Seeking Security in an Unsecure World

- Terrorism
- WMD Proliferation
- New Power Centers
- Natural Disasters
- Environmental Deterioration
- Critical Resources and Non-Renewables
The Increasingly Complex S&T Landscape

**EMERGENCE AND DISCONTINUITIES**

- new strategic spaces
- new strategic surprises?

**technology acceleration**

**technology convergence**

**dual-use applications**

**sustaining US competitiveness**

**rapid diffusion and ubiquity of advanced technologies**

**rise of new economic centers**
The New Strategic “Spaces” in Military Affairs and National Security Impacted by the Life Sciences

- Systems and Synthetic Biology
- Ubiquitous Sensing
- Infocosm and Meta-data
- Brain: Machine Interactions
- Environmental Sustainability

“Biospace”
“Connected Space”
“Knowledge Space”
“Smart Space”
“Shared Space”

Constantly Emerging and Evolving Multi-Dimensional Matrices of Knowledge Ecologies

Global Challenges
Systems of Innovation
Biosecurity: Outpacing Infectious Diseases

- Bioterrorism
- Infectious Diseases of Natural Origin
- Urbanization in Developing Countries
Improving the Nation’s Ability to Detect and Respond to 21st Century Urgent Health Threats: First Report of the National Biosurveillance Advisory Subcommittee

Report to the Advisory Committee to the Director, CDC

April 2009

United States Government Accountability Office

Testimony
Before the Committee on Homeland Security, House of Representatives

INFLUENZA PANDEMIC
Gaps in Pandemic Planning and Preparedness Need to Be Addressed

Statement of Bernice Steinhardt
Director, Strategic Issues

For Release on Delivery
Received at 2:09 p.m. EST
Wednesday, July 29, 2009

United States Government Accountability Office

GAO

December 2009

BIOSURVEILLANCE
Developing a Collaboration Strategy Is Essential to Fostering Interagency Data and Resource Sharing

United States Government Accountability Office

GAO-19-171

GAO

February 2009

VETERINARIAN WORKFORCE
Actions Are Needed to Ensure Sufficient Capacity for Protecting Public and Animal Health

United States Government Accountability Office

GAO

BIOSURVEILLANCE
Efforts to Develop a National Biosurveillance Capability Need a National Strategy and a Designated Leader

June 2010

United States Government Accountability Office

GAO

Building Resilient Preparedness and Response Capabilities for Biosecurity: A Less Than Satisfactory Report Card

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

United States Government Accountability Office

GAO

Report to Congressional Committees

Report to Congressional Committees

United States Government Accountability Office

GAO

Report to the Chairman, Subcommittee on Oversight of Government Management, the Federal Workforce, and the District of Columbia, Committee on Homeland Security and Governmental Affairs, U.S. Senate
A Shared Global Risk: The Omnipresent Threat Posed By Microorganisms and Parasites
The Global Public Health Challenge Posed by Rapid Urbanization in Developing Countries

- High Disease Transmission
- Expanded Eco-niches and Increased Zoonotic EID Risks
- Major Deficits in Health Infrastructure
- Lack of Safe Water
- Toxic Waste
“One Health”: The Rationale for Integration of Historically Separate Domains and Responsibilities

- Urbanization of DCs and emergence of new zoonotic EID threats
- Food chain as increasing source of disease risks
- Enhanced agricultural productivity to support global population growth
- Economic impact of agricultural disease on trade, development and resources/production footprints
New Diagnostic Technologies: A Neglected Area of Biodefense and Biosurveillance

- faster Rx
- accurate Rx
- prophylactic Rx for incident personnel
- robust triage
  - rationing
  - reassurance of “worried well”
  - quarantine decisions
- real time disease surveillance data
- faster ID of incident evolution
- faster incident containment and exposure controls

The Single Most Important Leverage Point For Rapid Mobilization of Resilient Responses to Epi-/Pan-demics and Bioterrorism
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
- Rapid detection alert for ‘atypical’ events as sentinel of potential bioterrorism
- Rich datasets for increasingly robust epidemiological modelling and infection control paradigms
Surveillance Systems for the Rapid Detection and Control of Infectious and Parasitic Diseases

- Signatures of Pathogenic Organisms
- Global Network of Surveillance and Diagnostic Testing Systems
- Rapid Analysis and Response to Diagnostic and Surveillance Information

Profile
Sense
Act
increasing resistance in G+ and G- pathogens in hospital and community settings

the **ESKAPE** pathogens

- *Enterococcus faecium*
- *Staphylococcus aureus*
- *Klebsiella pneumoniae*
- *Acinetobacter baumanii*
- *Pseudomonas aeruginosa*
- *Enterobacter species*
The I0 X ’20 Initiative (20 Nov. 2009)

- grand challenge to develop 10 new antibiotics by 2020

New US-EU Task Force (2 Nov. 2009)

- encourage R&D on new antimicrobial drugs
- yet to be defined strategy/funding
“If this virus (H1N1) was killing more of its victims, there’d be lots of questions about whether this vaccine was produced soon enough”

Dr. Michael Osterholm
Director, CIDRAP, Univ. Minnesota
USA Today 8 Oct. 2009
Combating ‘Agent-X’
The Imperative for Innovation in Vaccine Production Technologies

- production of the relevant epitopes by chemical synthesis versus traditional ‘biological’ production methods
- dramatic reduction in vaccine production time
- rapid scaleability and production plant flexibility versus ‘biological’ methods
- compositional uniformity of chemically synthesized antigens eliminates need for regulatory approval of individual lots (unlike biological products)
Framing Future Security Issues Demands a Broadened Conceptualization of National Security

- population, food and water
- infectious/parasitic diseases
- urbanization and resources footprint
- energy
- climate and environmental sustainability
- depletion of non-renewable resources
- global trade and finance
- military and security implications of economic and social instabilities
Feeding The Future

- Food chain increasingly complex, international and inter-dependent
- Food production over next 25 years ≈ total for 10,000 years
- Expanding middle class (1-2 billion) in NICs and some DCs and increased demand for grain and meat projected to increase by 160% by 2020
- Famines, shortages and food riots in DCs
- Impact of climate change on agricultural productivity
Systems Biology:
Comprehending the Design Principles of Complex, Adaptive Networks of Increasingly Higher Structural Order
Transcending Boundaries: Emergent Domains Arising from Technology Convergence In the Life Sciences

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- Bio-Enhancement
- Bionic-Enhancement
- Cognitive Enhancement
- Genetic Enhancement
The Expanded Dimension of the ‘Bio’ Challenge

- thinking beyond ‘bio’ as just infectious agents (bugs)

- systems biology
  - targeted disruption of ANY body function
  - novel C and B threats

- synthetic biology
  - exploring biospace: engineered organisms with novel virulence features
  - designer organisms to attack materials/infrastructure
**Synthetic Biology**

- Emerging technology with myriad applications across diverse industrial sectors

- **Healthcare**
- **Public Health**
- **Agriculture**
- **Functional Foods**
- **Novel Materials**
- **Textiles**

- **Bioenergy and Biofuels**
- **Industrial Enzymes**
- **‘Green’ Mfg**
- **Bio-remediation**
- **Clean Water**
- **Ubiquitous Sensors**
Synthetic Biology and Bio-inspired Systems Engineering

- use of microorganisms as bio-factories
- high performance materials made in completely different ways
- mimic resource efficiency of natural ecosystems
  - self-sustaining renewal resources
  - limit/eliminate waste stream
- manufacturing at room temperature in water versus high temperatures and toxic solvents
- highly distributed manufacturing units
- decoupling design and manufacture
Synthetic Biology: Genetic Modification of Living Cells to Produce Biofuels And Other Complex or Scarce Materials
Hydrocarbonoclastic Bacteria at Oil Spill Sites

- Alcanivorax borkumensis
- Thalasolituus oleivorans (estuarine)
- Oleispira antarctica (colder waters)
• modification of social patterns
• modification of cognitive structures
• memes as selection agents
• “the brain(s) in the cloud”
“Thanks to the proliferation of the many electronic devices that we use on a daily basis, from cell phones to GPS and the internet, that capture everything from our communications to our whereabouts, the complex system that we are most likely to tackle first in a truly quantitative fashion may not be the cell or the internet but rather society itself.”

A.L. Barabasi
Science (2009) 325, 413
Social Network Analysis and Predictive Behavioral Modeling
The Expanding Infocosm:
Massive Scale, Pervasive Surveillance and New Vistas in Cognition

Sensor Networks and Ambient Intelligence
Digital Anthropology: Surveillance and Privacy
Neurobiology and Decision Systems
Intelligent Machines

Massive Computing Power and Analytical Parsing
“Brains-on-Target”: Interactive Immersive Visualization of Complex Datasets for Optimum Decisions

- large scale computer simulations of complex phenomena
- integration of high volume datasets
  - high resolution imaging and sensor streams
- VR and AR environments
- systemic application of advances in cognitive neurobiology
- scenario modeling and gaming for systems performance assessment and public policy
The Multidimensional Roles of Science and Technology in National Security

- Defense and Homeland Security
  - sustained military dominance
  - robust homeland defense
- Intelligence
  - new capabilities for threat ID and pre-emption
- Biosecurity
  - managing ‘the global commons’
- Foreign Policy
  - science and technology as key (but neglected) elements of foreign policy
The Fragmented Silos of USG:
A Dangerous Vulnerability
Ignoring Systems Complexity:
A Dangerous Void in Military Affairs and National Security

- increasing evidence of dysfunctional USG analysis and decision-making frameworks
  - dual-use technologies, healthcare, energy, environment, education
- growing expertise gap in USG agencies
  - threat diversification, new technologies
  - open-source analysis
- under-leveraged engagement with private sector
  - novel technology trajectories
  - broadening international scope
  - access to expertise pool
- anachronistic legal and regulatory frameworks for global challenges
The Retreat from Complexity: The Insularity and Risk-Aversion of USG Analytical and Decision Frameworks

- CB threat viewed by too many as a ‘too hard’ problem
- denial, avoidance, paralysis
- sustained focus/funding on ‘the familiar’ and engagement of ‘usual suspects’
- false assurances from flawed, “quick-fix” initiatives
- lack of coherent integrated strategy
The Retreat from Complexity

BIG IDEAS
GO
UNEXPLORED
AND
UNFUNDED

TIMIDITY AND PRESERVATION
OF STATUS QUO
TRUMP BOLDNESS AND
DISRUPTIVE INNOVATION
The Need for Greater Urgency and Adoption of Systems-Based Approaches to Biosecurity

- current USG institutions and R&D vehicles are ill-suited to address current and projected challenges
- ‘rapid’ and ‘translation’ are countercultural to much of the academic and USG communities
- the cosmetic salve of seeming to ‘do something’ is meaningless absent tangible results
- extravagant resources are/will be wasted until a forceful integrated, cross-agency, cross-sector, ‘systems’ approach is adopted
- the engagement of corporate and international agencies is a critical success factor in addressing global biosecurity challenges