ASU Complex Adaptive Systems Initiative
Arizona State University

Science Foundation Arizona
Innovation at Work

Virginia G. Piper Charitable Trust

Innovation Demands Boldness: Meeting the Challenges of Escalating Complexity

Dr. George Poste
Director, Complex Adaptive Systems Initiative
and Del E. Webb Chair in Health Innovation
Arizona State University
george.poste@asu.edu
www.casi.asu.edu

Workshop, September 29th & 30th
Westin Kierland Resort Hotel in North Scottsdale

"Terrific and inspiring stories about the dreamers and doers who dared to create the modern face of this great nation." —JACK WELCH

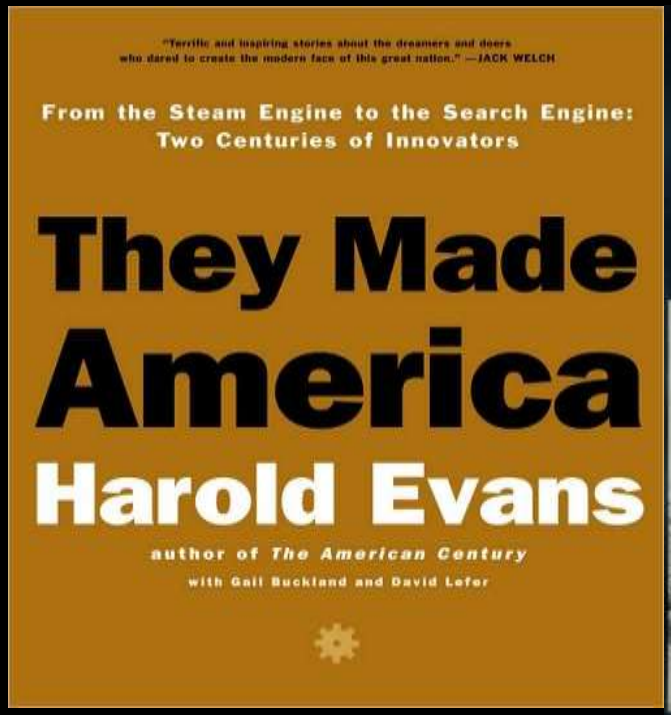
From the Steam Engine to the Search Engine: Two Centuries of Innovators

They Made America

Harold Evans

author of *The American Century*

with Gail Buckland and David Lefer



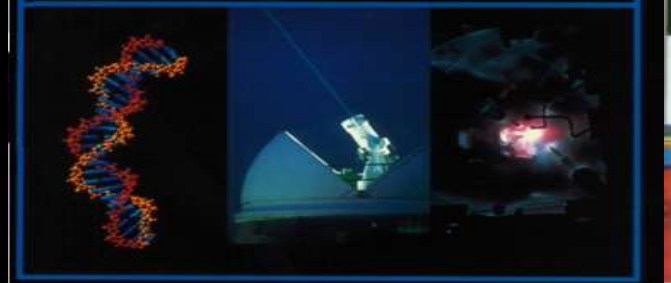
THE NOBEL CENTURY

A CHRONICLE OF GENIUS

INTRODUCTION BY ASA BRIGGS

SCIENCE

A HISTORY OF DISCOVERY IN THE TWENTIETH CENTURY



TREVOR I. WILLIAMS

THE AMERICAN CENTURY

Varieties of Culture in Modern Times

Norman F. Cantor

Author of *The Civilization of the Middle Ages* and *The Sacred Chain*

Picture Essays by Mindy Cantor

Optimism and Progress: A Core Element of US Culture

American Progress: Manifest Destiny
by John Gast (1872)

- "A New Order of the Ages"
- unfinished pyramid as symbol that US will always grow, improve and build

"…..banking establishments
are more dangerous than standing armies,
and the principle of spending money
to be paid out by posterity
…..is but swindling futurity
on a larger scale"

"Manufactures are now as necessary
to our independence
as to our comfort."

Thomas Jefferson


SPECIAL ADVERTISING SECTION


The Machines
That Ate
The Market


GOLDMAN
SACHS
COME ON IN
BANK
Of
AM
LOOSE
MORGAN STANLEY

US Services and Manufacturing 2000-2009

- financial services expanded from 10 to 45% of the earnings of the S&P 500 in 2009
- in 2000 high-technology products generated positive trade balance and a $50 billion deficit in 2007
- 47% of revenue for US S&P countries now earned overseas
- the equity cult: from 1952 to 2006 US pension funds increased equity weighting from 17% to 69%
- $249 billion net loss in US stock-based mutual funds since 2007

Systemic Risk

- delusional faith in unfettered markets and global free trade
  - transactional and short term focus
- replacement of domestic manufacturing base with service industries
- off-shoring of design and engineering now marketing may follow manufacturing
- “bread and circuses”: rampant consumerism, political populism and quick fixes
- trade imbalance, deficits and unsustainable debt
- ad hoc and conflicting economic, political and regulatory policies
- decline of the national innovation ecosystem?

From Small-Time to Prime-Time: Companies with #1 Global Market Share

Company	Industry	Country
SAMSUNG	flash memories, hard disks, flat screen monitors	South Korea
ARACRUZ	market pulp for paper products	Brazil
sasol reaching new frontiers	synthetic fuels	South Africa
tsmc	logic semiconductors	Taiwan
misc MISC BERHAD	liquefied natural gas shipping	Malaysia
GAZPROM	natural gas	Russia
Tenaris Tubular technologies. Innovative services.	oil pipes	Argentina

“Intel can move wherever it must to thrive
but I sometimes wonder
how my grandchildren
will earn a living”

Dr. Craig Barrett
Former Chairman, Intel

Intel Investment in PRC Fabrication Facility

“Intel’s goal is to support a transition from manufactured in China to innovated in China”

Remarks by Paul Otellini CEO, Intel at celebration to launch the initiative. Great Hall, Bejing

- **investment will generate additional $1 billion in profits over 10 years versus operating same facility in US**

21st Century Dung

- US exports of scrap metal and waste exports to China in 2008 of $7.6 billion
- exceeds exports of next three strongest categories
  - semiconductors, aircraft and parts, oil seeds and grain
- US trade deficit with China
  - $250 billion with $100 billion in high-tech goods)
  - computer equipment China's biggest export to US ($46 billion)

Vulnerability of Global, National and Local Supply Chains in a Major Epidemic/Pandemic

Medicines

- "just-in-time" supply networks
  - major hospitals 2/3 deliveries per day
- majority of drug intermediates, excipients and final products sourced off-shore
- 95% generic drugs used in US (64% of total Rx) are made off-shore, primarily in PRC and India
- no national stockpile for routine prescriptions

- can the world accommodate continued economic growth at a pace that the public has come to expect?
- can Western labor markets withstand the competitiveness of emerging nations?
- are standard theories of ‘comparative advantage’ that are central to traditional economic policy relevant in a global context?
- how will Western countries address the economic/infrastructure/production “voids” created by population ageing?
- how we innovate for sustained competitveness?

“Actually, these aren’t bad times to be delusional.”

Meeting Previous Grand Challenges

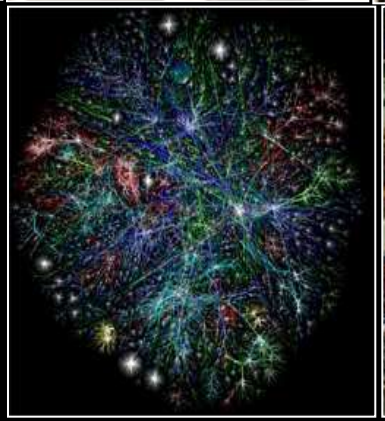










Innovation

The application of ingenuity to improve individual quality-of-life and promote societal systems that protect and expand literacy, aspiration, economic prosperity, security and sustainability

Source: Info Week 13 September 2010

Explorations in the OED, Second Edition, VIII, 998

"Innouatore: an alterer, disturber"
Florio 1598

"…..this world shall either be abolished by annihilation, or be innovated, and as it were, transfigured."
T. Boyle 1674

"There are many who supposing themselves wiser than others, endeavor to innovate. "
T. Hobbes 1651

"The insights of economics do not illuminate the process of innovation"
J. P. Lewis 1959

"The Air Force sounded more exciting and more innovative."
N. Armstrong 1970

Incremental Innovations

- linear extensions of established methods, products and services
- a.k.a. minnovation
- value proposition easily understood by consumers, producers and financial markets

Disruptive Innovations

- non-linear and radical shifts in technology trajectories that replace the status quo
  - products and/or services
  - processes: reduced time and cost
- Schumpeterian ‘creative destruction’
- a.k.a. dislocation, discontinuity, tipping points, infections, ‘Black Swans’
- new value proposition rarely sensed and often rejected by current KOLs/companies/financial markets
- typically arise at margins of existing domains or at the convergent interstices between separate domains

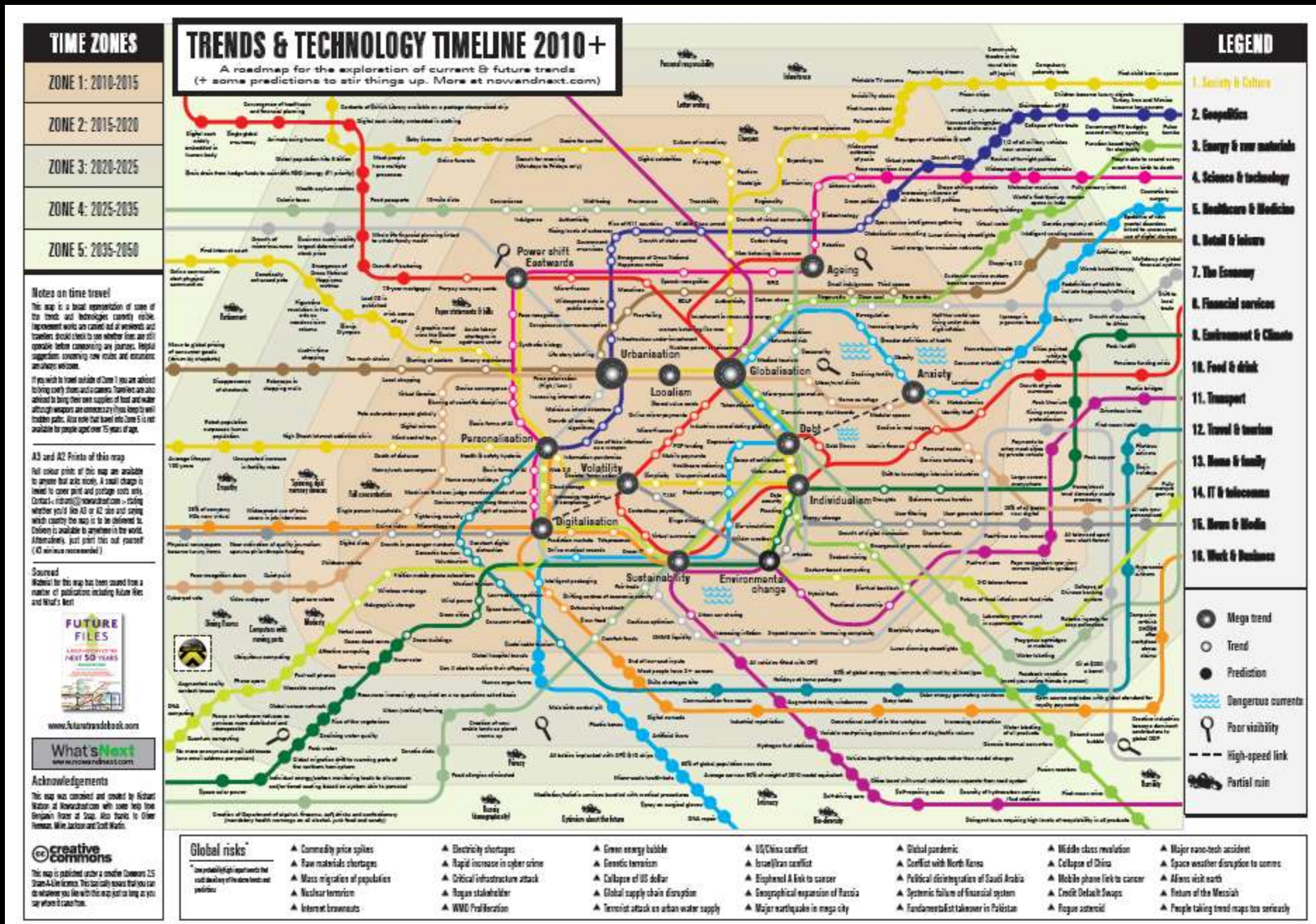
Reverse Innovation

- traditional innovation based on assumptions of affluence and abundance
- for emerging markets affordability and sustainability will drive innovation
- reverse innovation (GE): transfer of innovation from emerging to established markets

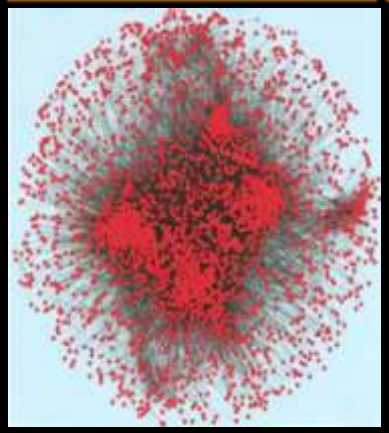
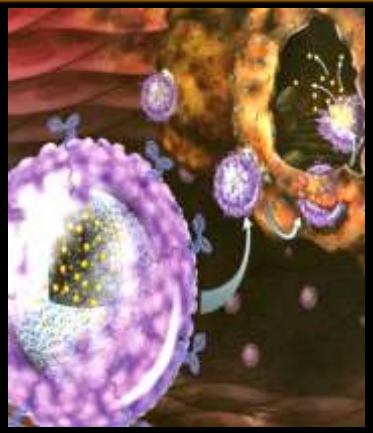
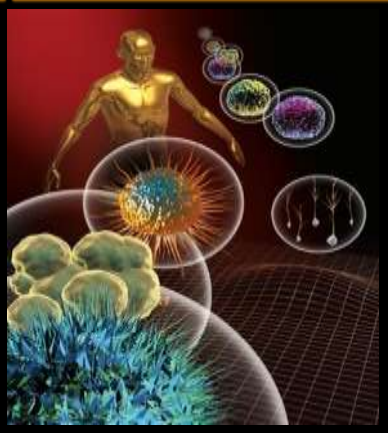
Reconfigured Innovations

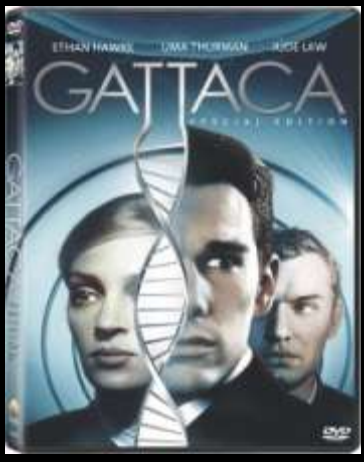
- creation of novel products/services incorporating features/competencies from different industries
  - sensors and smart devices
- reconfigurations can also be highly “disruptive”
- use of available technology in a novel way
  - hijacked planes in 9/11, IEDs
  - cybercrime

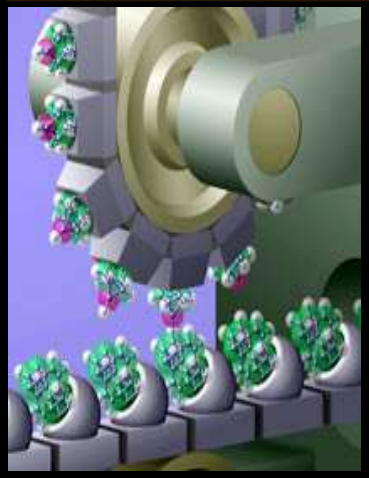
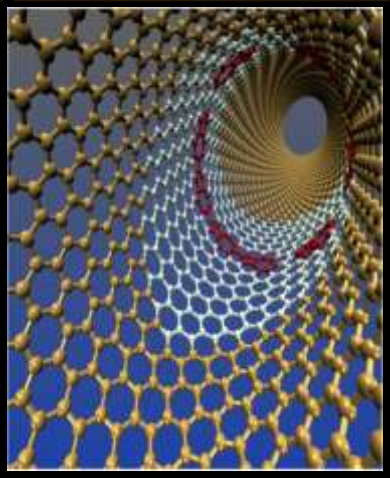
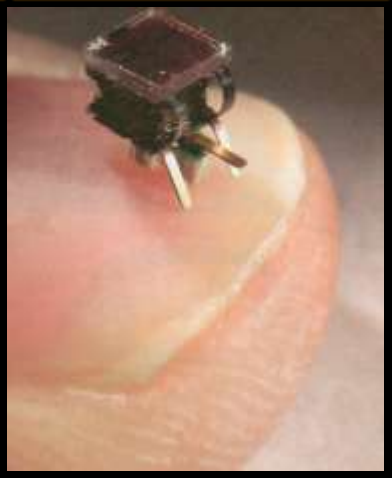
“Constructively Discontent”

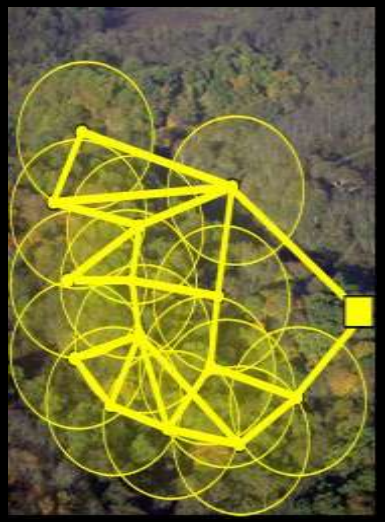
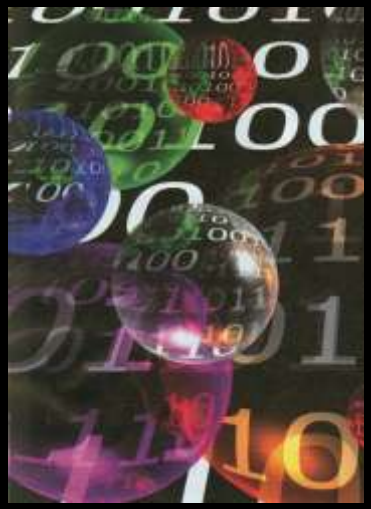
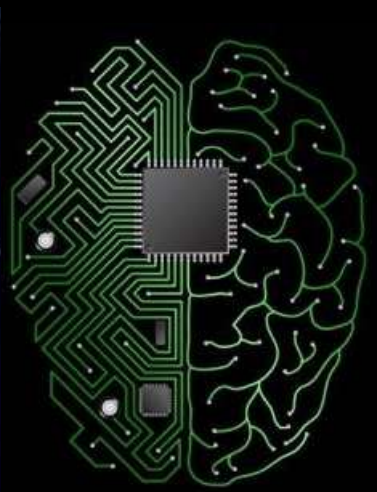

TIME ZONES
ZONE 1: 2010-2015
ZONE 2: 2015-2020
ZONE 3: 2020-2025
ZONE 4: 2025-2035
ZONE 5: 2035-2050
Notes on time travel
This map is a basic representation of some of the trends and technologies currently visible. Improvement works are carried out at weekends and travellers should check to see whether lines are still operable before commencing any journeys. Helpful suggestions concerning new routes and destinations are always welcome.
If you wish to travel outside of Zone 1 you are advised to bring comfy shoes and a camera. Travellers are also advised to bring their own supplies of food and water although weapons are unnecessary if you keep to well trodden paths. Also note that travel into Zone 5 is not available for people aged over 75 years of age.
A3 and A2 Prints of this map
Full colour prints of this map are available to anyone that asks nicely. A small charge is levied to cover print and postage costs only. Contact richard@nowandnext.com stating whether you'd like A3 or A2 size and saying which country the map is to be delivered to. Delivery is available to anywhere in the world. Alternatively, just print this out yourself (40 minutes recommended)
Sources
Material for this map has been sourced from a number of publications including Future Files and What's Next
FUTURE FILES
A BRIEF HISTORY OF THE NEXT 50 YEARS
www.futuristsbookshop.com
What's Next
www.nowandnext.com
Acknowledgements
This map was conceived and created by Richard Watson at Nowandnext.com with some help from Benjamin Fraser at Stop. Also thanks to Oliver Freeman, Mike Jackson and Scott Martin.
creative commons
This map is published under a creative Commons 2.5 Share-A-Like licence. This basically means that you can do whatever you like with this map just so long as you say where it came from.
TRENDS & TECHNOLOGY TIMELINE 2010+
A roadmap for the exploration of current & future trends
(+ some predictions to stir things up. More at nowandnext.com)
Power shift Eastwards
Ageing
Urbanisation
Globalisation
Anxiety
Loalism
Personalisation
Debt
Volatility
Individualism
Digitalisation
Sustainability
Environmental change
LEGEND
1. Society & Culture
2. Geopolitics
3. Energy & raw materials
4. Science & technology
5. Healthcare & Medicine
6. Retail & leisure
7. The Economy
8. Financial services
9. Environment & Climate
10. Food & drink
11. Transport
12. Travel & tourism
13. Home & family
14. IT & telecomms
15. News & Media
16. Work & Business
Mega trend
Trend
Prediction
Dangerous currents
Poor visibility
High-speed link
Partial ruin
Global risks*
* Low probability high impact events that could develop if the above trends and predictions
Commodity price spikes
Raw materials shortages
Mass migration of populations
Nuclear terrorism
Internet brownouts
Electricity shortages
Rapid increase in cyber crime
Critical infrastructure attack
Rogue stakeholder
WMD Proliferation
Green energy bubble
Genetic terrorism
Collapse of US dollar
Global supply chain disruption
Terrorist attack on urban water supply
US/China conflict
Israel/Iran conflict
Blighned A link to cancer
Geographical expansion of Russia
Major earthquake in mega city
Global pandemic
Conflict with North Korea
Political disintegration of Saudi Arabia
Systemic failure of financial system
Fundamentalist takeover in Pakistan
Middle class revolution
Collapse of China
Mobile phone link to cancer
Credit Default Swaps
Rogue asteroid
Major nano-tech accident
Space weather disruption to comms
Aliens visit earth
Return of the Messiah
People taking trend maps too seriously

Transcending Boundaries:
Emergent Domains Arising from Technology Convergence

Systems and Synthetic Biology	Targeted Rx and Gene Controls	Regenerative Medicine	HPO	Genetic Identity
				

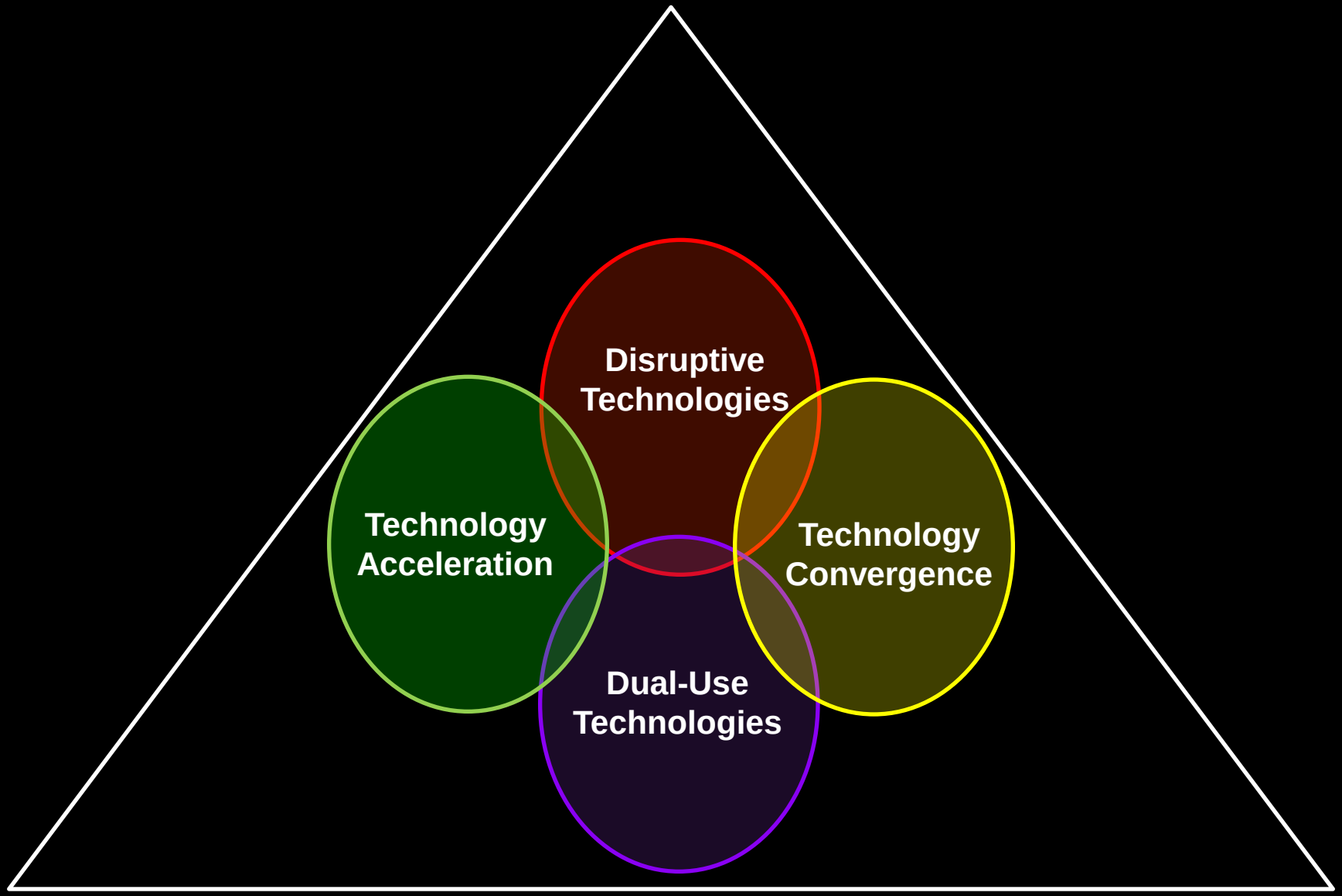
Bio-Enhancement	Bionic-Enhancement	Cognitive Enhancement	Genetic Enhancement	Bio-Stratified Population
				

Molecular Foundries	Novel Materials	Micro-Devices	Ubiquitous Sensing	Robotics
				

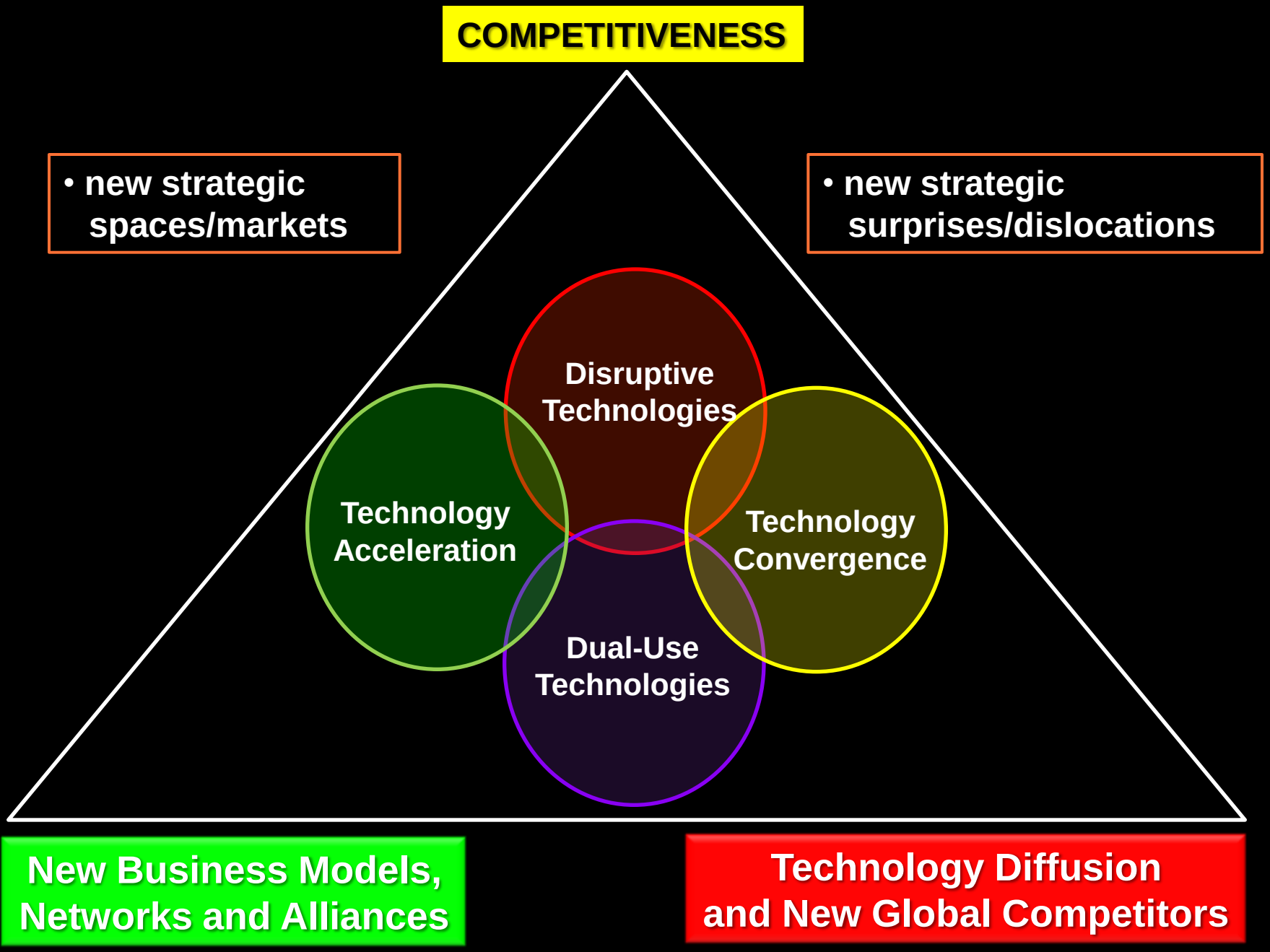
Ambient Intelligence	Digital Cultures	Cogint	Intelligent Machines	Competition and Espionage
				

Massive Computing Power and Analytical Parsing

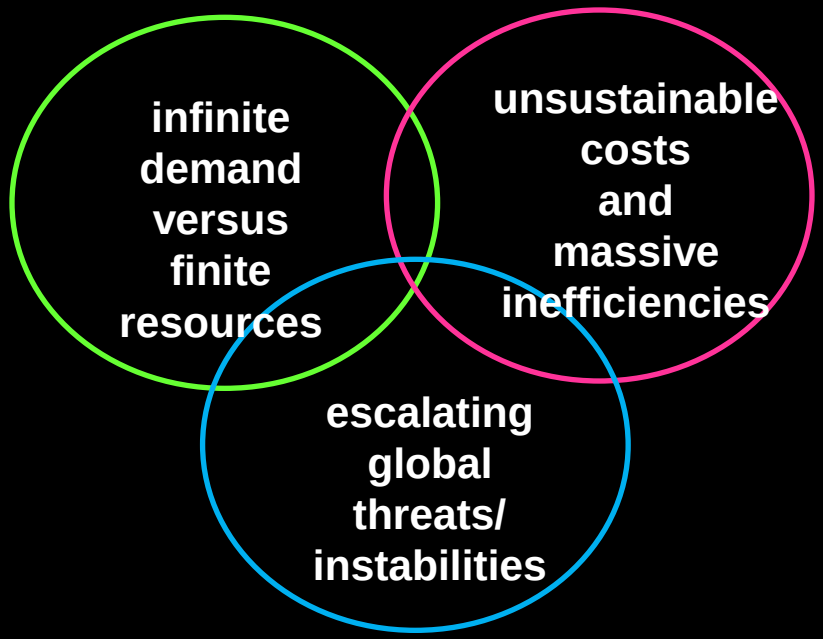
The Strategic Environment for Technology



The Strategic Environment for Technology

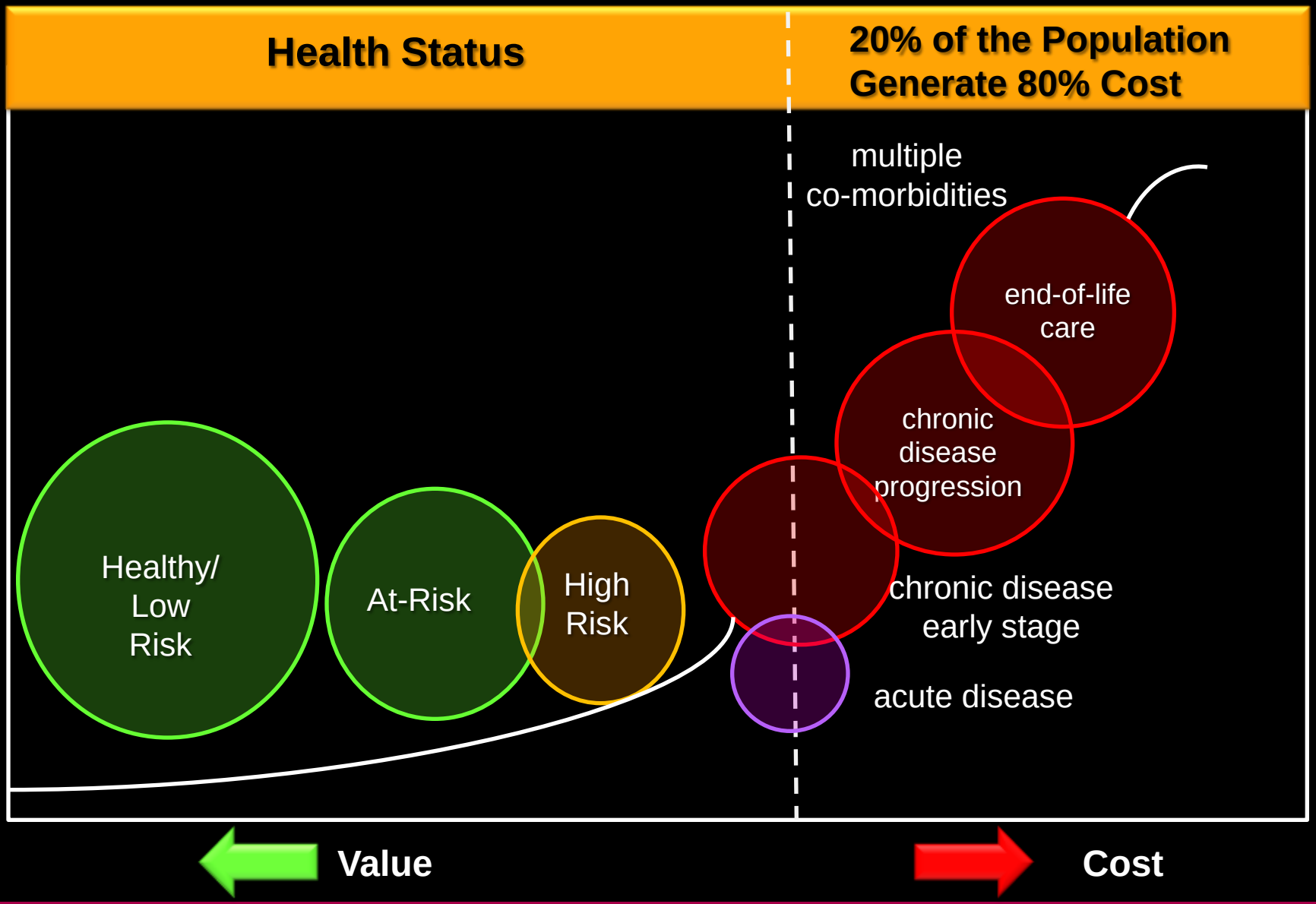


Sustaining Healthcare Innovation in an Era of Economic Constraint



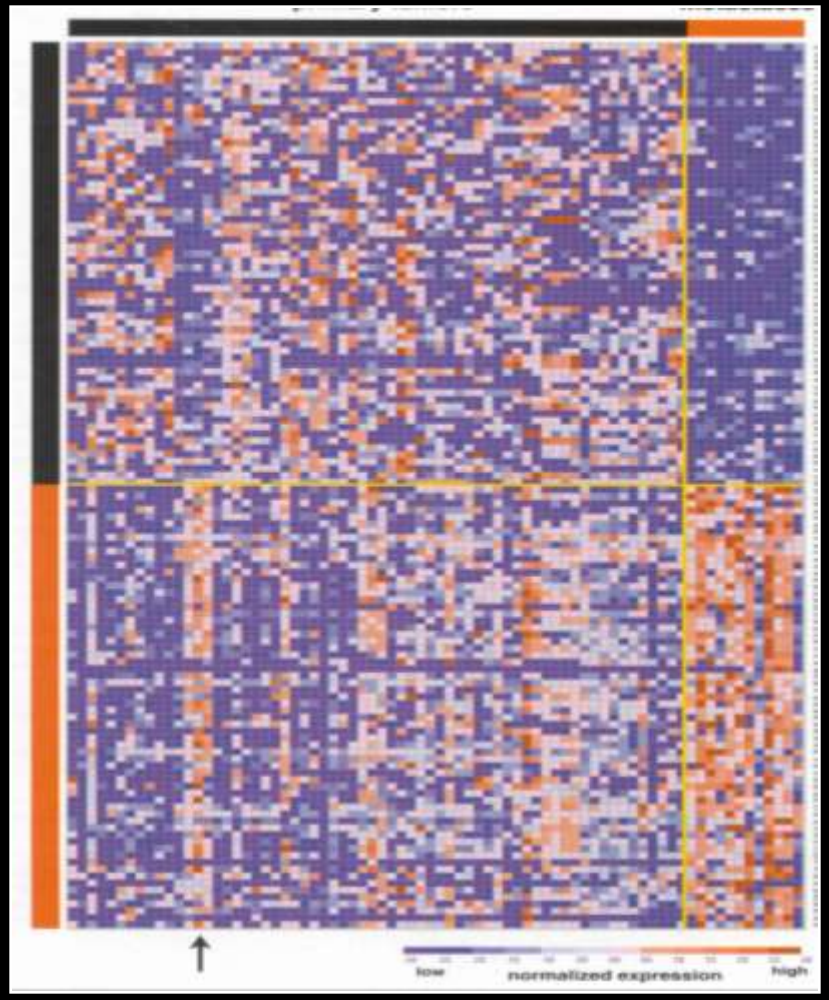
"For the first time in history,
the United States is raising a generation of children
who may live sicker, shorter lives
than their parents.
We must act now to reverse this trend."

The Economic, Social and Clinical Benefits of Proactive Mitigation of Disease Risk and Chronic Disease Co-Morbidities



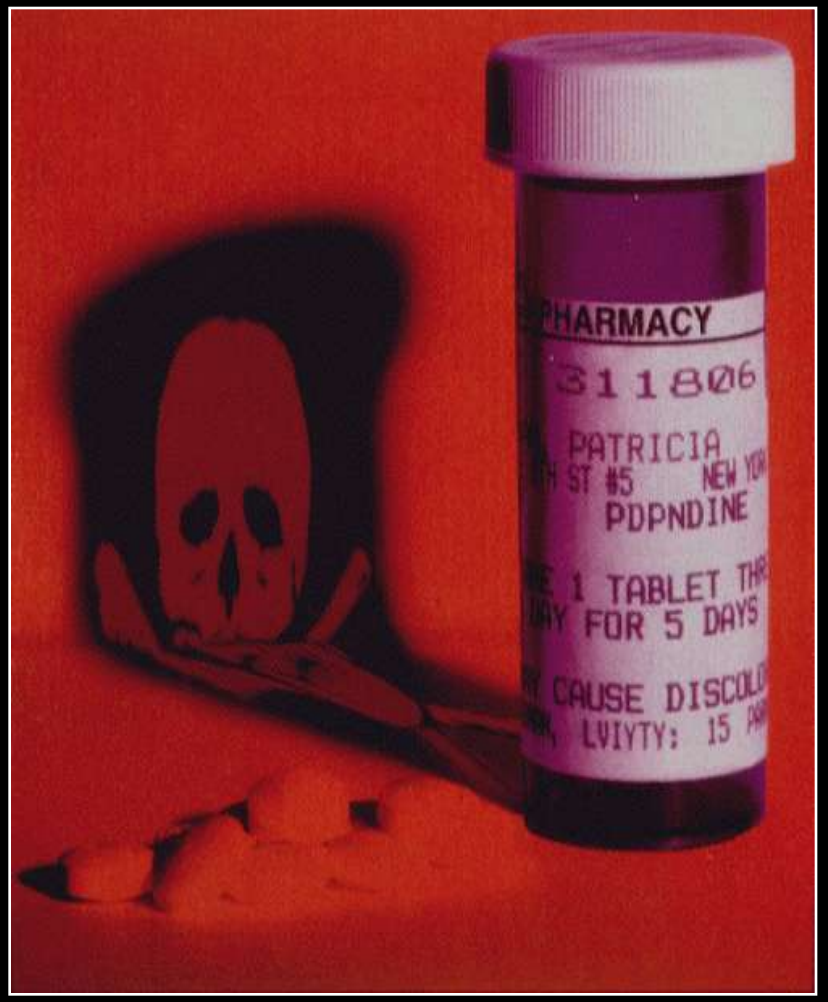
From Pharmaceuticals to Pharmasuitables

Disease Subtyping:



Right Rx for Right Disease

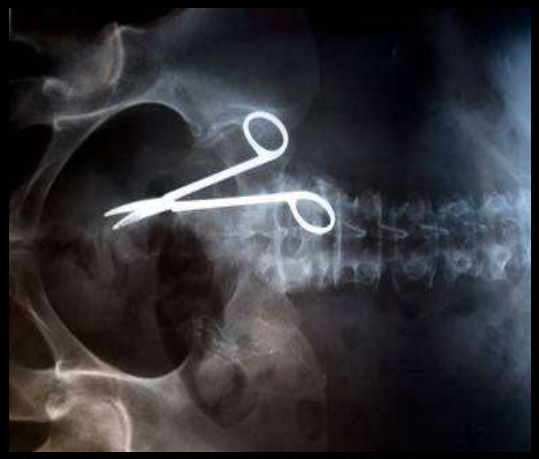
Individual Variation and AE risk



Right Rx for Right Patient

Tracking and Mitigating The Major Cost of Inefficiencies in Healthcare

Overt Error | **Non-Compliance** | **Adverse Rx Events**



Hospital-Acquired Infections | **Cost of Hospital Re-admissions** | **Inaccurate, Inaccessible or Ignored Information**

‘The Medical Home’: Integrated Care Services for Independent Living

Deloitte.

Connected Care

Technology-enabled Care at Home

Produced by the
Deloitte Center
for Health Solutions

Audit . Tax . Consulting . Financial Advisory.

State of Technology in Aging Services According to Field Experts and Thought Leaders

By:
Majd Alwan, Ph.D.,
Center for Aging Services Technologies (CAST)
American Association of Homes and Services for the Aging (AAHSA)

and

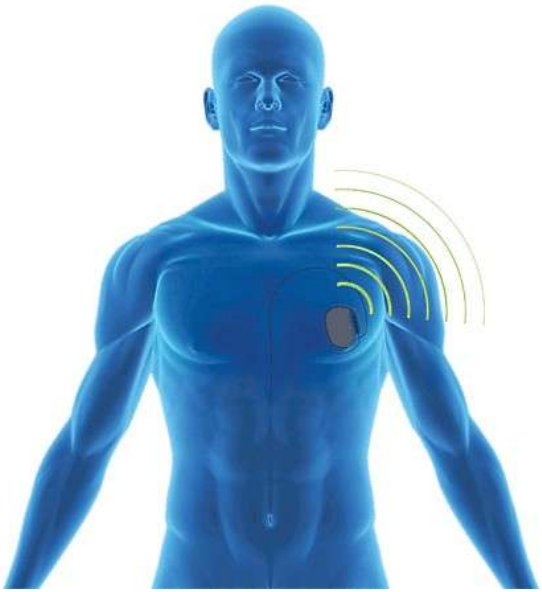
Jeremy Nobel, M.D., M.P.H.,
Harvard School of Public Health

Report Submitted to: Blue Shield of California Foundation

February 2008

cast™
Center for Aging Services Technologies

m.Health



Remote Health Monitoring and Chronic Disease Management

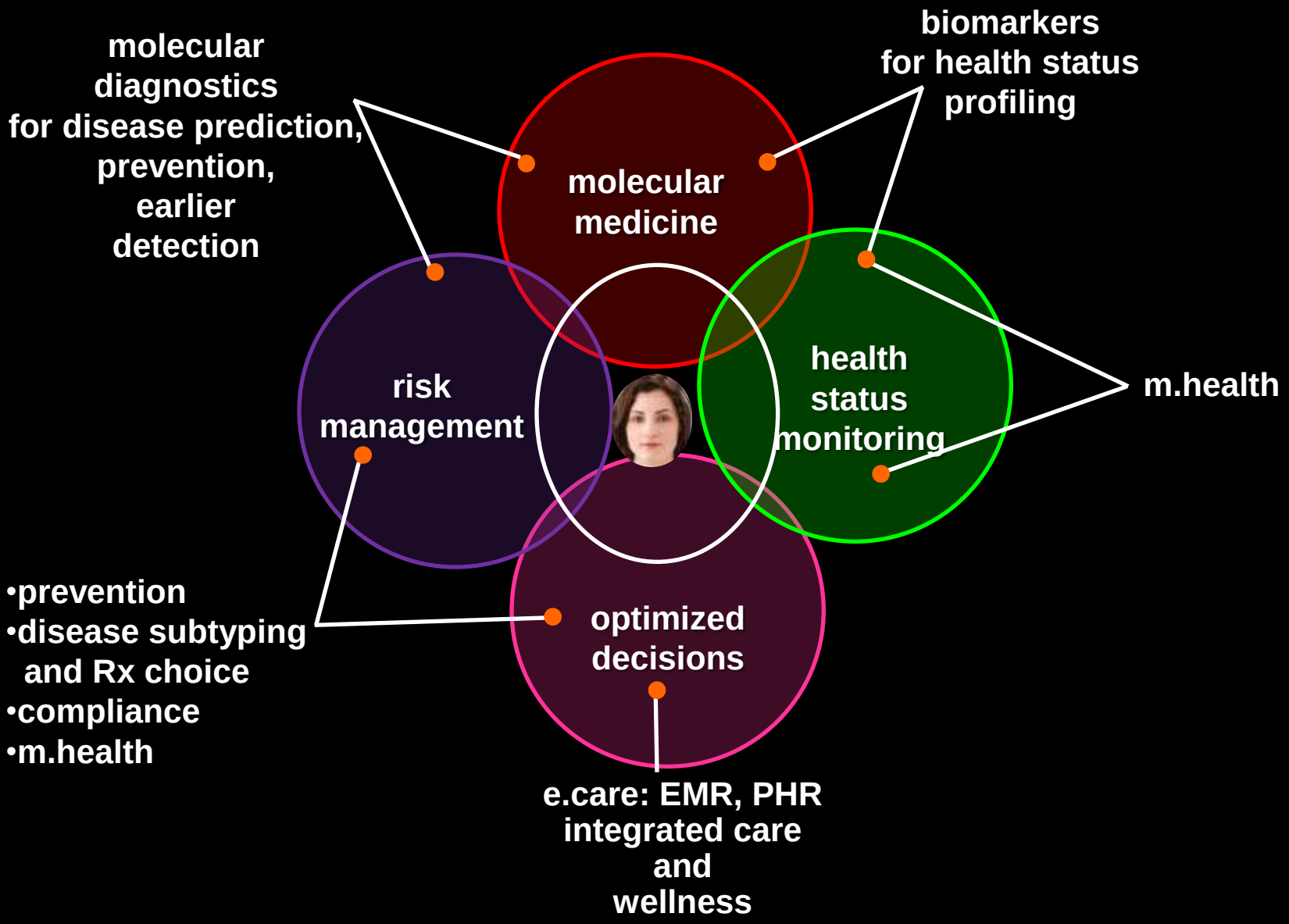
Lifestyle and Fitness

Information for Proactive Health Awareness (Wellness)

Social Networks and Consumer: Patient Empowerment

Source: R&D Directions May 2010

The Key Strategic Elements in the Evolution of Healthcare

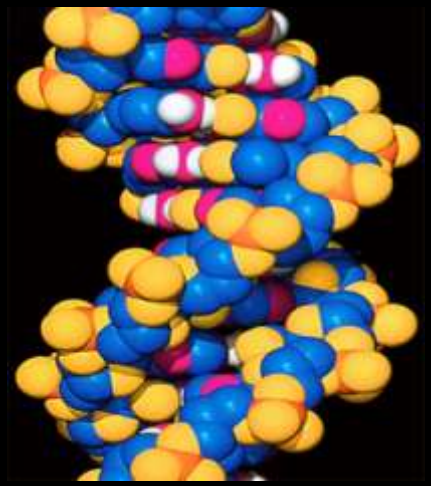


“Managing Mega-Data”

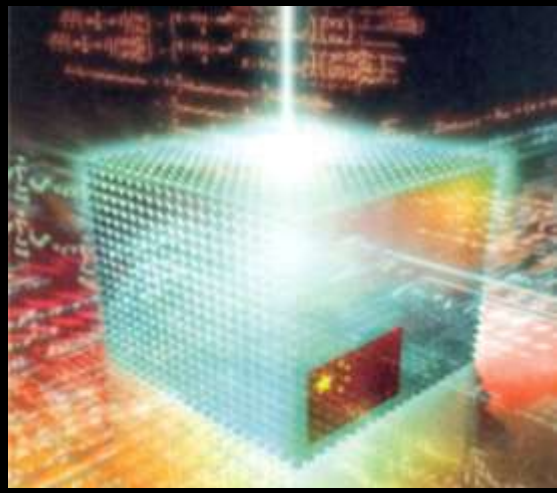
volume

scale

global networks

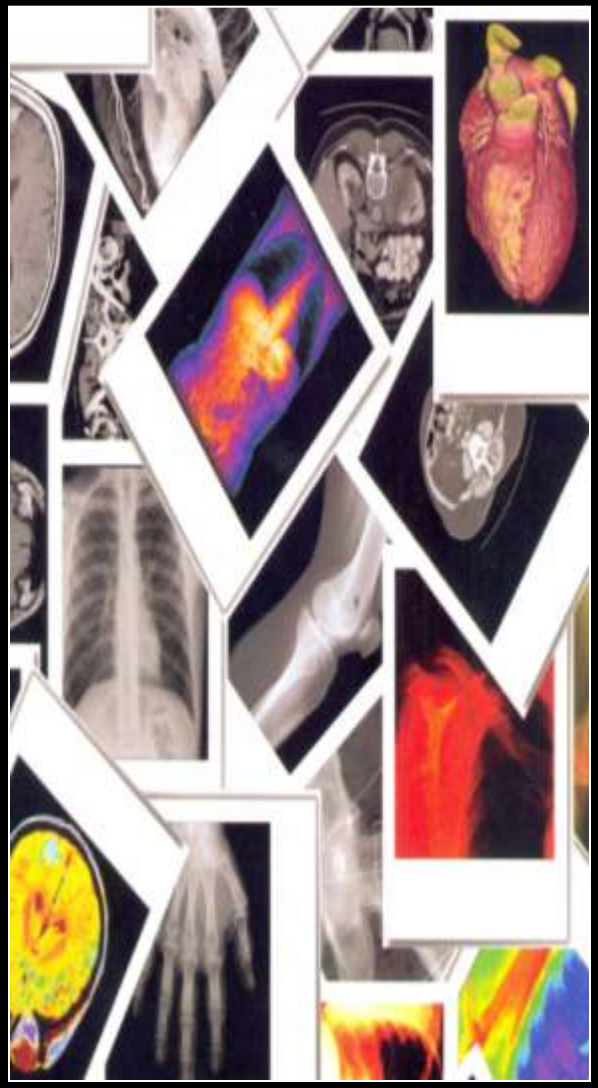


heterogeneity



integration

How Much New Technology Can We Afford?



The Global Public Health Challenge Posed by Rapid Urbanization in Developing Countries

High Disease Transmission

Lack of Safe Water

Toxic Waste

Major Deficits in Health Infrastructure

Expanded Eco-niches and Increased Zoonotic Risks

Bad Bugs and Few New Drugs

NO ESKAPE!

NO INCENTIVES FOR INDUSTRY INVESTMENT

Geo-demographic Information Systems (GIS): Real-Time, Front Line, Ground Zero Data from Field Sampling and Sentinels

The Global Food Supply: New Tensions and Risk of Conflicts

- food chain increasingly complex, international and inter-dependent
- food production over next 25 years Ξ total for last 10,000 years
- expanding middle class (1-2 billion) in NICs and some LDCs and increased demand for grain and meat projected to increase by 160% by 2020
- famines, shortages and food riots in LDCs
- least expensive sourcing also least safe
- the impact of climate change

The Economist

The battle of Bangkok

America's surprising primaries

Does Facebook know too much?

Labour after Gordon Brown

How to plug an oil well

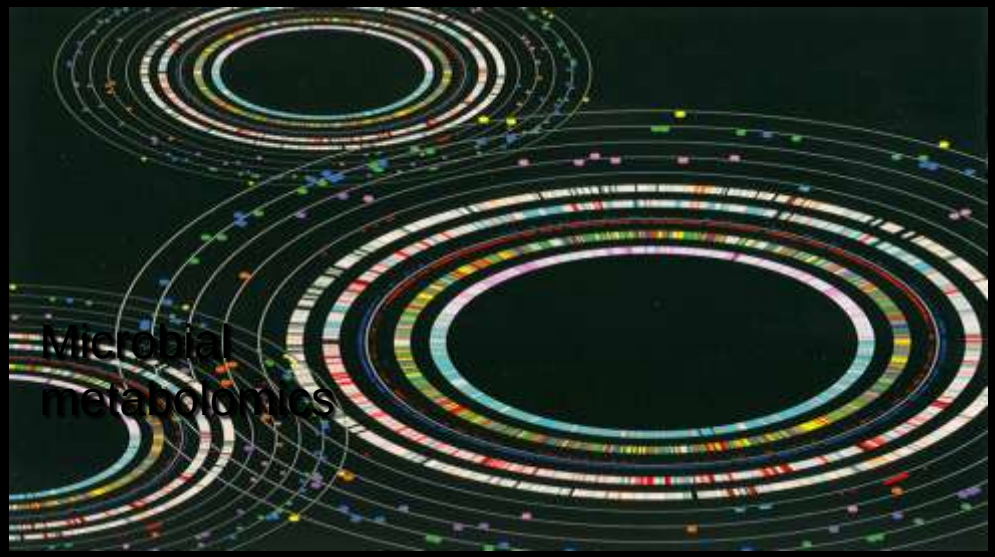
MAY 22ND–28TH 2010

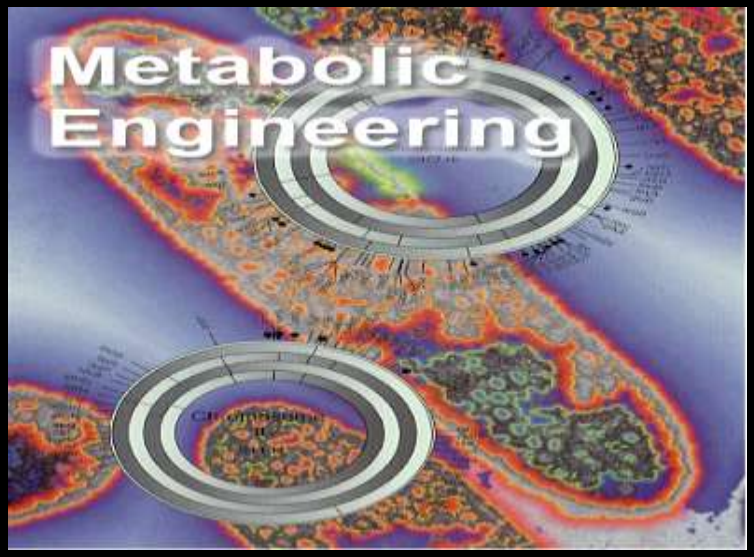
Economist.com

And man made life

The first artificial organism and its consequences

Synthetic Biology and Building A New Industrial Ecology Engineering Novel Organisms with Novel Functions





Synthetic Biology

- emerging technology with myriad applications across diverse industrial sectors and military applications

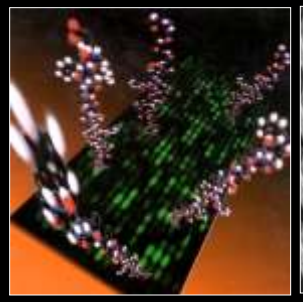
Healthcare

Public Health

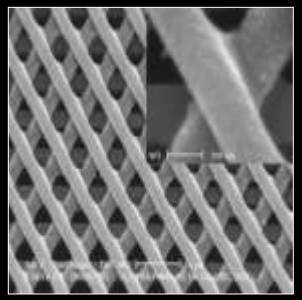
Agriculture

Functional Foods

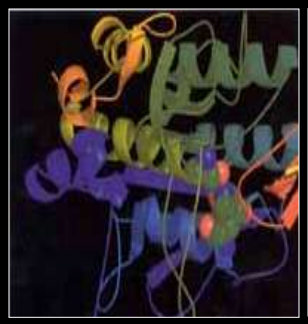
Novel Materials



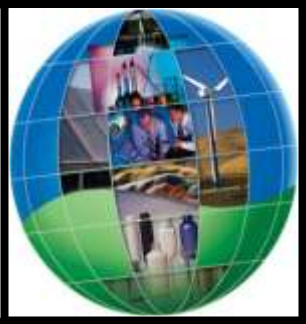
Textiles



Bioenergy and Biofuels



Industrial Enzymes



'Green' Mfg

Bio-remediation

Clean Water

Ubiquitous Sensors

Novel Materials

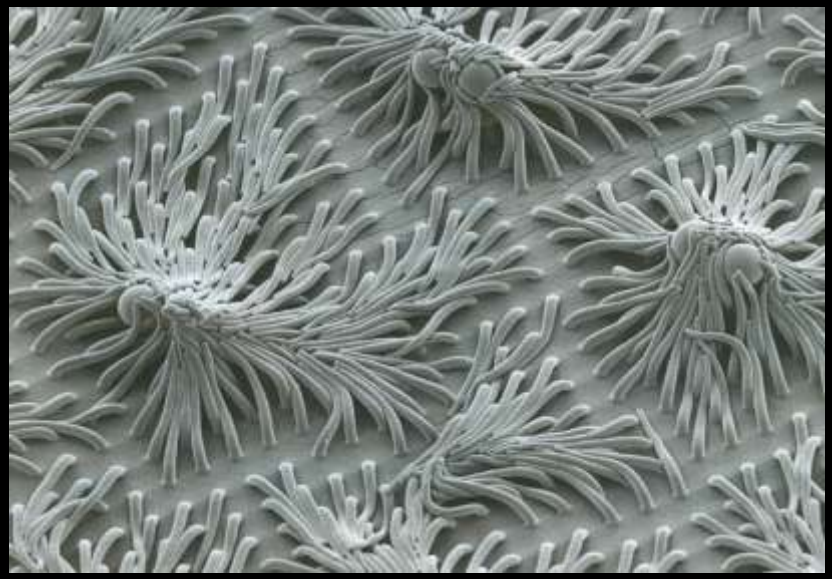
- flexible superfast electronics

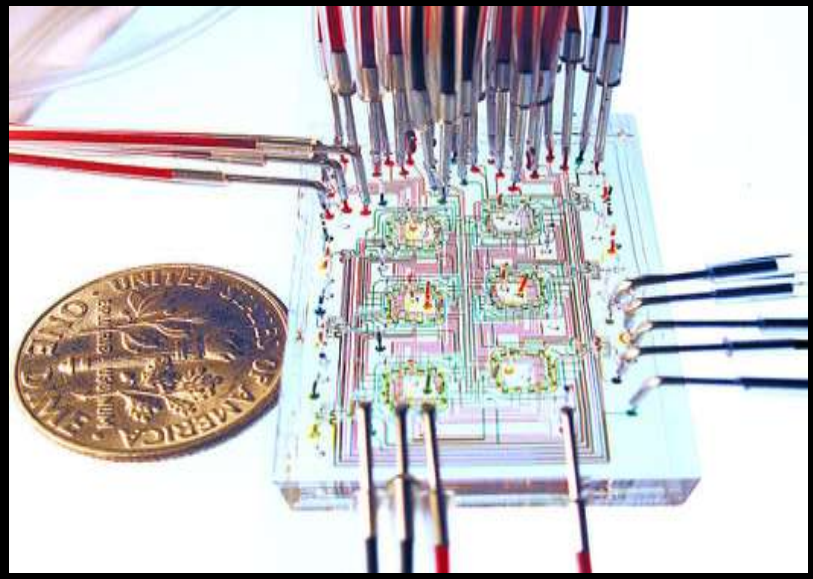
- non-reflective coatings
- black body materials

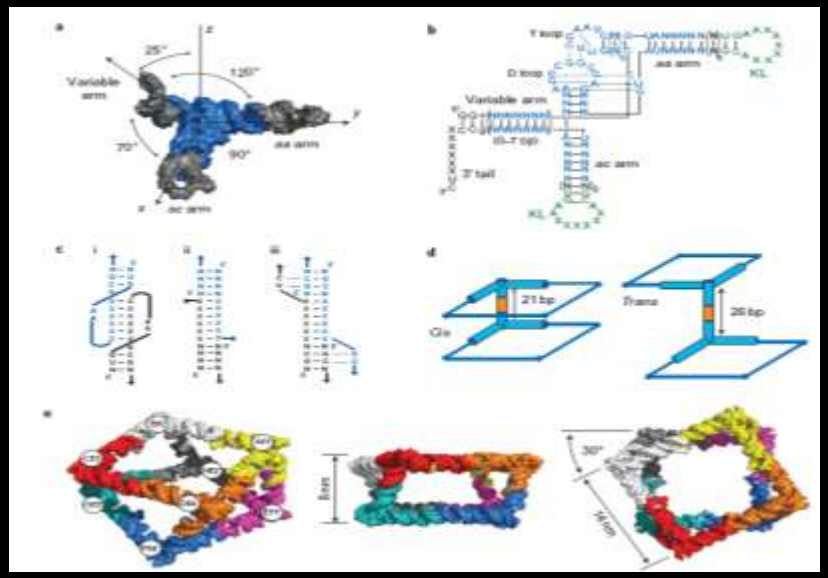
- metamaterials

- switchable materials

Nano- and Meso-Scale Engineering and Directed Molecular Assembly for Novel Materials, Sensors and Self-Assembling Devices







Robotics
4D Jobs: Dull, Dirty, Detailed and Dangerous





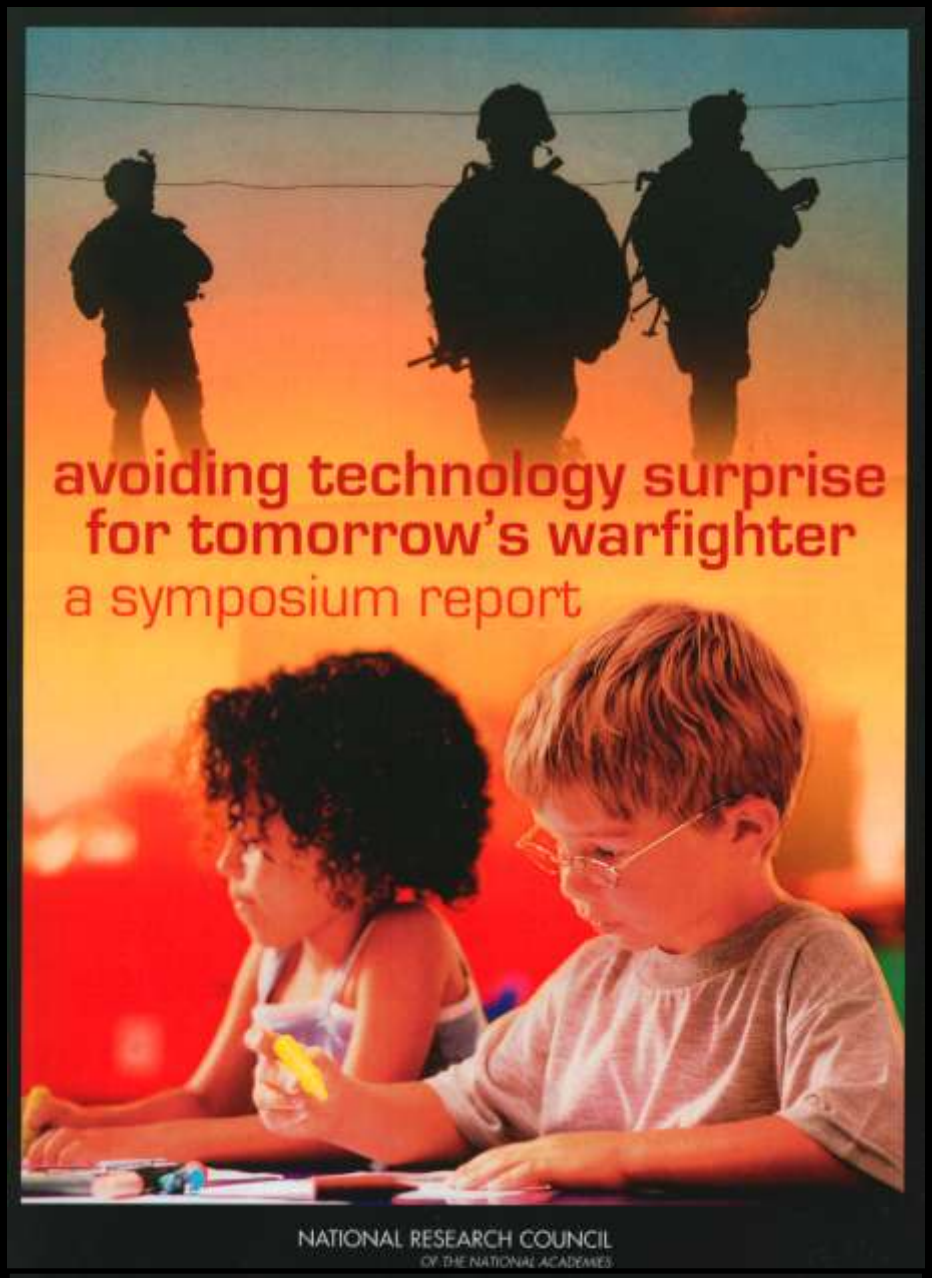

"Every age has its own kind of war,
its own limiting conditions
and its own peculiar preconceptions."

Claus von Clausewitz

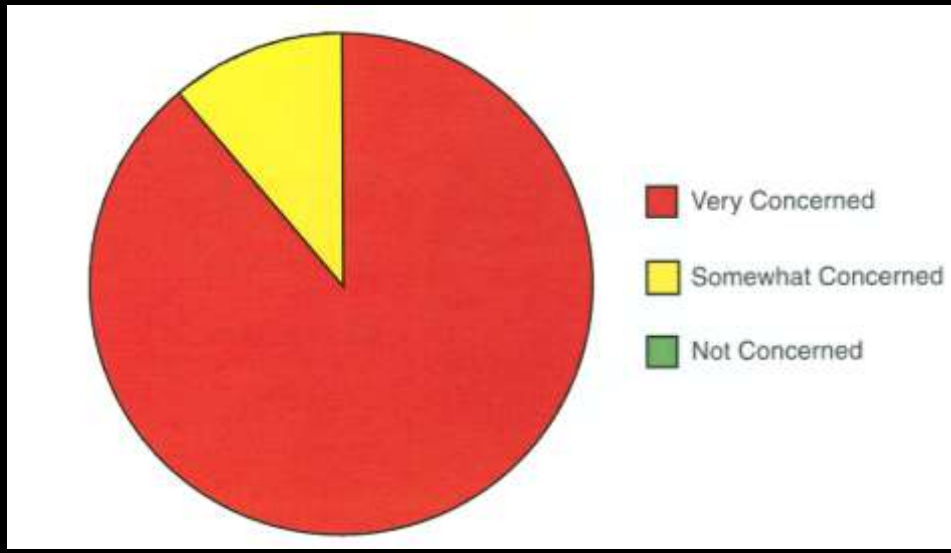
- security policy is determined by changing threats and their deployment
- there is no single security policy that serves all needs equally well

Convergence and Complexity in National Security

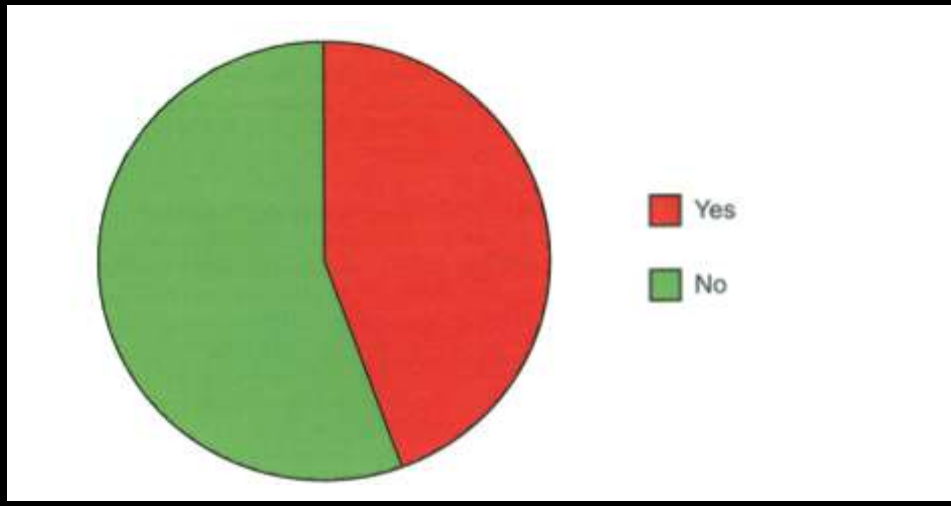
- new doctrinal dynamics for new threats
- asymmetric warfare, terrorism and non-state actors
- homeland defense
- WMD proliferation
- cyberspace, space, sea and air
- diplomacy, strategic engagement, new institutions and treaties
- instabilities generated by natural phenomena
  - disease, food production, water scarcity
  - depletion of natural resources
- openness of stability of worlds common spaces (the commons)



NRC Symposium
29 April 2009



How concerned are you about the potential for technology surprise?



Have you ever experienced surprise?

COMMISSION ON THE PREVENTION OF WEAPONS OF MASS DESTRUCTION PROLIFERATION AND TERRORISM

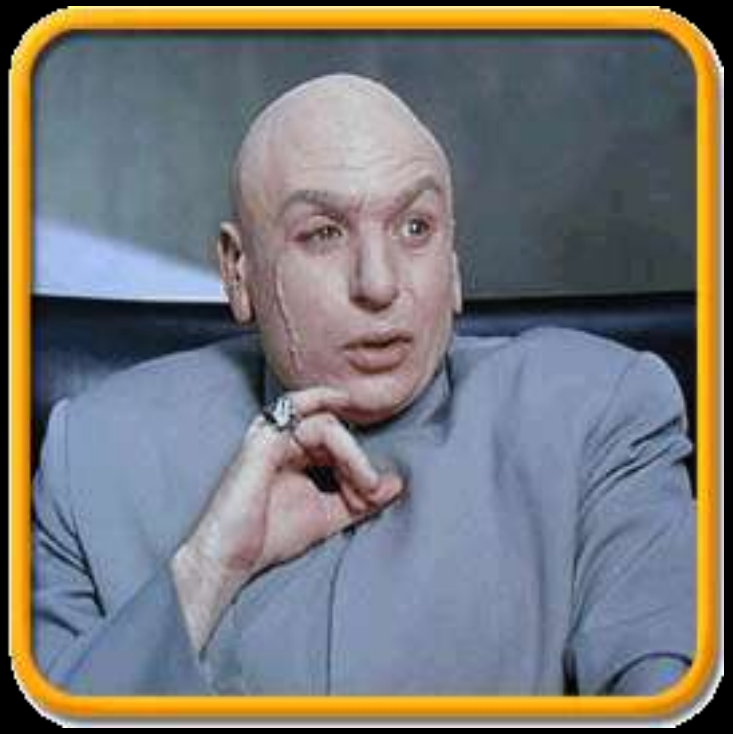
Prevention of WMD Proliferation and Terrorism Report Card

An Assessment of the U.S. Government's Progress in Protecting the United States from Weapons of Mass Destruction Proliferation and Terrorism

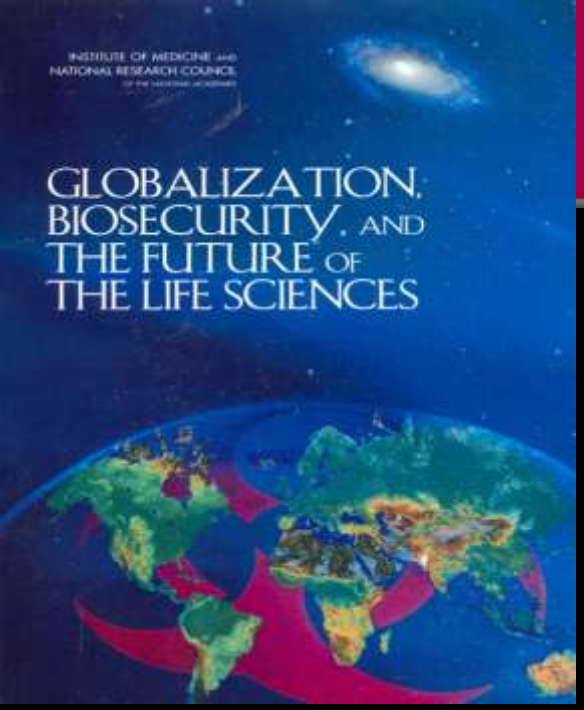
January 2010

"Each of the three last Administrations have been slow to recognize and respond to the biothreat"

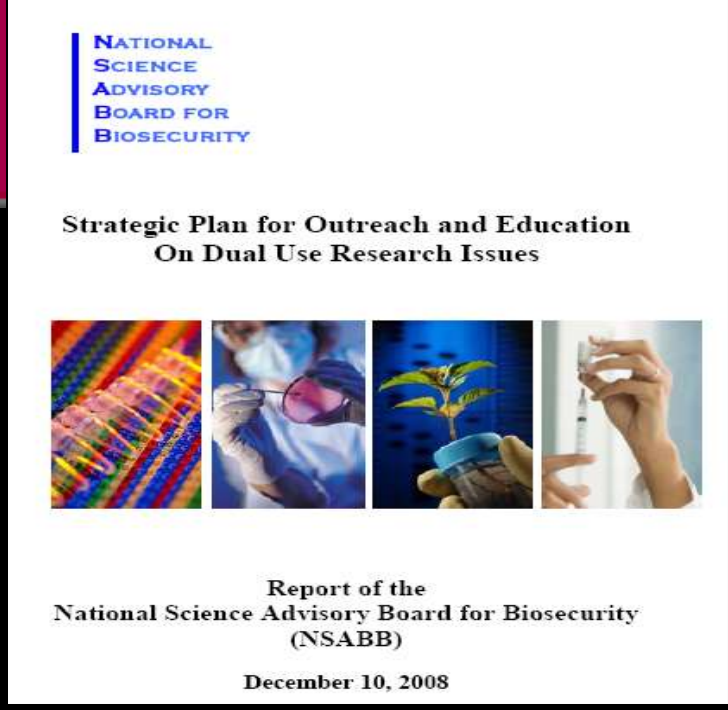
Future Trajectory Trends and Threat Expansion

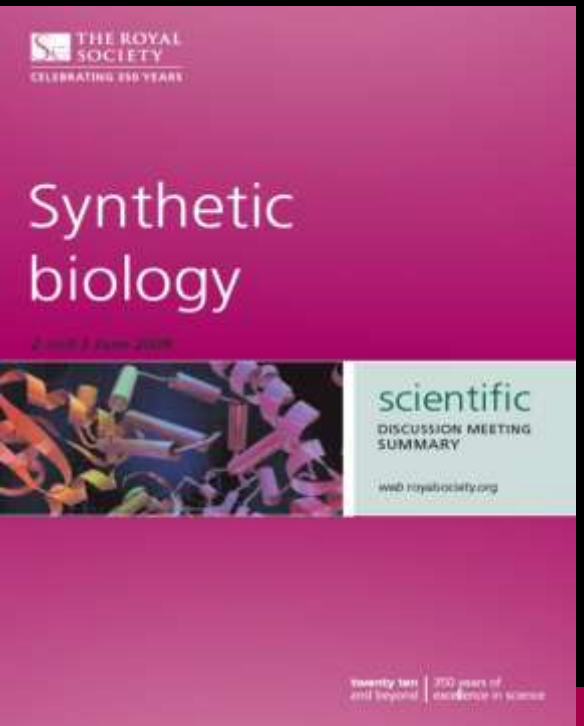


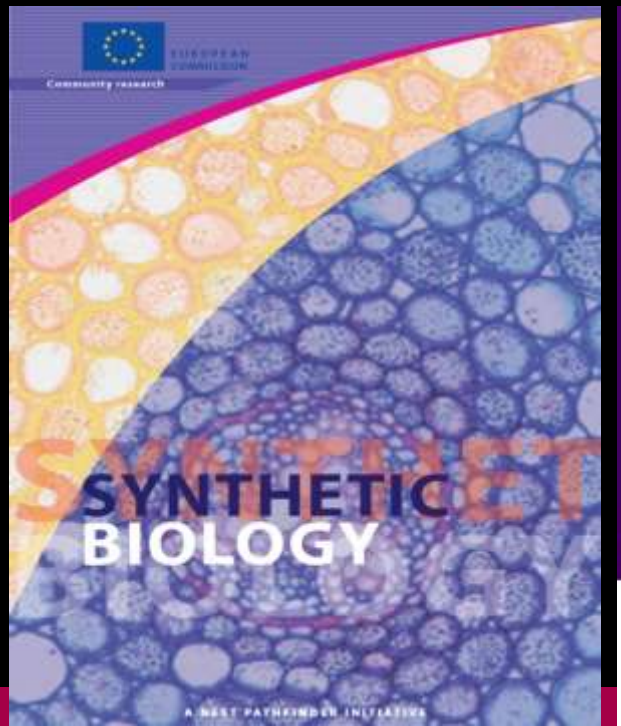
New ‘Dual-Use’ Technologies

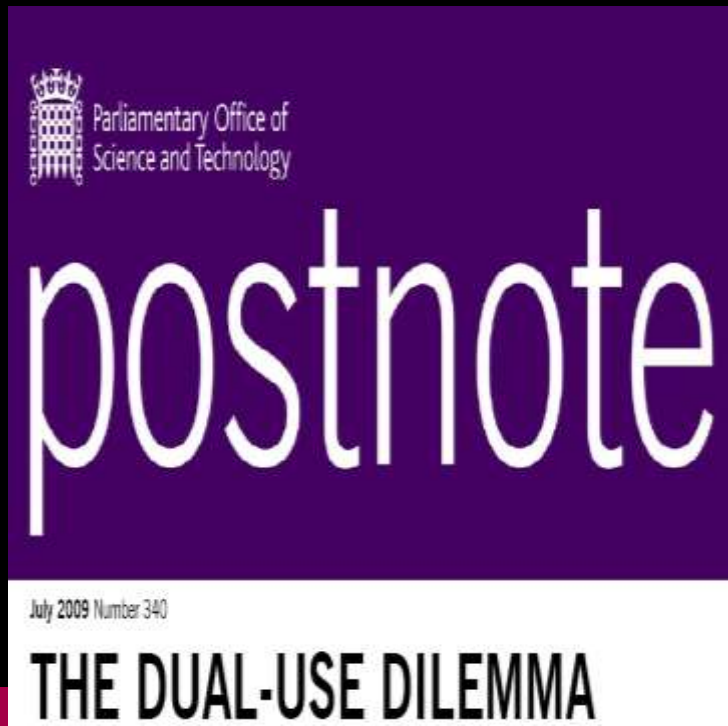

INSTITUTE OF MEDICINE AND
NATIONAL RESEARCH COUNCIL
GLOBALIZATION, BIOSECURITY, AND THE FUTURE OF THE LIFE SCIENCES


THE ROYAL SOCIETY
CELEBRATING 350 YEARS
New approaches to biological risk assessment
Science Policy Centre
INTERNATIONAL WORKSHOP
web.royalsociety.org/policy
twenty ten and beyond | 350 years of excellence in science


NATIONAL SCIENCE ADVISORY BOARD FOR BIOSECURITY
Strategic Plan for Outreach and Education On Dual Use Research Issues
Report of the National Science Advisory Board for Biosecurity (NSABB)
December 10, 2008


THE ROYAL SOCIETY
CELEBRATING 350 YEARS
Synthetic biology
scientific
DISCUSSION MEETING SUMMARY
web.royalsociety.org
twenty ten and beyond | 350 years of excellence in science


Community research
SYNTHETIC BIOLOGY
A NEST PATHFINDER INITIATIVE

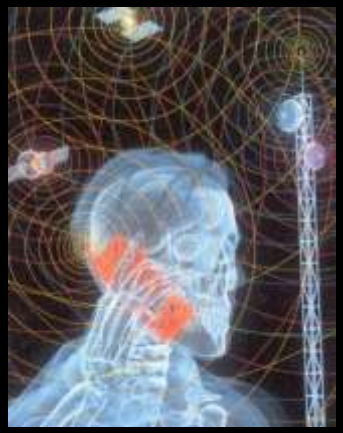

Parliamentary Office of Science and Technology
postnote
July 2009 Number 340
THE DUAL-USE DILEMMA

The New Strategic "Spaces" in Military Affairs and National Security

Systems and Synthetic Biology

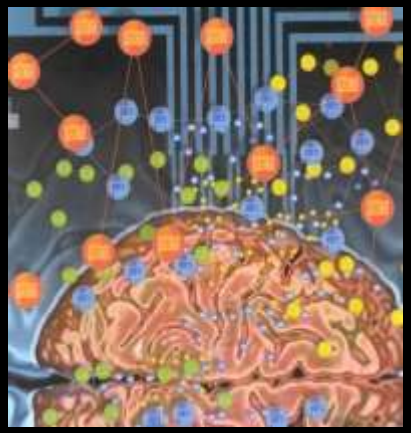
"Biospace"

Ubiquitous Sensing



"Connected Space"

Brain: Machine Interactions



"Smart Space"

Infocosm and the Metaverse

"Cyberspace"

Militarization of Space

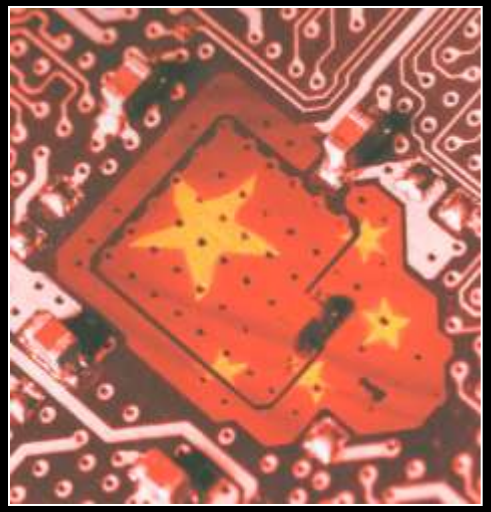
"Outer Space"

Constantly Emerging and Evolving Multi-Dimensional Matrices of Knowledge Ecologies

Global Challenges

Systems of Innovation

The PRC Strategy for Cyberwar



- "to cut off the enemy's ability to:
  - obtain, control and use information
  - influence, reduce and destroy decision-making and command decision"

  Wang Houqing and Zhang Xingye, Eds.
  Science of Campaigns
  National Defense University Press, 2000


Capability of the People's Republic of China to Conduct Cyber Warfare and Computer Network Exploitation

Prepared for

The US-China Economic and Security Review Commission

Information Systems Sector
7575 Colshire Drive
McLean, VA 22102
October 9, 2009

NORTHROP GRUMMAN


SAIC

China's Use of Perception Management and Strategic Deception

Prepared for the U.S.-China Economic and Security Review Commission
by
Dr. Eric C. Anderson with Mr. Jeffrey G. Engstrom
Science Applications International Corporation

Revised November 2009

Source: Jane's Int. Rvw. 3-10

Cyber-Attacks and Vulnerable Infrastructure: Compromising Critical Systems

Great Expectations: Intelligent Monitoring Systems for Improved Analysis of National Security Threats and Their Implications

- dramatic expansion in ‘signatures for interest’
- formidable data mining and context analytics
- new tradecraft
- new open sources (OSINT)
- new ways to validate sources
- new technical competencies
- new knowledge integration tools
- new behaviors

The Infocosm: Emerging Networks of Global Connectivity

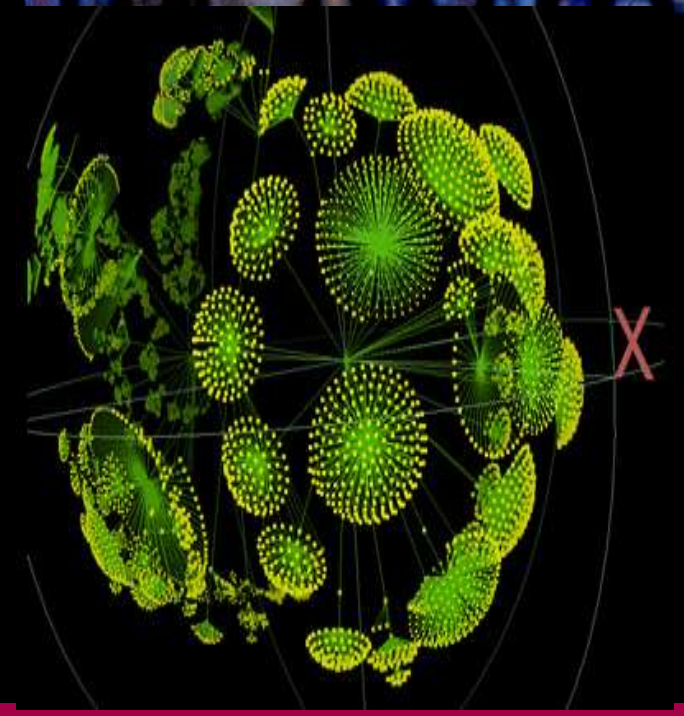
Ubiquitous Sensing: (Ambient Intelligence) AORTA: Always On, Real Time Analytics

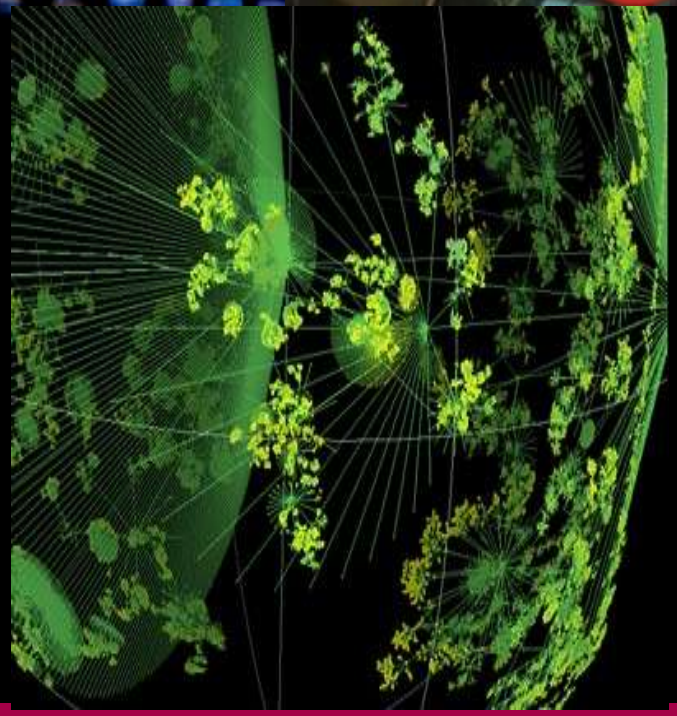
- instant information: anything, anywhere, anytime
- the internet of things
- miniaturized sensors and a monitored world
  - infrastructure, agriculture, health, finance, ecosystems, security, military
- from deep blue to deep space to inner space
- “intelligent” adaptive sensor networks (swarms)
- global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

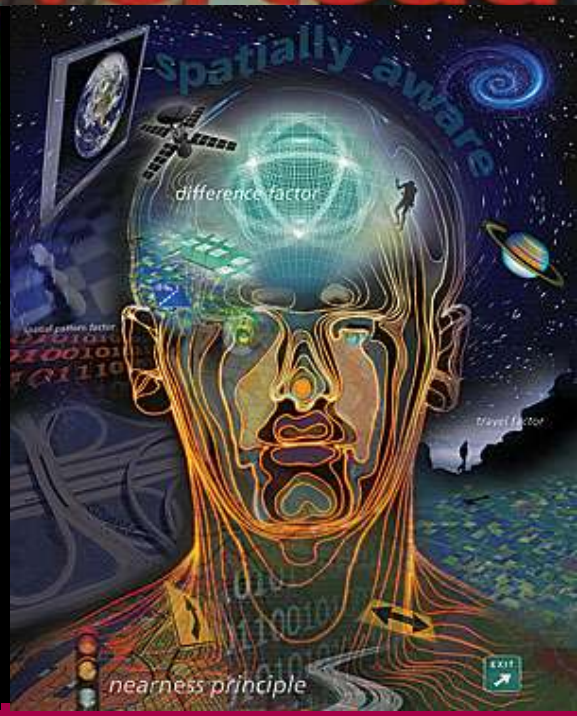
SIS: Societal Information Technology Systems- Ubiquitous Sensing in a Wireless World

- “digital traces”
  - expanded sensor repertoires of routine devices
- estimated 7 trillion wirelessly connected devices and objects by 2017 (c.1000/person)
- mobile devices and monitoring consumer habits
  - behavioral targeting
  - contextual targeting
  - social network profiling
- the politics of privacy
  - growing pressure for legislative oversight
  - US Energy and Commerce Internet Subcommittee
  - EU Article 29 Working Party
- two-thirds of new products now come with some electronic component or tracking potential

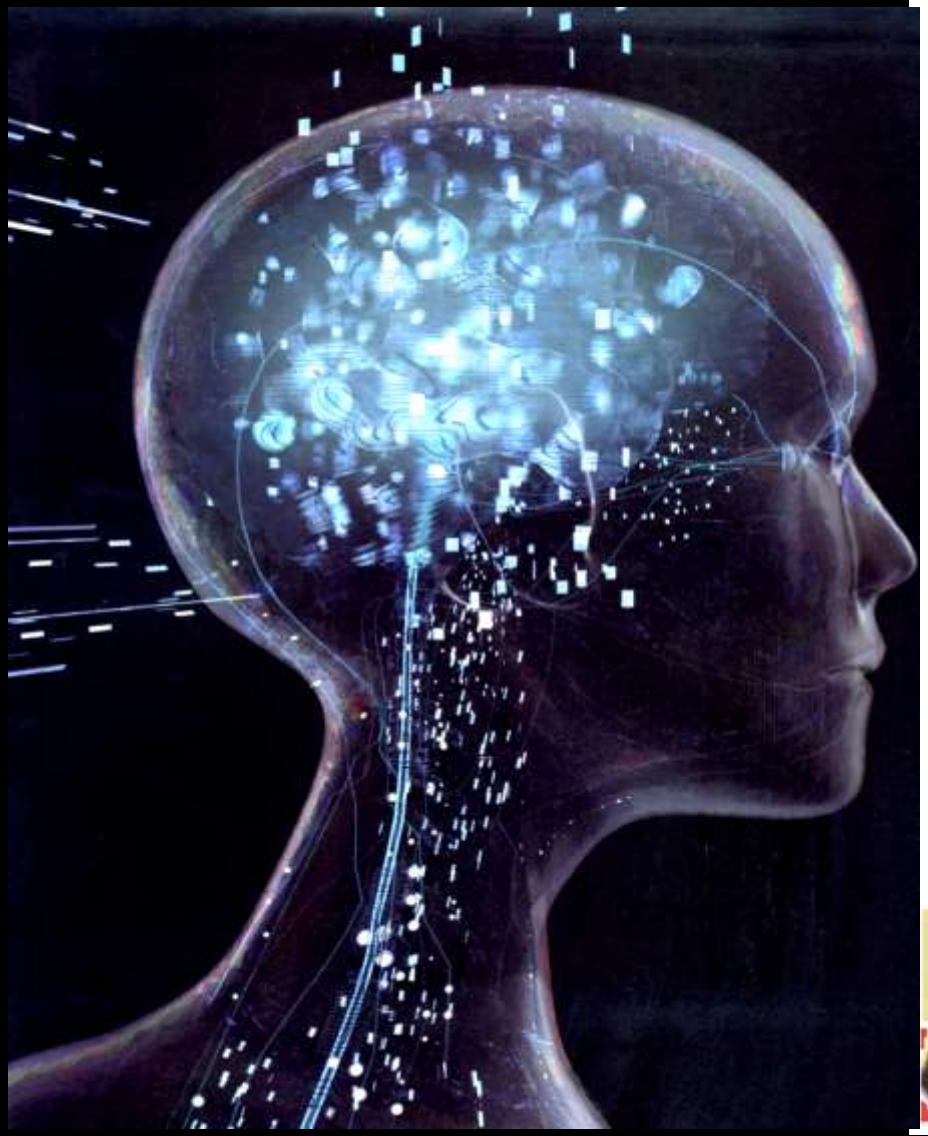
Enhancing Human Capabilities to Use the Increased Volume, Diversity and Complexity of Information Flows

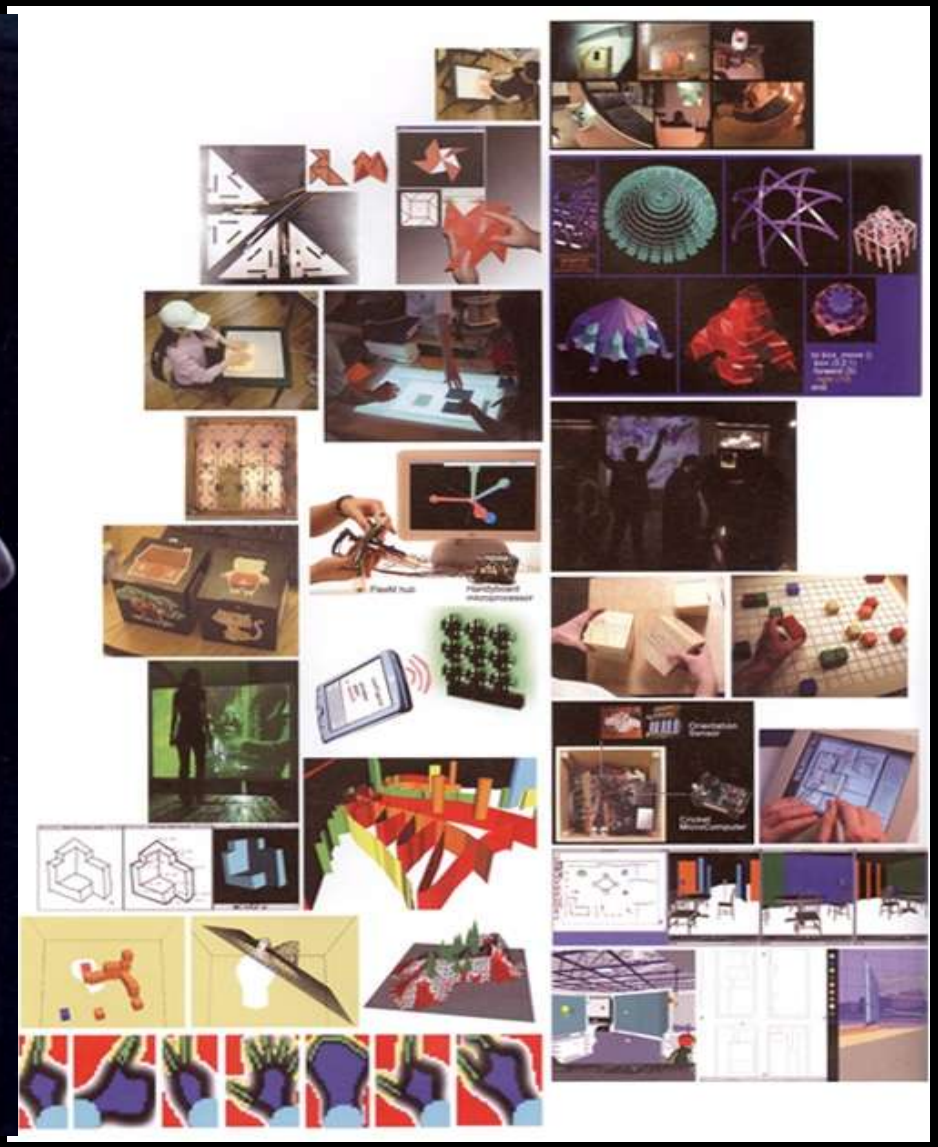






Cognitive Biology, Customized Data Formats and Visualization for Improved Decision-Making





Exabyte World*

- multipetabyte data sets emerging
  - national security, big science
  - medical imaging
- Large Hadron Collider estimated 15 petabytes/year
- smart electricity grid
  - stream of four numbers transmitted every second (current, phase, frequency, time)
  - 0.05 gigabytes per customer/year
  - 100 million customers ≡ 50 petabytes/year before compression

*J. Beyea (2010) Science 328, 979

The Intellectual Frontiers of Computer Science

- network science and analytics
- mobile computing
- enterprise computing
- distributed systems and grids
- cognitive biology and user-interface design
- visualization
- artificial intelligence
- cyberspace protection

Artificial Intelligence and Automated Invention

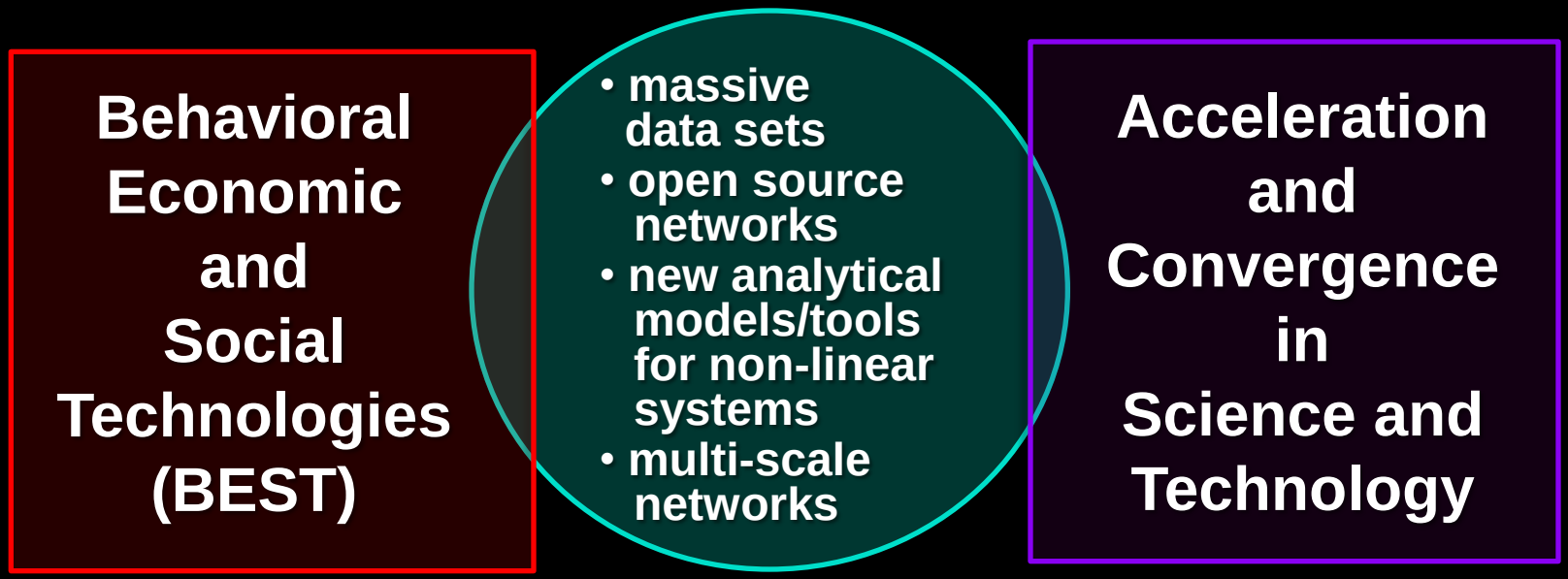
- next-generation (synthetic) neural networks
  - self-assembling
  - use of parallelism for process subdivision: “imagitrons: and “perceptrons” (Imagination Engines)

Ideas Autonomously and Intelligently Designed by Non-Human, Machine Intelligence

Touch the Future:
Computing Platforms as Socio-Biological Systems

- modification of social patterns
- modification of cognitive structures
- memes as selection agents
- “the brain(s) in the cloud”

The Marriage of the Hard and Soft Sciences
New Networks of Intellectual Fusion



Social Sciences

- poor cousin to the hard sciences
- from no data to data overload
- vast increase in computing power and limitless pool of participants profiled via internet actions
- unprecedented opportunity to study human behavior and interactions in real time
- define domains in which individual or collective behavior dominates

Can Economics Be Transformed from the Dismal Science into Definitive (Predictive) Sociology?

The Biology of Decision-Making: Understanding Cognitive and Confirmation Biases

"Extraordinary Popular Delusions
and the
Madness of Crowds"

Charles Mackay, 1841

"Irrational Exuberance"

Alan Greenspan
Chairman, US Federal Reserve

Myths, Rumors and Irrational Behavior: Cognitive and Confirmation Biases

- cultural reinforcement by herd psychology
- amplification by the toxic echo-chamber of the modern media
- higher predisposition for acceptance in periods of uncertainty, stress, disorder, fear
- the sunk cost fallacy: reluctance to acknowledge/reverse major decisions with high economic/emotional/personal tolls
- decreased ‘generalized trust’ but increased ‘particularized trust’
  - Farhad Manjo: True Enough-Learning to Live in a Post-Fact Society
- prewired mechanism for resolution of cognitive dissonance?

Ingenuity Capital

- social
- intellectual
- financial
- institutional
- legal

"Why Johnny Can't Read"
Rudolf Flesch 1955

"Why Johnny Can't Write"
Newsweek 8 Dec. 1975, pp 58-65

"Why Johnny Now Speaks Like His Texts and His Tweets"

REPORT TO THE PRESIDENT

PREPARE AND INSPIRE:
K-12 EDUCATION IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATH (STEM) FOR AMERICA'S FUTURE

Executive Office of the President

President's Council of Advisors on Science and Technology

SEPTEMBER 2010

PREPUBLICATION VERSION

Source: http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-stemed-report.pdf

CHANGE THE EQUATION

"It's time to restore science to its rightful place, and . . . to wield technology's wonders to meet the demands of a new age." President Barack Obama

Source: http://www.changetheequation.org/

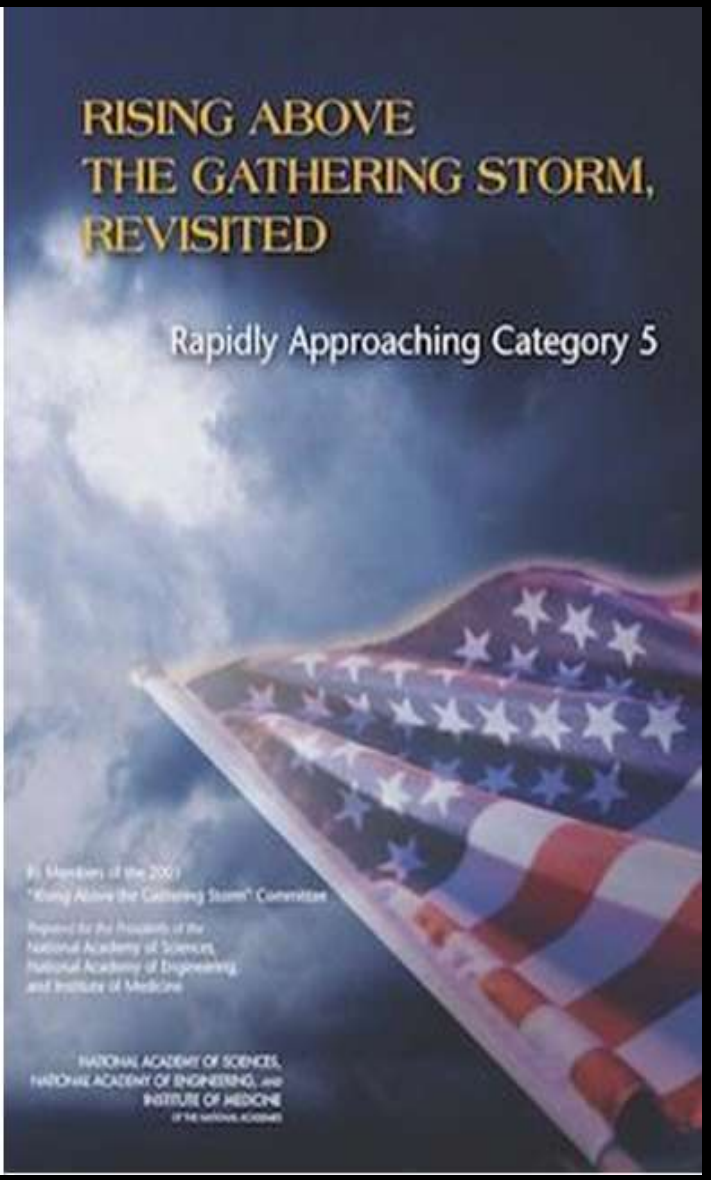
"It is common for young men and women
who have had years of education
to know nothing of the world."

Doris Lessing
Acceptance Speech for Nobel Prize
in Literature

U.S.News & WORLD REPORT

Annual Survey 2010

"If colleges were businesses,
they would be ripe for hostile takeovers
complete with serious cost-cutting
and painful reorganizations."


RISING ABOVE
THE GATHERING STORM,
REVISITED
Rapidly Approaching Category 5
NATIONAL ACADEMY OF SCIENCES,
NATIONAL ACADEMY OF ENGINEERING, and
INSTITUTE OF MEDICINE


EXECUTIVE OFFICE OF THE PRESIDENT OF THE UNITED STATES
REPORT TO THE PRESIDENT
JUNE 2005
COMPUTATIONAL SCIENCE:
ENSURING AMERICA'S
COMPETITIVENESS
PRESIDENT'S
INFORMATION TECHNOLOGY
ADVISORY COMMITTEE


One Hundred
Thirty-Three
Thousand
H-1B Visa
Applications Submitted
In Two Days

Science Education

- truth is an issue of intellectual integrity
- science education is an ethical issue
  - informed (literate) citizenry in era when increasing problems and solutions involve S&T
  - endow individuals with capabilities to evaluate evidence
  - assess risk versus benefit
  - demand informed policy and responsible governance
  - opportunities denied or realized
- some would argue it's also moral issue

Business Education: Have MBA Programs Distorted Priorities and Metrics for Business Performance?

- aspiration of best graduates to join major financial and consultancy houses
- ranking of B.schools by graduate starting salaries
- primary source of now discredited financial market prediction models
- narrow, disproportionate focus on finance/economics versus analysis and management of the trends shaping escalating complexity
- predominant curriculum channeling to non-S&T topics creates dangerous knowledge void in corporations/financial markets

Nature (2010) 467, 264

Curriculum of the future?

The lectures at Singularity University cover ten core topics:

Futures studies and forecasting

Policy, law and ethics

Finance, entrepreneurship and economics

Networks and computing systems

Biotechnology and bioinformatics

Nanotechnology

Medicine and neuroscience

Artifical intelligence and robotics

Energy and environmental systems

Space and physical sciences

Automated Industrial Processes

- cost reduction, open access and cloud computing as key drivers of automated invention technologies
- prosumers and continuous redesign of products/services
- parallel improvements in low cost automated fabrication tools for manufacturing (plus offshoring)
- escalation of dual use dilemma and hacker threats
- implications for IP law

Automated Industrial Processes

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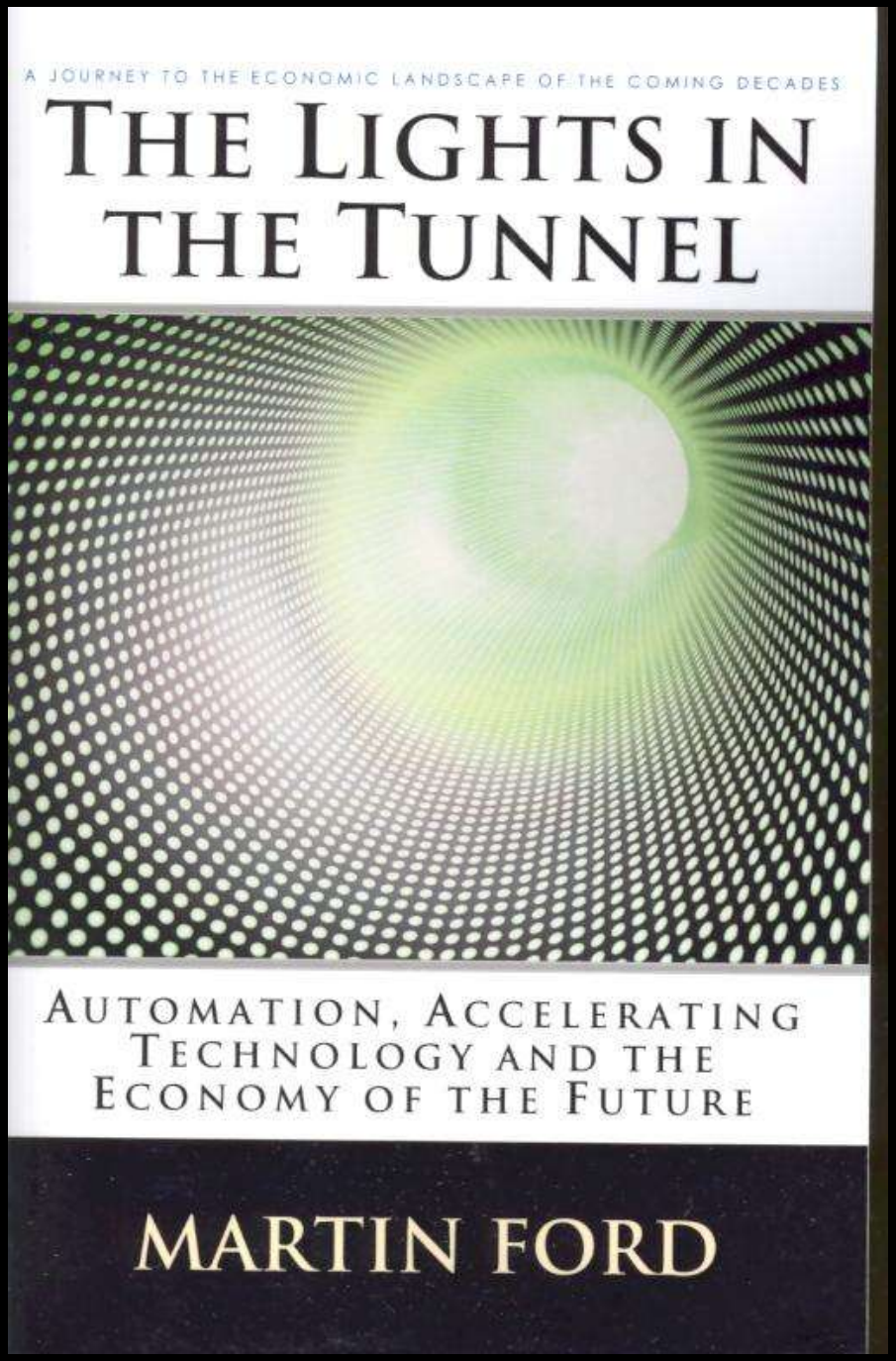
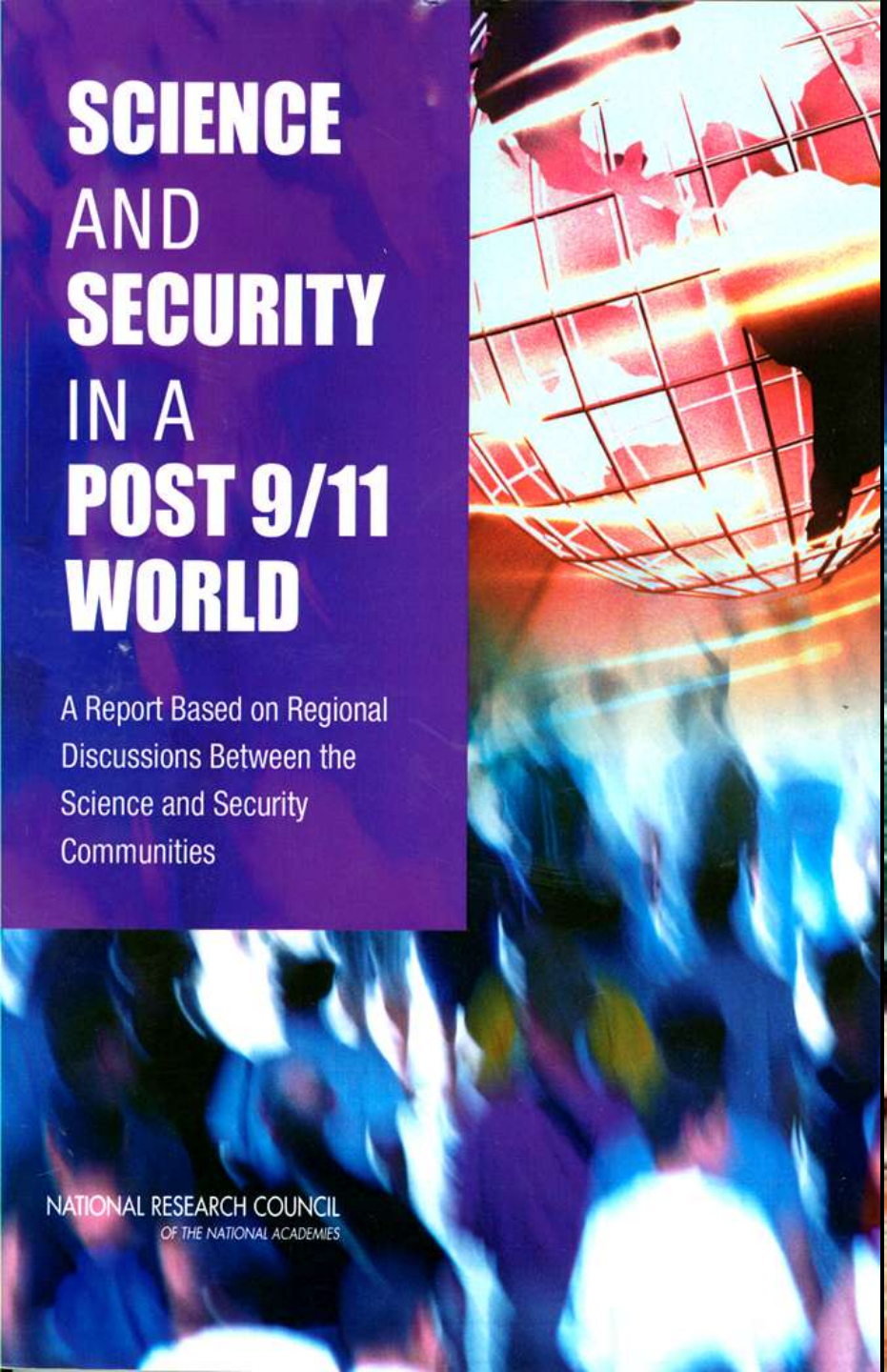
Impact on Employment and Higher Education Curricula


A JOURNEY TO THE ECONOMIC LANDSCAPE OF THE COMING DECADES
THE LIGHTS IN THE TUNNEL
AUTOMATION, ACCELERATING TECHNOLOGY AND THE ECONOMY OF THE FUTURE
MARTIN FORD

SCIENCE AND SECURITY IN A POST 9/11 WORLD

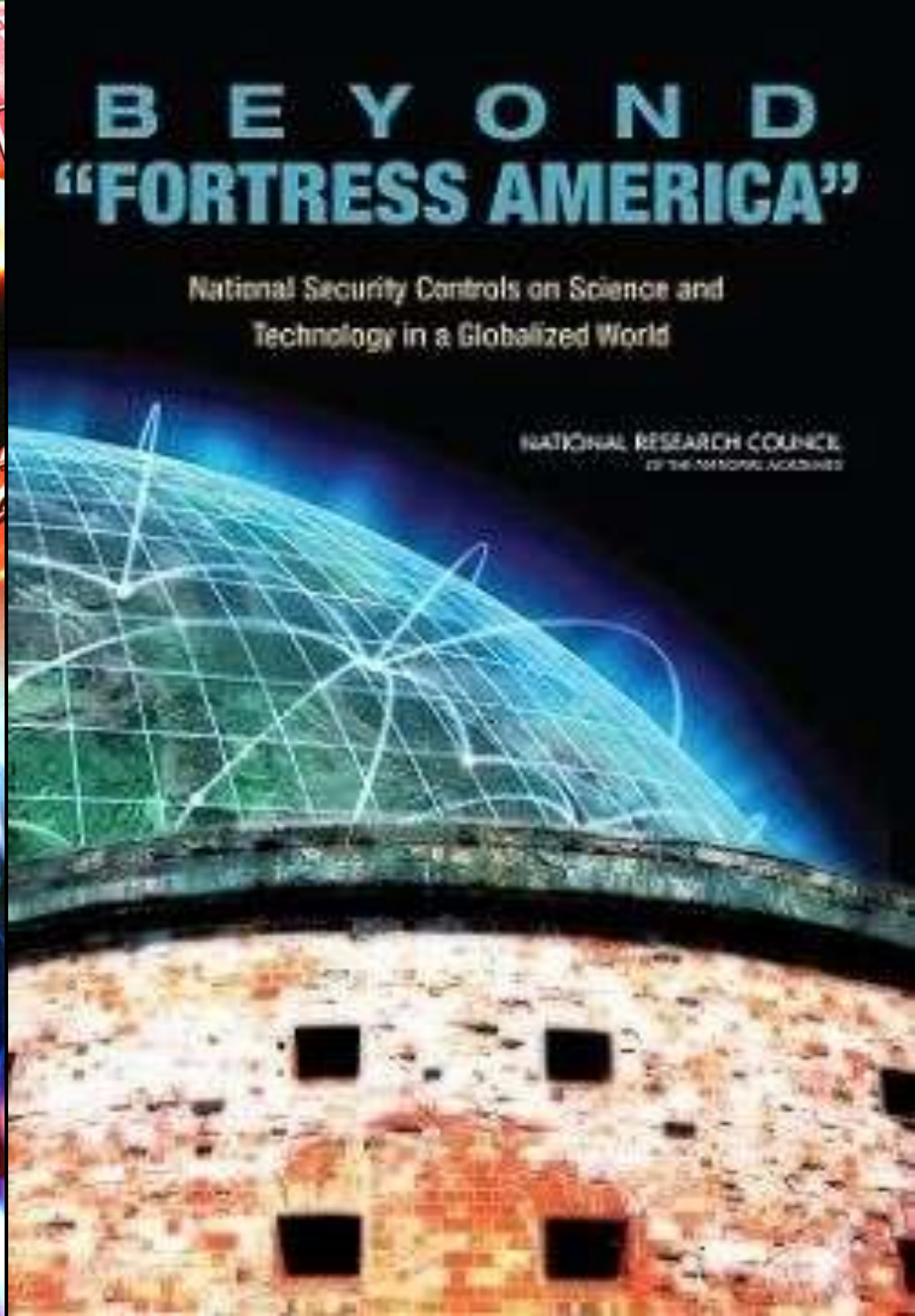
A Report Based on Regional Discussions Between the Science and Security Communities



NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES

BEYOND "FORTRESS AMERICA"

National Security Controls on Science and Technology in a Globalized World



NATIONAL RESEARCH COUNCIL

“Fortress America”: NRC Report

- outdated USG export controls created market niche for foreign competitors

aerospace

  - European Aeronautic Defence and Space Company
  - Swiss Propulsion Laboratory

satellites

  - Thales Alenia Space

carbon composites

  - M. Torres (Spain)

miniaturized electronics

  - multiple countries

- off-shoring by US companies to avoid export controls and access foreign markets

Asymmetries in Global Trade

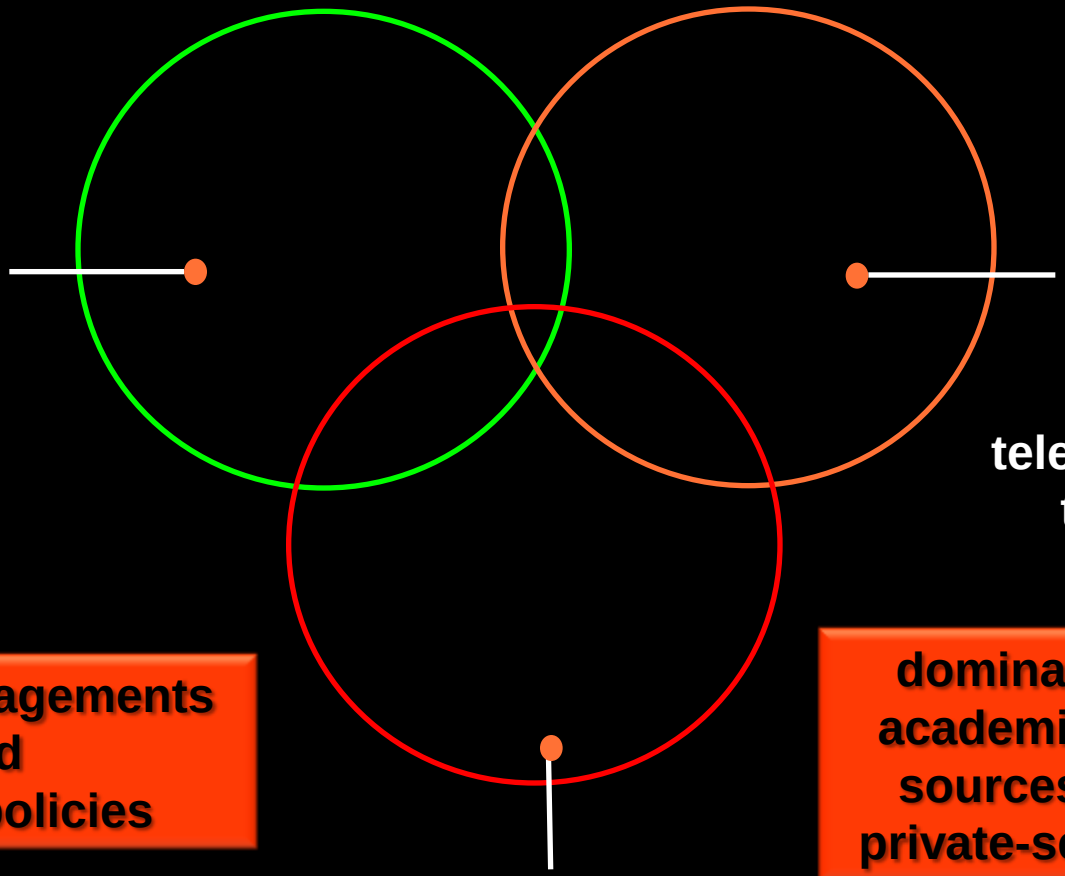
- tolerance of dumping, currency manipulation and other free-trade distortions by neomercantile countries
  - accelerates offshoring of US-based production
  - lower cost seen as benefit to US consumer despite impact on domestic industry
  - opponents condemned as Smoot-Hawley protectionists
- coercive agreements for both investment and technology transfer for access to foreign markets
- disadvantageous bilateral agreements to promote perceived higher geopolitical priorities
  - PRC ARJ21 commuter jet and Taiwan

- uncoupling of the strategic primacy and attention accorded geopolitics/national security from formulation of robust economic and industrial policies

National Policies

purposeful doctrine and proactive strategies

predominantly reactive short-term policies



geopolitics

military affairs

national security

agriculture
education
energy
environment
financial markets
healthcare
telecommunications
transportation

erratic engagements and ad hoc policies

dominant input from academic/civil service sources with limited private-sector expertise

trade, industry, intellectual property
competitiveness, sustainability

Current Regulatory Frameworks Are Anachronisms

- traditional regulatory models designed for oversight of “one purpose” industries
- lack experience, knowledge and agility to shape and regulate emerging industrial ecosystems
  - inter-agency communication and decision authorities
  - convergent industries
  - global supply chains
  - internet commerce and crime
  - state-owned industries versus free market policies
  - implications of emerging technologies
- undermine competition and innovation
- susceptible to ‘gaming’ by anti-industry activists

The Schizophrenic Attitude Towards Strategic Planning for National Competitiveness

- pervasive distrust of corporatism in academia, media and politics

versus

- time, cost and risk to master technical complexity
- legislation and regulation focused internally to limit competitive dynamics of domestic base becomes de facto industrial policy and failure to assess competitive risk from foreign investment patterns

versus

- timidity in opposing free-trade distortions and asymmetries imposed by emerging neo-mercantile nations

National Industrial Policies

- 863 Program
- State-Owned Assets Supervision and Administration Commission (SASAC)
- world's largest sovereign wealth fund

- Council on Economic Planning and Development
- Green Silicon Island

- Singapore Development Authority
- A*

- Ministry of International Trade and Industry

The Dynamics of Neo-mercantilist Markets

- explicit targeting of specific industries
- investment and policy support to achieve first-mover advantage and economy of scale
- explicit or implicit requirements for foreign companies to invest and transfer technology as condition for market acceptance
- currency undervaluation to promote exports
- asymmetric trade agreements that favor offshoring of US-based production promoted for geopolitical objectives

Resources Chokepoints

- control of 95% world's supply of rare earth metals
  - lanthanides (57-71)
  - scandium (21)
  - yttrium (39)
- curtailed export quotas
  - 48,5000 tonnes (2004)
  - 31,310 tonnes (2009)
  - 35,000/year for next 6 years
- aggressive courtships of mineral-rich African regimes

- explicit industrial policy via national development bank (BNDES)
- loan interest less than half market rates for targeted industries
  - biotechnology (agriculture), pharmaceuticals, IT
- support of M&A activity by Brazilian companies
  - Brasil Foods
  - Braskem(petrochemicals)
  - Electrobras (electricity)
- Petrosal
  - new sovereign wealth fund to develop *pre-sal* off-shore oil reserves
  - $224 billion over next five years
  - 65% of equipment must be purchased from Brazilian companies

Dangerous Times

- public confidence in every economic and political institution at all time low
- political divisiveness, short-termism and technical literacy
- anachronistic policies and inadequate institutional agility to respond to escalating challenges
  - accelerating change
  - global inter-dependencies
  - ‘emergence’ and radical discontinuities
- people respond irrationally when afraid
- absent feeling reassured people gravitate to whatever fills the void

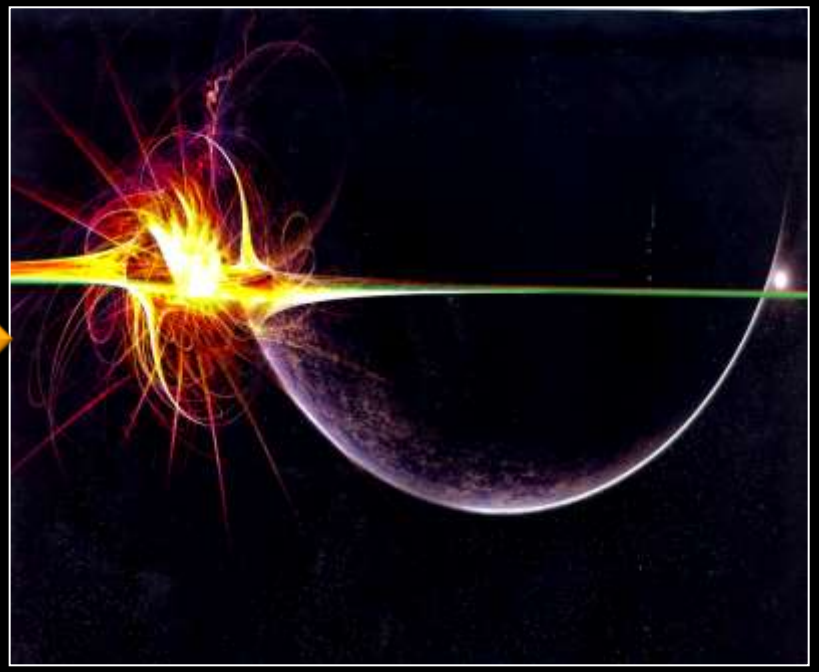
The Multi-Dimensional Complexity of Innovation

Features of Complex Adaptive Systems: Highly Optimized Tolerance and Far-From Equilibrium States

Convergence

- novel interactions between previously distinct agents/networks/systems

Emergence

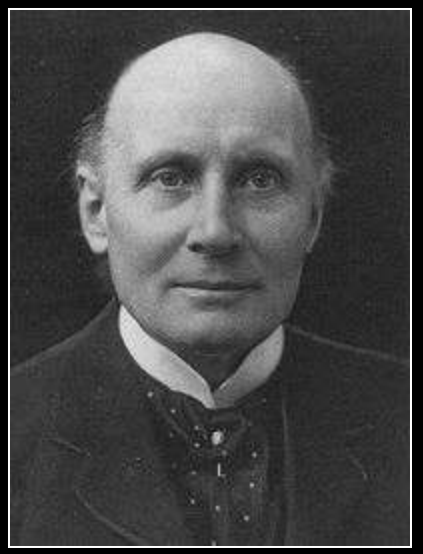


- new patterns of convergence trigger new system with highly different and often unpredicted features

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

“Unintended Consequences” Robert Merton (1936)

- omnipresent component of new socio-technological systems
- anticipation and imagination are crucial in introducing new elements into tightly coupled systems
- effects of changes and breakdowns can propagate quickly, often unseen, into domains far from their origin
- stability and safety are not static phenomenona



**“We think in generalities,
but we live in detail.”**

Alfred North Whitehead

The Fundamental Question

"Has our capacity to build complex systems transcended our evolutionary cognitive abilities and agilities to comprehend multidimensional and non-visual data and devise ways to mitigate the intrinsic risks generated by escalating complexity?"

- **defines the intellectual and pragmatic terrain in which human populations and individuals must identify, analyze and respond to complexity**

The Imperative to Develop New Analytics for Design Parameters in Complex Systems and Predictive Modeling of Non-Linear Dynamics

- dangerous knowledge void in relation to rapid evolution of large scale networked systems
- poor prediction of precursors of critical transition or cascading system collapse
  - tipping point, critical thresholds, catastrophic bifurcations
  - “normal accidents” (C. Perrow)
- evolution of systems too complex to be understood and too important to be turned off

EARLY WARNING SIGNALS OF CRITICAL TRANSITIONS

“Plug the Damn Hole”

President Obama
Alleged commentary to staff
Washington Post 25 May 2010

THE 29 July 2010

Ignorance lays Parliament open to ‘nonsense debates’

Andrew Miller admits that busy MPs avoid science policy as it is too challenging. Paul Jump reports

ties and science minister David Willetts, preferring to get a sense of his "general philosophy".

He was impressed by the minis-

He dismissed criticism that the committee was light on direct scientific expertise, adding that "there is also merit in any committee being

The Retreat from Complexity: The Insularity and Risk-Aversion of USG Analytical and Decision Frameworks

- ‘too hard’ problems
- denial, avoidance, paralysis
- sustained focus/funding on ‘the linearly familiar’ and funding the ‘usual suspects’
- growing and dangerous deficits in USG expertise in next generation “disruptive technologies”

The Retreat from Complexity

BIG IDEAS GO UNEXPLORED AND UNFUNDED

TIMIDITY AND PRESERVATION OF STATUS QUO TRUMP BOLDNESS AND DISRUPTIVE INNOVATION

BOLDNESS!

CIA Recovery of Soviet Submarine K-129 at Depth of 16,500 feet (August 1974)

"A government or organization too timid to undertake calculable risks in pursuit of proper objectives would not be true to itself or to the people it serves."

CIA Studies in Intelligence Failure 1985
National Security Archive
Declassified 13 Feb. 2010

Preparedness and Competitiveness: Building Resilient Systems

- designing organizations, processes and performance with enduring resilience
- new competencies (table stakes)
- new capabilities (ability to win)
  - competencies + robust, agile processes
- robust, agile processes
  - understanding complexities
  - build/integrate cross-disciplinary expertise
  - constantly changing expertise matrices as the problem ‘morphs’
  - new patterns of public:private engagement
  - individual and institutional incentives

STAR METRICS

***S**cience and **T**echnology for **A**merica's*
***R**einvestment: **M**easuring the **EffecTs** of **R**esearch*
*on **I**nnovation, **C**ompetitiveness and **S**cience*

FDP Technical Data Requirements Discussion
July 15, 2010

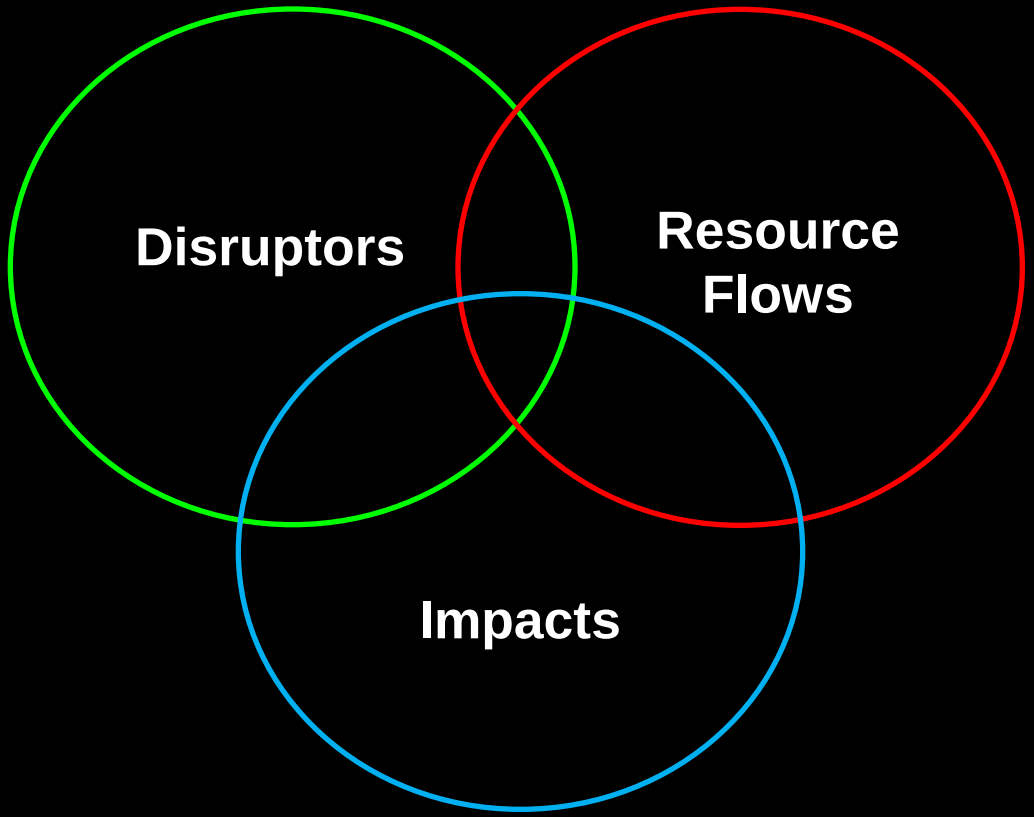
Challenge.gov beta
Government Challenges, Your Solutions

Categories

- Defense (4)
- Economy (2)
- Education (6)
- Environment (7)
- Health (11)
- International Affairs (1)
- Jobs (1)
- Science & Technology (18)
- Personal and Public Safety (4)

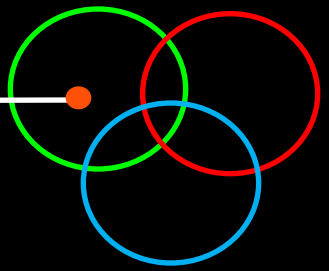
Maintaining and Expanding The Competitive Commons

Change, Grand Challenges and Competitiveness



Change, Grand Challenges and Competitiveness

Disruptors



Triggers

- convergence
- collapse
- emergence
- complexity

Drivers

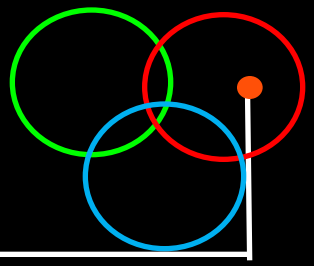
- innovation
- distrust and dysfunction
- complacency
- risk:reward
- governance
- geopolitics
- globalization
- urbanization

Grand Challenges

- sustainability
- demographics
- security
- stability
- connectivity
- predictability

Change, Grand Challenges and Competitiveness

Resource Flows



Hard Assets

- traditional infrastructure
- digital infrastructure
- geography/ natural resources
- workforce
- capital
- military

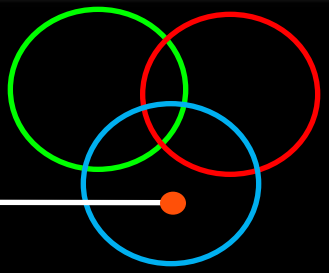
Soft Assets

- cultural precedents
- confidence
- aspiration
- education
- health system
- laws/ regulations
- political stability
- leadership
- trust

Agile Assets

- vision
- new knowledge ecosystems
- global networks
- open-source and social media
- emerging nations/markets

Change, Grand Challenges and Competitiveness



Impacts

Outputs

- educated public/ workforce
- products/ services
- R&D sourcing
- manufacturing base
- workforce

Requirements

- strategy
- policies
- operating practices
- institutional architectures
- investment incentives
- oversight and regulation
- metrics

We Must Find a Way….

- to better understand, quantify and make explicit the linkages between
  - population growth
  - consumption growth
  - ecosystem decline
  - resource scarcity
  - political, economic and social stability
  - national security
- to communicate this knowledge to policy makers and the public
- to formulate public policies that embrace complexity and embed agility for sustained competitiveness

Engaging With Complexity

- irreducible complexity

versus

- reducible complexity

versus

- ‘engageable’ complexity (limits of us)

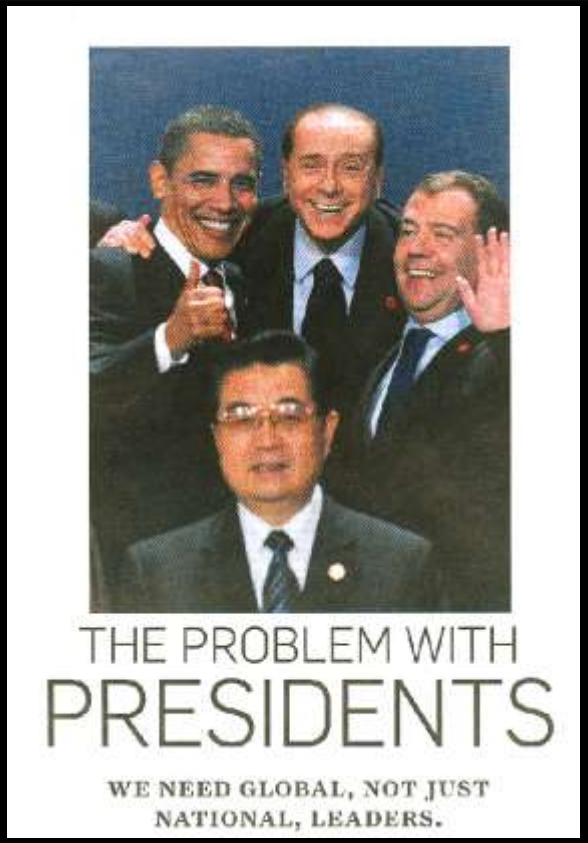
and

- ‘transferable’ complexity (cross-disciplinary education and applications)

and

- ‘pragmatic’ complexity (adoption by non-expert end-users)

Challenges Are Global But Politics is Still Local: The Cultural and Institutional Limits of Governance



- supranational oversight and harmonized regulation
- global commons
- WMD proliferation
- cyber-vulnerability
- terrorism
- climate change
- infectious disease
- finance and trade

Building A New International Consensus

Rude Shocks and Wake Up Calls

Reset and Redesign: Defining New Frameworks for Education, Research and Competitive Innovation

- reality (ugly and unavoidable)
- realignment (expectations and endpoints)
- repurposing (leverage and improve core assets)
- reinvention (boldness)
- robustness (agile, adaptation to relentless change)
- re-read and re-learn (history)
- radical (complex challenges will not be solved by timidity or incremental changes)

Reset and Redesign

- commit to radical reform of educational systems to embrace emerging career requirements
  - professional incentives
  - standards, metrics and accountability
  - K-12, higher education (not just STEM)
  - cultural recalibration of ‘success’ and ‘what matters’ (rewards)
- rationalize immigration policies
  - current challenges
  - attracting foreign talent to expand knowledge-based capabilities

Reset and Redesign

- retool our workforce for leadership in vanguard technologies
- rebuild high-value manufacturing and exports
- reduce national dependence on service-industries
- build and embed an intelligent digital ecosystem into every domain

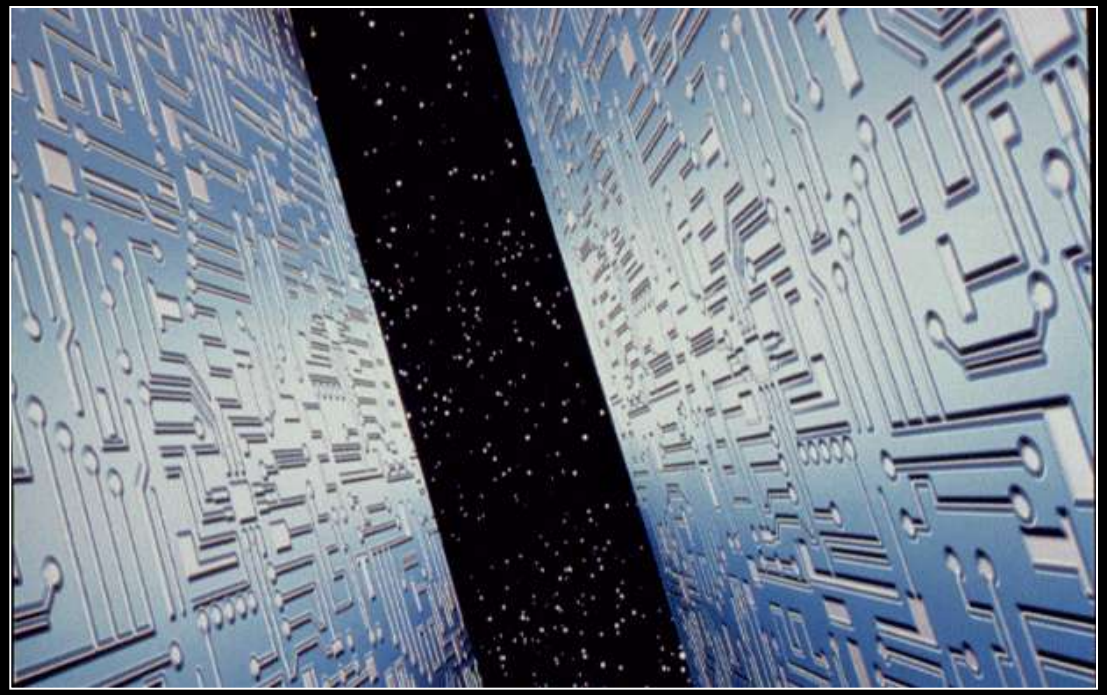
Reset and Redesign

- set national goals for 2025
  - grand challenges in education, health, emerging and sustainability
  - knowledge management, national security
  - high-value jobs and manufacturing capabilities for new industries as 20% total employment

“What have future generations ever done for us.”

Groucho Marx

Aspiration and Engagement with Grand Challenges



“The only way of discovering
the limits of the possible
is to venture a little way past them
into the impossible”

Arthur C. Clarke
Profiles of the Future (1962)


JULY/AUGUST 2010
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