# Science, Technology, & International Affairs

### Margaret E. Kosal

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### From Beakers to Bombs: At the Intersection of International Security and Technology



### Roadmap

DR. KOSAL

- Science to Security
- Research Portfolio
- Engaging Policymakers



### From Science to International Security

- Ph.D., Chemistry UIUC
   Bio-inorganic chemistry and nano-structured materials
- Co-founder ChemSensing
   Inc.

Explosives, biological and chemical detection

- Fellow at Stanford's Center for International Security and Cooperation (CISAC)
- Other prior affiliations:

Center for Nonproliferation Studies Monterey Institute of International Studies (CNS MIIS) Naval Postgraduate School

Northwestern Medical School







### **Detection Chemical Agents**

SmellSeeing arrays were exposed to a variety of chemical agents, simulants, precursors and toxic industrial chemicals.



after

**Sarin (GB)** 89 mg/m<sup>3</sup>

(Arrays cut in half to fit in gas chamber.)



In collaboration with Battelle Memorial Institute & US Army SBCCOM

### **Detecting Microbiologicals**





### **Electronic Nose for Distinguishing Beer**

### Samuel Adams Boston Lager



Beck's Dark



Heineken Imported Lager



### Kirin Ichiban Special Premium



Corona Extra



4% Ethanol in Water



### **Multivariate Statistical Analysis**



Figure 10. A dendrogram of 94 tests of 18 beers. Clear separation of beers by class (i.e., lager vs. ale) is observed and even very similar beers are distinguishable

Suslick, K.S.; Kosal, ME.; et al. "Seeing Smells: Development of an Optoelectronic Nose," Química Nova, 2007, 30, 677-681

- FDNY invited by Chief Joe Pfeifer to Randall's Island to lecture on chemical and biological terrorism
- CIA, NNSA, USMA & NPS intelligence analysis & counter-/non-proliferation
- DHS VIP Observer TOPOFF 3
- AAAS, NAS, & NATO technical threat anticipation
- International opportunities: Norwegian Institute of International Affairs (NUPI) & Moscow Institute of Physics and Technology
- OPCW chemical weapons destruction & public's role



### **Advisor in the Defense Department**

#### • S&T Advisor to the ATSD(NCB) - OSD

Interface with other DoD offices and interagency groups

Nonproliferation and Arms Control Technology Working Group (NPAC TWG) National Nanotechnology Initiative (NNI) Counterproliferation Review Committee (CPRC) National Science Advisory Board on Biosecurity NATO RTO Nanotechnology for Defense Group

#### Liaison to DTRA-CB

Chairing the Nanotechnology for Chem-Bio Defense 2030 Study & Workshop
Advising the DTRA-CB SPO Nanotechnology Initiative and on the Transformational Countermeasures Technology Initiative (TCTI)
Coordinating CBDP basic research efforts, including the basic research strategy

#### Advisor to Chief of Staff of the Army

Design, organization, & employment of future Army Joint & conventional-SOF interoperability Modernization priorities

Counter-WMD force structure & capabilities









Live agent training, Joint Senior Leaders Course, Ft Leonard Wood, July 2007

## Foreign Language



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### **Technology's Role in Politics & War** ... & the Role of Politics & War in Technology

Peter Turchina, et al., **War, Space, and the Evolution of Old World Complex Societies,** *Proceedings of the National Academy of Sciences (PNAS)*, published online 23 September 2013.



"Comparison between data and model predictions for three historical eras [one shown]. Red indicates regions that were more frequently inhabited by large-scale polities, yellow shows where large polities were less common, and green indicates the absence of large polities."

### **Terms** ... & some working definitions

- Science is a process used to
  - determine causal relationships
  - <u>Repeatable</u>
  - <u>Public</u>
  - pertains to physical and natural world
- **Technology** is a <u>process</u> and <u>resulting tools</u> (or products) by which <u>humans modify</u> nature (or their environment) <u>to meet their needs</u> and wants (both are important)
- Politics is a process by which groups of people make decisions
- **Policy** is a course or principle of action adopted or proposed by a government, party, business, or individual

#### International Affairs

- Interactions between and among nation-states; (most formal definition, Westphalian states)
- Systematic structures and patterns of interaction of the human species; (constructivist)
- Interactions that impact politics by nation-states (state-based actors), and non-state actors (terrorists, multi-national corporations, NGOs, transnational interest groups, mafia, organized crime)

# **Role of S&T in National Power**

### Global Leadership in S&T is transitory

- In the 19<sup>th</sup> century, and at the outset of the 20<sup>th</sup> century, the dominant global S&T power was Europe
- Since the middle of the 20<sup>th</sup> century, the dominant global S&T power has been the United States
- Prominence in the 21<sup>st</sup> century is contested

### In the 21<sup>st</sup> century ...

- The scientific challenges are themselves more complex in nature and global in impact
- Scientific research itself is increasingly international
- Technology is developed within a global framework
- Security is much more prominent

### S&T Capacity May Make the Difference Between Poverty and Wealth...



## ... but High Tech Does Not Always Equal High Income



Source: World Development Indicators, 2007

### Role of S&T in International Development

- Growing recognition that development "is built not merely through the accumulation of physical capital and human skill, but on a foundation of information, learning and adaptation..." (World Bank, 1999)...
- Historically high rates of return on investment in S&T
  - "the dominant engine of economic growth" (Solow)
  - Versus the marginal rates in agriculture >40%
- But relevant knowledge remains under-produced, underutilized, unevenly distributed (UNDP)
  - Private investments lag because of large public spillovers, property rights issues...
  - Public investments static or falling due to perceived irrelevance, inefficiency of results.

### Reasons Cited for Why Science & Technology Is Important For International Development

- For Poverty Alleviation
  - Agriculture
  - Health
- For Sustainable Development
- For Sustainable Energy and Environment
  - Clean Water
  - Electricity
  - New Power Sources
  - Limiting Environmental Degradation

- For Economic Growth
  - Education
  - Employment
  - Sustainable Income Generation
  - Facilitating Global Trade
  - International Integration
- To Control Infectious Disease
- ... and ?

## Disease & Intelligence

#### Intelligence tested

IQ v burden of infectious disease in 184 countries



"Mens sana in corpore sano: Parasites and pathogens may explain why people in some parts of the world are cleverer than those in others," *The Economist*, 1 June 2010,

http://www.economist.com/node/16479286?story\_id=16479286&CFID=138627586&CFTOKEN=84069344

# Importance of S&T in US Policy

"In the 21<sup>st</sup> century, American foreign policy must have a sound scientific foundation. And we must build on that foundation to stem the spread of infectious diseases such as HIV/AIDs, to stop proliferation of weapons of mass destruction, to lift people out of poverty, and lead states onto the path of sustainable development. Now more than ever, American science must enlighten American statecraft. But the partnership between science and statesmanship is a two-way street. American diplomacy must also help advance world science."

#### Former Secretary of State Colin Powell – May 2004

# ... & for National Security

- "... In addition, we will provide military advice and equipment to free nations which will cooperate with us in the maintenance of peace and security.
- "Fourth, we must embark on a bold new program for making the benefits of our scientific advances and industrial progress available for the improvement and growth of underdeveloped areas.
- "More than half the people of the world are living in conditions approaching misery. Their food is inadequate. They are victims of disease. Their economic life is primitive and stagnant. Their poverty is a handicap and a threat both to them and to more prosperous areas.
- "For the first time in history, humanity possesses the knowledge and skill to relieve the suffering of these people."

-- President Harry Truman, January 1949

## S&T: Critical for 21stC Diplomacy

Good that

Data from March 2013 Pew Global Attitudes Project:

<u>Region</u>	Admire U.S. for S&T <u>Advances (%)</u>	American Ideas/Customs <u>Spread (%)</u>
Europe	~67	~33
S.E. Asia	~82	~33
Africa	~85	~42
Americas	~76	~36
Islamic World*	~73	~14

\* Seven countries with majority Muslim populations

### Soft Power

- Proposed by Joseph Nye
- Descriptive Theory

"Soft power is the ability to get what you want by attracting and persuading others to adopt your goals. It differs from hard power, the ability to use the carrots and sticks of economic and military might to make others follow your will."\*

#### International Studies Review



\* "WMD Terrorism Research: Where to From Here?" International Studies Review, March 2005, vol. 7, p. 140



#### Over 13,000 petition White House to build a Death Star

Published December 10, 2012 / FoxNews.com

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resources and begin construction of a Death Star by 2016 □.

"By focusing our defense resources into a space-superiority platform and weapon system such as a Death Star, the government can spur job creation in the fields of construction, engineering, space exploration, and



# SCIENCE

If you don't make mistakes, you're doing it wrong. If you don't correct those mistakes, you're doing it really wrong. If you can't accept that you're mistaken, you're not doing it at all.

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