It's still quite amazing to me," says Lovley.

The find has important practical implications. Lovley and others had thought



INSTITUTE OF PHYSICS PUBLISHING NANOTECHNOLOGY
Nanotechnology **17** (2006) 1778–1785 doi:10.1088/0957-4484/17/6/039

A nanomechanical device based on light-driven proton pumps

Quan Ren[1], Ya-Pu Zhao[1,3], Li Han[2] and Hui-Bin Zhao[2]

[1] State Key Laboratory of Nonlinear Mechanics (LNM), Institute of Mechanics, Chinese Academy of Sciences, Beijing 100080, People's Republic of China
[2] Institute of Electrical Engineering, Chinese Academy of Sciences, Beijing 100080, People's Republic of China

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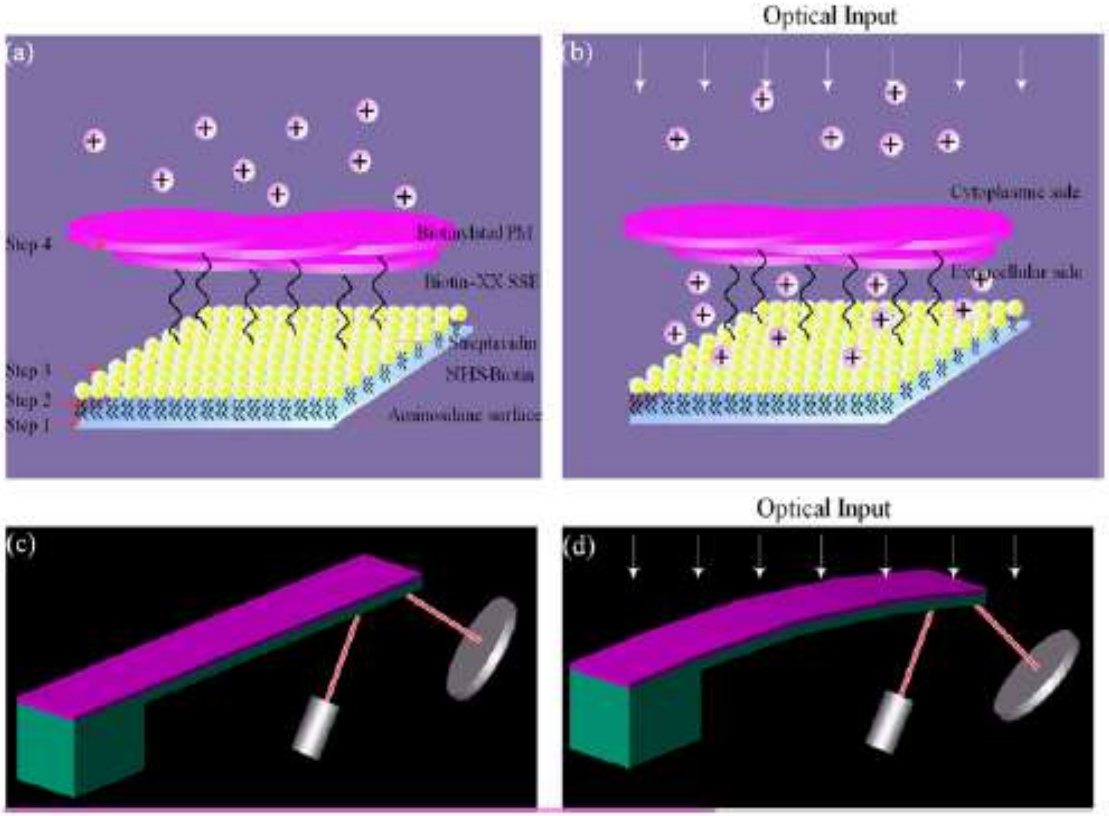
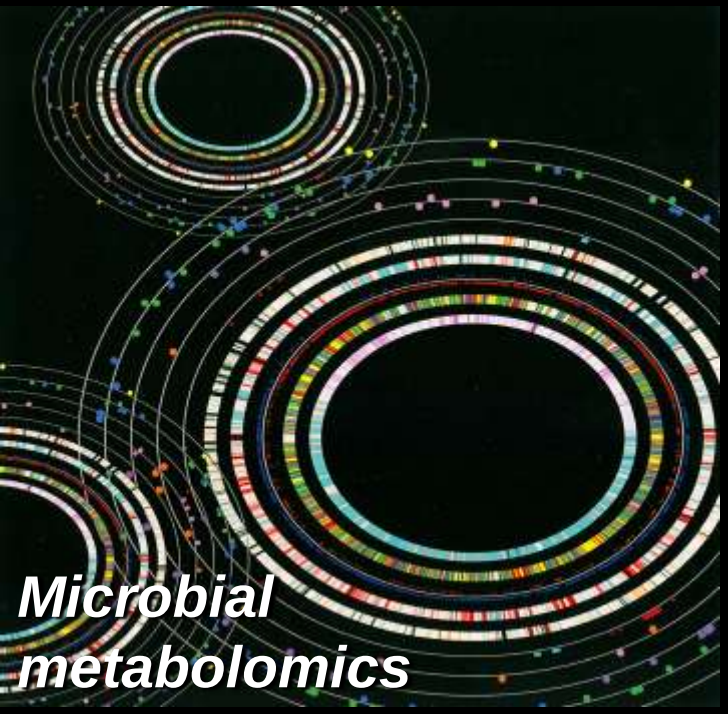
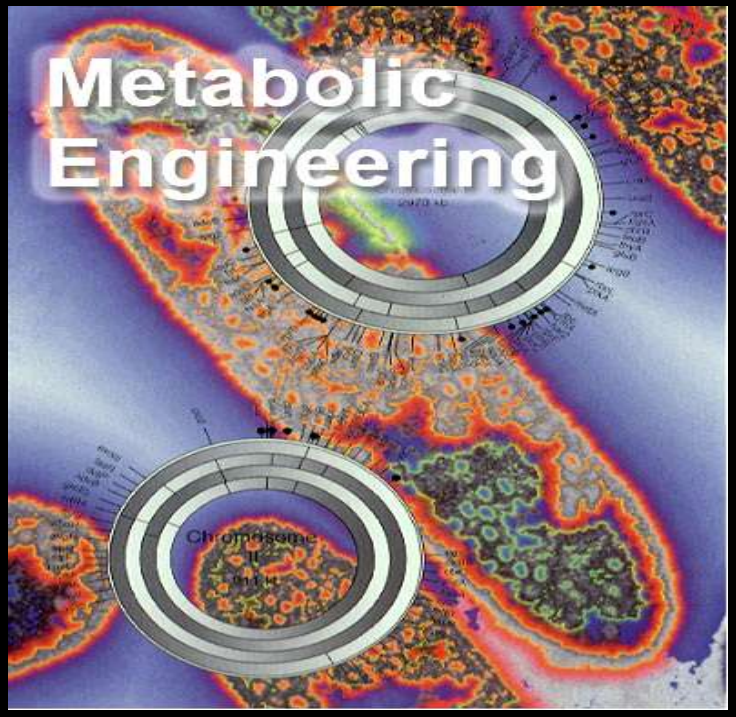
Abstract
In this paper, a hybrid device based on a microcantilever interfaced with bacteriorhodopsin (bR) is constructed. The microcantilever, on which the highly oriented bR film is self-assembled, undergoes controllable and reversible bending when the light-driven proton pump protein, bR, on the microcantilever surface is activated by visible light. Several control experiments are carried out to preclude the influence of heat and photothermal effects. It is shown that the nanomechanical motion is induced by the resulting gradient of protons, which are transported from the KCl solution on the cytoplasmic side of the bR film towards the extracellular side of the bR film. Along with a simple physical interpretation, the microfabricated cantilever interfaced with the organized molecular film of bR can simulate the natural machinery in converting solar energy to mechanical energy.

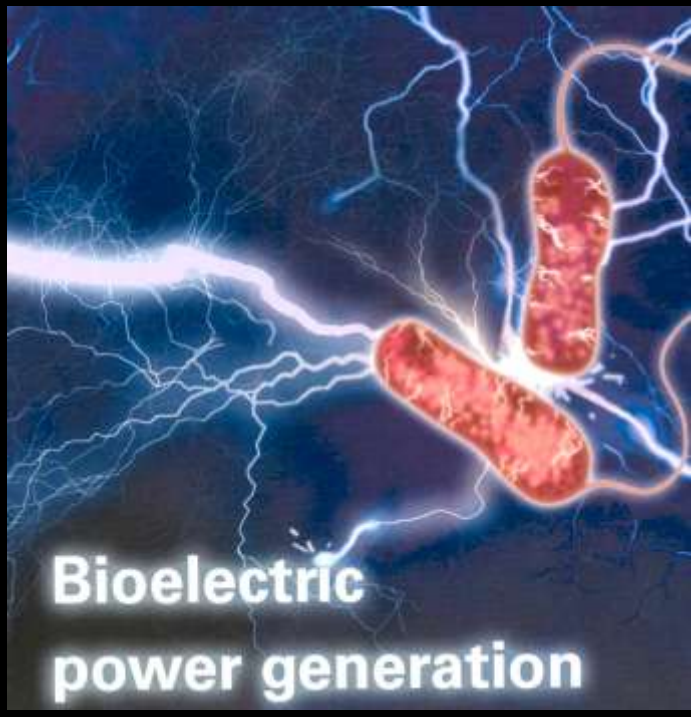


Synthetic Biology:

Biosynthetic Process Engineering
and
Industrial Process Transformation







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Plug and Play Genetics

Minimal Genomes

- introduce coding/control elements for desired function(s)

Altered Regulation of Endogenous Circuits

- up-or down-regulation via modulation of defined regulatory node(s)

De Novo Design and Incorporation of Novel Functions

- novel enhancer/ promoter elements
- modulation at different hierarchical levels
- incorporation of novel modules/cassettes
- incorporation of non-natural coding/information elements

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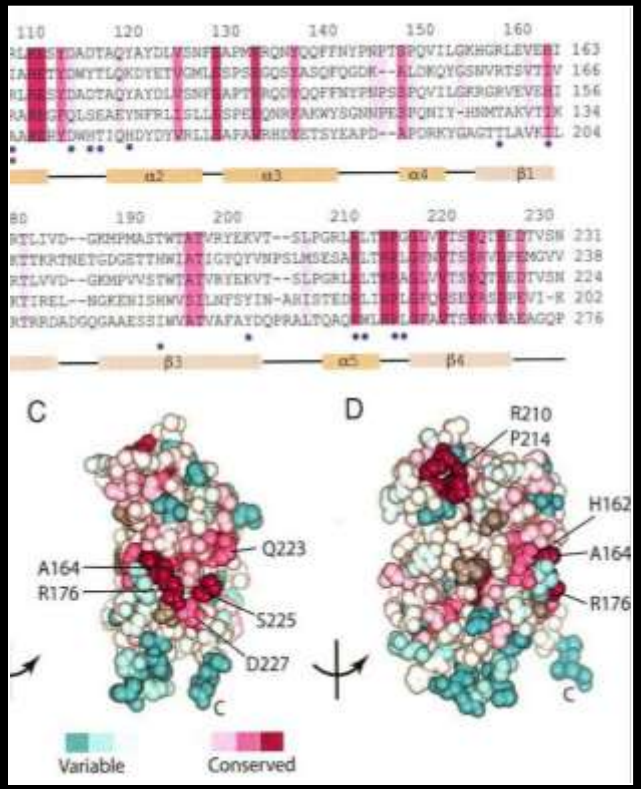
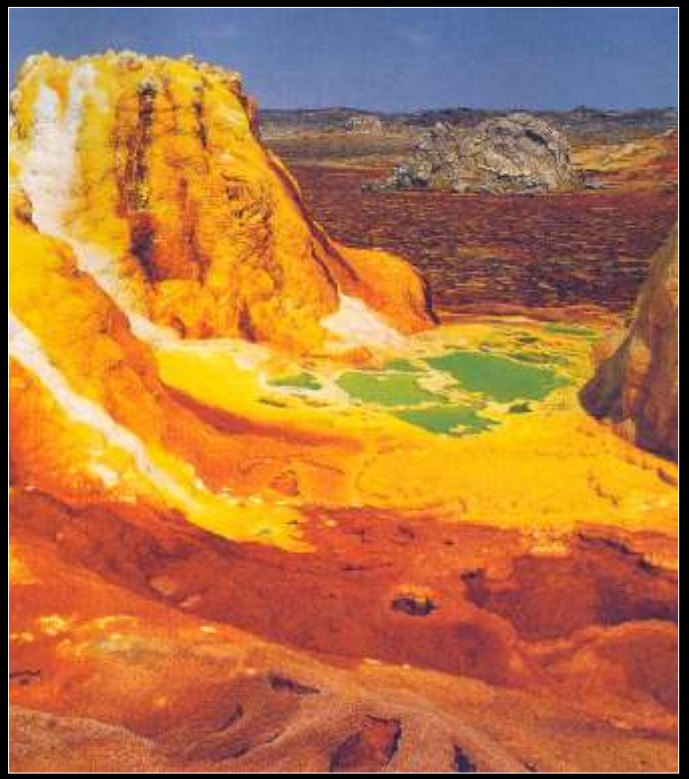
Ecogenomics: Mapping the Extraordinary Genomic Diversity and Biosynthetic Capabilities of Microbial Life





genomics

eco-niches

extremophiles

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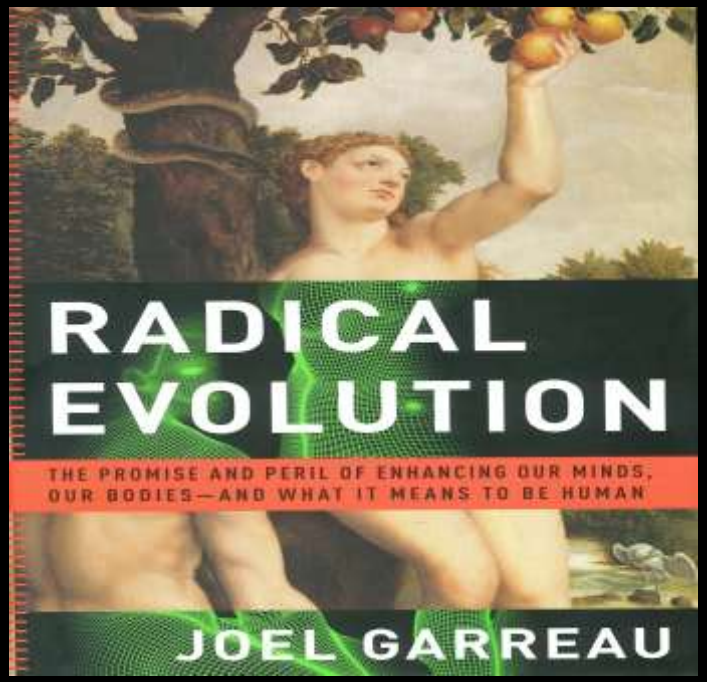
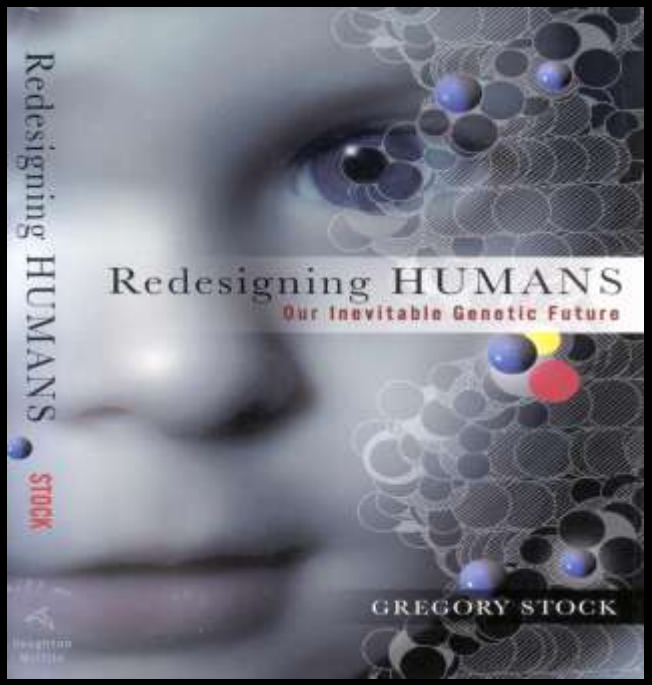
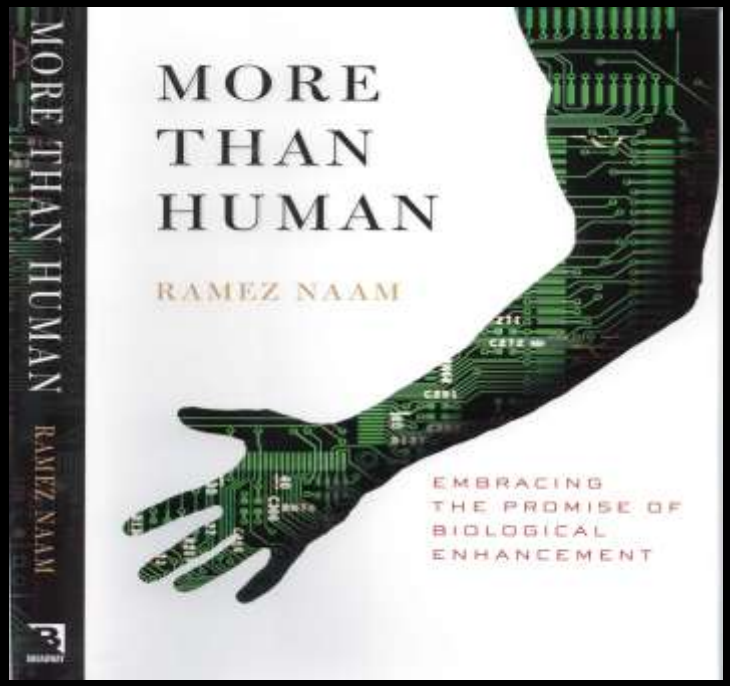
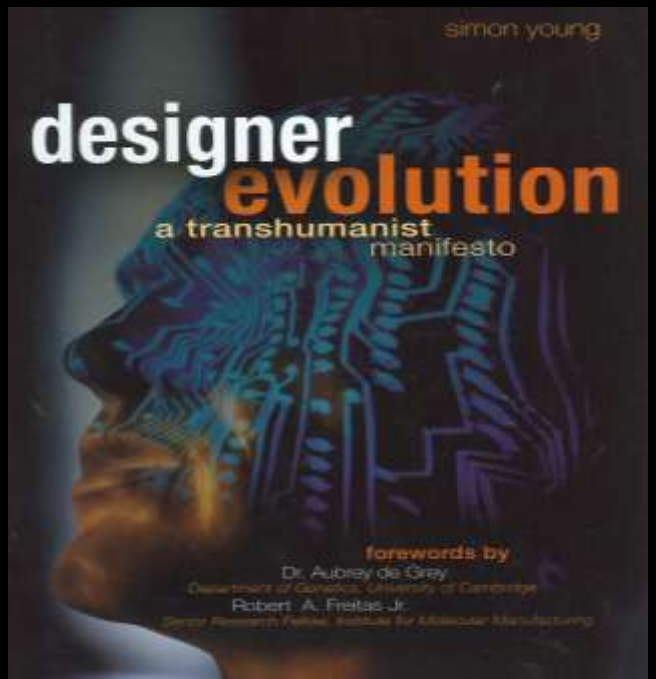
Synthetic Biology

- production of novel organisms with engineered biosynthetic capabilities
  - biodegradation
  - bioremediation
  - biosentinels
- directed evolution: gene ‘shuffling’ and protein engineering
  - genesis of hypervirulent/immune evasion organisms
  - novel toxins and other biomodulators
  - anti-materiel agents
- genetic enhancement (non-heritable) and eugenic modification (heritable)

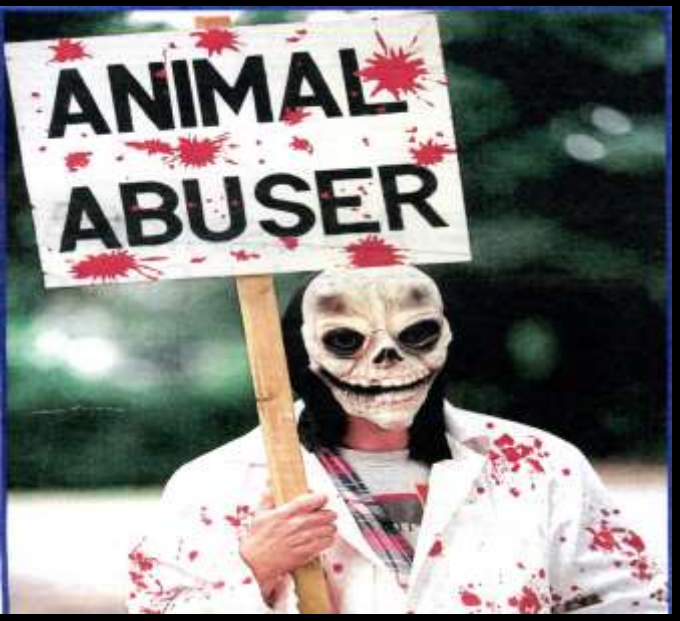

RADICAL
EVOLUTION
THE PROMISE AND PERIL OF ENHANCING OUR MINDS, OUR BODIES—AND WHAT IT MEANS TO BE HUMAN
JOEL GARREAU

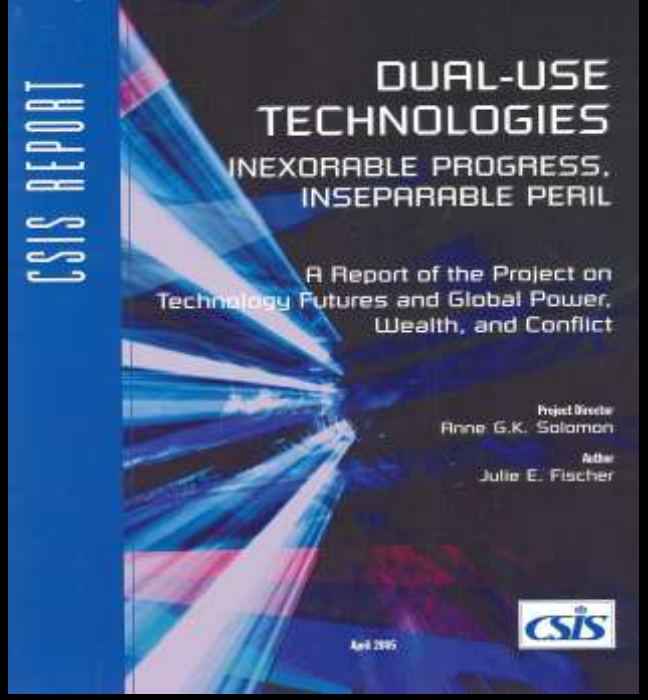

Redesigning HUMANS
Redesigning HUMANS
Our Inevitable Genetic Future
STOCK
GREGORY STOCK


MORE THAN HUMAN
RAMEZ NAAM
MORE
THAN
HUMAN
RAMEZ NAAM
EMBRACING
THE PROMISE OF
BIOLOGICAL
ENHANCEMENT


simon young
designer
evolution
a transhumanist
manifesto
forewords by
Dr. Aubrey de Grey
Robert A. Freitas Jr.

Controversy and Divisiveness of New Technologies

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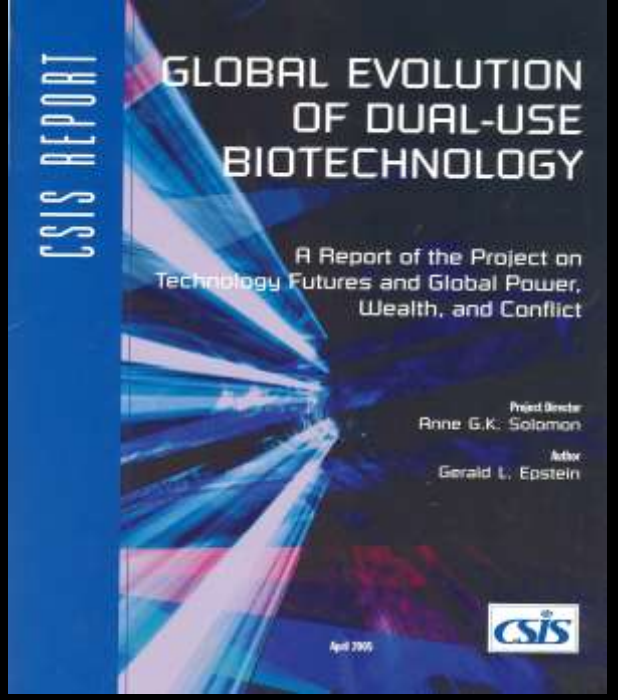
INEXORABLE PROGRESS, INSEPARABLE PERIL
A Report of the Project on Technology Futures and Global Power, Wealth, and Conflict
Project Director
Anne G.K. Solomon
Author
Julie E. Fischer
CSIS
April 2005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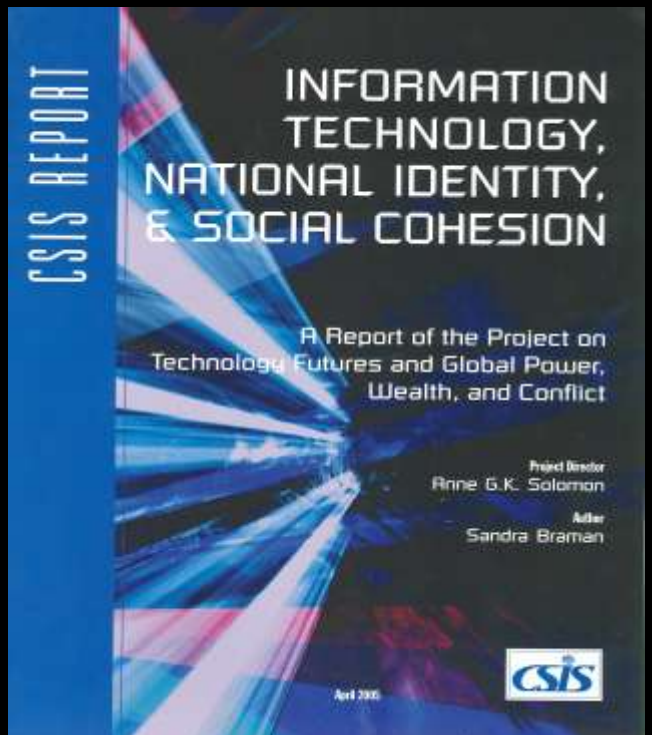
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A Report of the Project on Technology Futures and Global Power, Wealth, and Conflict
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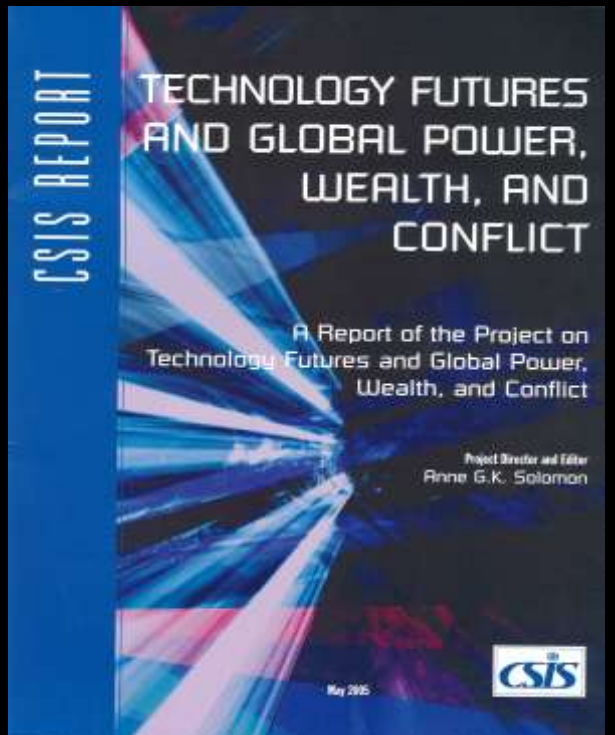
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TECHNOLOGY FUTURES AND GLOBAL POWER, WEALTH, AND CONFLICT
A Report of the Project on Technology Futures and Global Power, Wealth, and Conflict
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Limitations in Science and Technology Policy

- anachronistic institutional and legislative frameworks for cogent analysis and decision-making
  - robustness and transparency (data capture and analysis)
  - value (benefit)
  - risk (real/potential)
  - uncertain trajectories and extended timeframes
  - the paralysis of precaution
  - national imperatives versus international actions

No Ambiguity, No Error (No Problem)

Mr. Spock: “Insufficient data, Captain”

Captain Kirk: “Insufficient data is not sufficient, Mr. Spock.
You’re the Science Officer.
You’re supposed to have sufficient data
all the time”

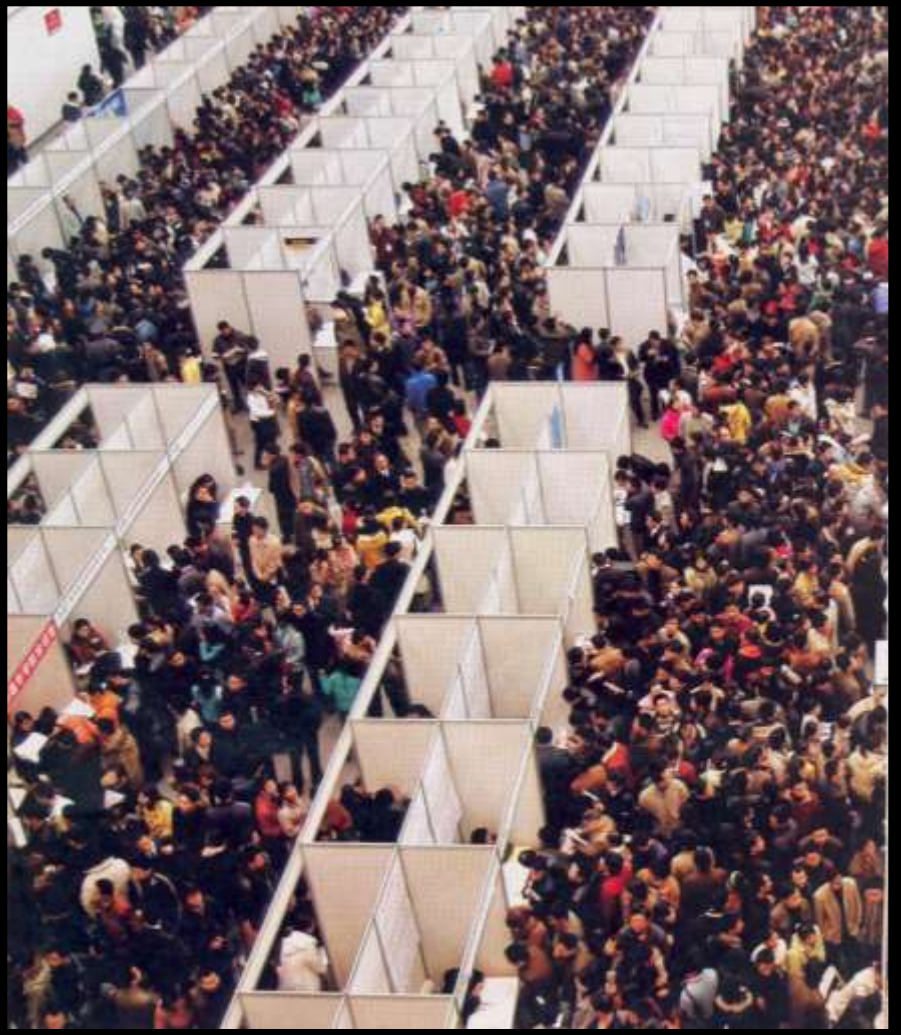
Star Trek
The Immunity Syndrome

National Competitiveness in Transforming and Disruptive Technologies

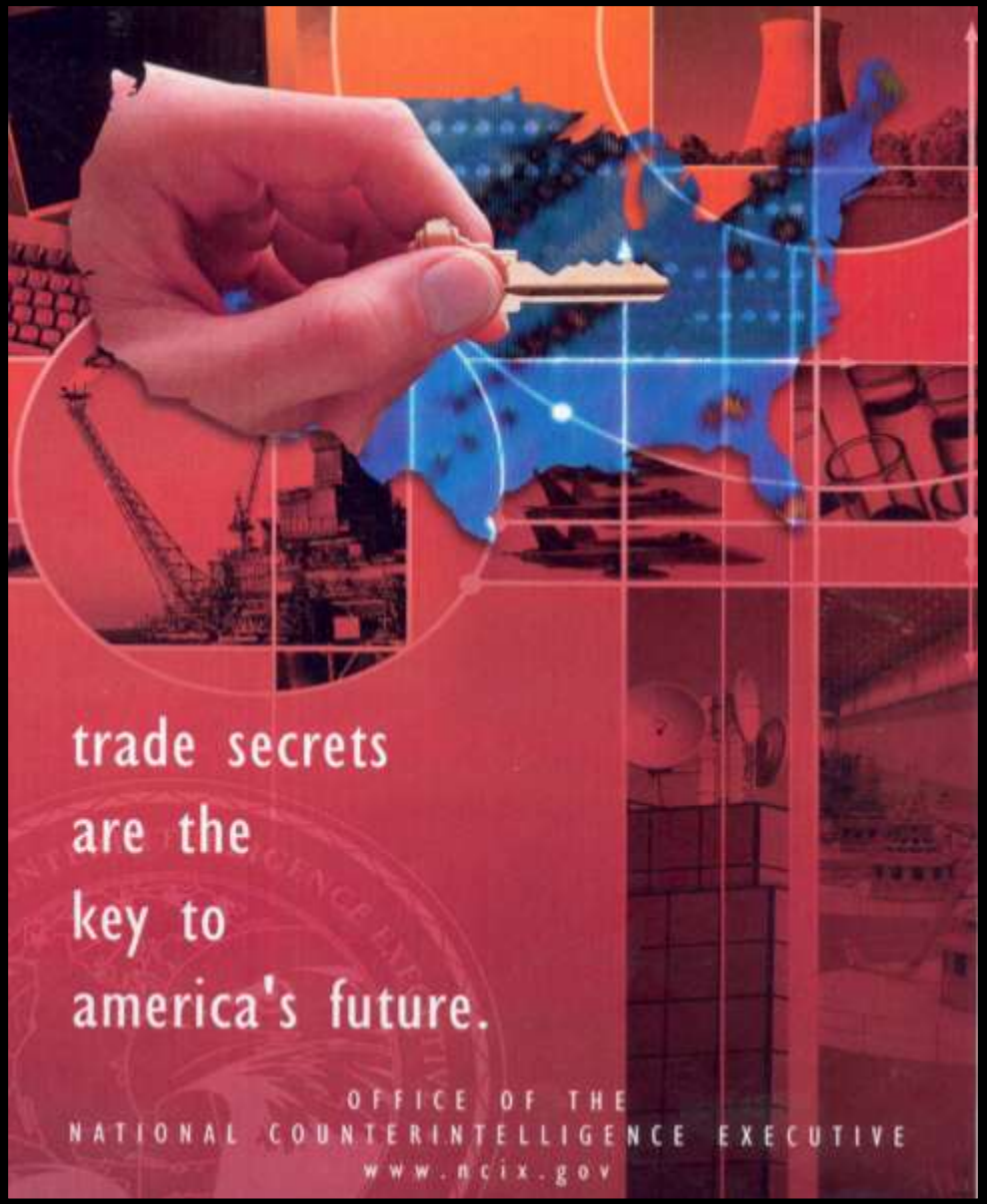
Creating Incentives to Address Market Failures

The Obligate Role of Private-Public Partnerships in Biosecurity and Global Health

A global force



The Increasing Importance and Vulnerability of Industry to Espionage for both Defense and Non-Defense Technologies



Conclusions

- current government institutions and R&D vehicles are ill-suited to address current and projected challenges
- extravagant resources are/will be wasted in until an integrated, cross-agency systems-approach is adopted
- complex multi-dimensional, trans-disciplinary problems will not be solved by current unitary and fragmented approaches
- the cosmetic salve of seeming to ‘do something’ is meaningless if it achieves nothing

The Effect of Human Activities Amplified by New Technologies

- accelerating technology convergence
- rapid technology diffusion and global reach
- speed and connectivity of digital networks
- brain: machine interfaces: a new co-evolution
- increasing range of dual-use technologies

The Effect of Human Activities Amplified by New Technologies

- unintended consequences: increasing difficulty of prediction of dislocative perturbations in complex, adaptive systems
- new technologies as catalyst for greater distributive justice and equity or harbinger of technological dystopia?
- oversight and global policies for dual-use technologies

Addressing New Security and Intelligence Challenges

- obligate dependence on private sector participation demands that relevant corporate partners be consulted and incentivized
- public : private partnerships to develop novel responses will yield parallel benefits in diverse civilian markets with significant societal benefits
  - medicine, agriculture, environmental management
  - robotics, computing, telecommunications
  - materials, energy and sustainable resources
  - enhanced human performance and novel BMI technologies

“The lights must never go out.
The music must always play.
Lest we should see where we are,
lost in a haunted wood
children afraid of the dark,
who have never been happy or good”

W.H. Auden
Poem: September 1, 1939

“Politics is the art of the possible,
the calculated science of survival”

Prince Otto von Bismarck

“Survival owes little to the art of politics,
but everything to the calculated application
of science”.

Professor Rudolph Virchow
(in reply)

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Polychromix

par home

Infinite Power Solutions

TenXsys Inc.

InfiniteZ

TerraGO TECHNOLOGIES

piXlogic The Visual Search Company

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3VR Security

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