Symposium on Reforming Science & Technology Policymaking and Human Resource Development
Session 2: Interdisciplinary Education for Science & Technology Policy

The MIT Technology and Policy Program

Kenneth A. Oye
Engineering Systems Division and Department of Political Science
Massachusetts institute of Technology

March 1, 2012
University of Tokyo

MIT ESD
Massachusetts Institute of Technology
Engineering Systems Division

Basic Features of Some Technology Policy Programs

MIT Engineering Systems Division - Technology & Policy Program

- 2 year Masters for students with S&T backgrounds
- Core + social sciences + tech concentration + RA + thesis
- Dual degree option

Cambridge Judge Business School - Technology Policy Programme

- 1 year Masters for students with S&T backgrounds
- Professional Practice Stream and Research Stream

Princeton Woodrow Wilson School - STEP Certificate

- 4 courses + paper for WWS students
- 3 courses + paper for students in other graduate programs

MIT Science and Technology Policy Certificate (Proposed)

- 2 core courses + 2 electives for S&T PhD students
- Bottom up initiative from School of Science doctoral students

TPP Program Overview

Master of Science in Technology & Policy

- Typical program length -- 4 semesters /2 years
- Dual degree option with other MIT departments – add 1 semester+
- Research-based degree with thesis and RA
- Policy oriented internships between years 1 and 2
- Focus on multiple professional competencies
  - Specialized science/engineering in technical concentration
  - Microeconomic-political-legal analytics
  - Quantitative and formal methods

TPP Curriculum

Core Integrative

- Leadership
- Introduction to Tech & Policy
- Research & Presentation
- Thesis

Policy Analysis Methods & Frameworks

- Science, Tech & Public Policy
- Tech, Law & Public Policy
- Microeconomics
- Elective Methods
  - Engineering Systems Analysis for Design
  - Real Options
  - System Dynamics

Professional Development

- Technical Concentration ($\geq$ 30 units)

- Internship

SCIENCE, TECHNOLOGY AND PUBLIC POLICY

POLITICAL ECONOMY

Political Institutional Failure
Economic Market Failure
IP and Antitrust
Externalities:
Imperfect Info – risk shield
Adverse select - insurance
Coordination
- Technical standards
- Regulatory harmonization

KNOWLEDGE POLITICS

Creating Knowledge
- Education and R&D

Assessing Knowledge
- Technocratic v Adversarial
- Health / Medicine / Env
- Military and intelligence
- Emerging Technologies

IMPROVING POLICY

- Designing Indicators
- Improving Anticipation
- Improving Adaptation

FALL 2010	CLASS SCHEDULE			
Class / Date	Topic	Core Analytic Issues and Trade Offs	Historical Cases	Contemporary Cases
01 Th 09/09	Justifying Public Policies	Market failure – Handout 1A	NA – MIT daily life examples	Current policy examples
02 Tu 09/14	Critiquing Public Policies	Institutional failure – Handout 1B	NA – MIT daily life examples	Current policy examples
03 Th 09/16	Unstable Property Rights	Incentives for invention vs limits on diffusion of fruits of innovation	Bell patent; Deforest-Sarnoff audion, State Street, Amazon	Genes, Cox-2 and PDE5 inhibitors, HIV drugs, CIPRO, Linux, RIM, KCR, Venter
04 Tu 09/21	Continued			
05 Th 09/23	Monopoly, Oligopoly and Monopsony	Limit rents and concentrations of power vs capture scale benefits	Standard Oil, Alcoa, IBM, ATT-MCI, trucking air deregulation	Microsoft (US & EU), Airbus-Boeing, telecom and cable, Google
06 Tu 09/28	Continued			
07 Th 09/30	Environmental Externalities I Transfer Payments	Externalities, Exchange, Extortion Coasian Bribery	Rio Grande, Rhine, Baltic water; Kola air, Russia nuclear	Costa Rica Fundecor, AIJ, CDM, post Bali Technology Transfer and Emissions
09 Tu 10/05	Environmental Externalities II Regulation and Competition	Externalities, Rents, Influence Costs Stiglerian Regulation and Limits	British smoke laws, Clean Air Act, Montreal Protocol	US SEER 13, EU recycling, Japan fumigants, EU diesel,Climate Change
08 Th 10/07	Disease Externalities	Limit spread of disease vs limit mobility, trade and freedom	19th century sanitation and shipping rules	Smallpox, Polio, HIV, TB, malaria, BSE, SARS, Avian flu, antibiotic resistance
10 Tu 10/12	Security Externalities	Limit diffusion vs maintain markets	Classification systems, COCOM	Patent secrecy, encryption controls, bio and nuclear controls, FISA, deemed exports
11 Th 10/14	Incomplete Information and Imperfect Consent	Shield from risk and/or exploitation vs limit gains from private exchange	Food safety, narcotics, gambling, OSHA , child labor	COUHES, food irradiation, US-China trade, FDA safety and efficacy
12 Tu 10/19	Adverse Selection	Individual rationality and collective irrationality; insurance moral hazard	Energy, real estate and banking panics and lender of last resort	Tech stock bubble / bust, medical insurance and genetic screening
13 Th 10/21	Coordination Technical Standards	Timing, Definition, and Scope of Standards under Uncertainty	Screw threads, grain grades, firearm parts, VHS-Beta,TCP-IP	Codes, EU-EMAS, US, and ISO, BioBricks, Future Internet
14 Tu 10/26	Coordination Regulatory Standards	Diversity, Harmonization, and Laxity under uncertainty	Codex Alimentarus, Tanker and Freighter safety standards	Health, safety and environmental regulations and WTO / NAFTA
15 Th 10/28	Midterm Examination	Closed Book Exam		
16 Tu 11/02	Creating Knowledge Education and Research	Provide knowledge through research and education vs provide pork	Manhattan, NASA, synfuels, fusion	Synthetic Biology, EU Priority Emerging Technologies
17 Th 11/04	Applying Knowledge Procurement Policy	Provide health, energy, environment, defense vs provide pork	Aircraft and naval procurement and production lines	McCain Pork List and CBO analysis of V22, ATF, SSN
18 Tu 11/09	Knowledge Assessment Problems and Responses	Adversarial and Neutral Methods Boundaries and Expertise	US litigation, devil's advocacy, NRC, HEI, Universities	Breast implant torts, passive smoking and research funding
Th 11/11	No Class- Veteran's Day			
19 Tu 11/16	Assessing Health , Safety and Environmental Risks	Controllable vs Credible Predictable vs Credible	Cholesterol dietary standards, US-UK triazolam efficacy safety	Transfat diet, Plan B efficacy and safety, Vioxx safety and efficacy
20 Th 11/18	Continued	Institutional arrangements for credible unbiased assessment	Methyl Mercury, Harvard Six Cities Particulates	Climate Change Assessments by US EPA and IPCC
21 Tu 11/23	Assessing Military Capabilities and Security Risks	Secure vs Open Closed vs Credible	USSR tests, Bomber and Missile Gaps, C3I, Patriot	National Missile Defense and Alaskan and Polish Deployments
Th 11/26	No class – Thanksgiving			
22 Tu 11/30	Continued	Institutional arrangements for credible secure assessment	Iraq Chemical, Biological, and Nuclear by UNMOVIC and US	North Korea and Iran and NIE and IAEA, design/demonstration fuel cycle
23 Th 12/02	Evaluating Policy Using Performance Indicators	Reiner-Causal ascription & indicators Direct / indirect effects on behavior	Review cases + US Clean Air Act; US Iraq, US and EU HDV	Review cases + US Energy; US Education; US Nano Initiative
24 Tu 12/07	Improving Policy Uncertainty and Correction	Anticipation, Adaptation, Selection McCray-Learn from policy experience	Review cases + US/EU PM and SOx, drug after market, NTSB	Review cases + UN Climate Change and Technology Transfer
25 Th 12/09	Summary and Review Distribution of Essay Pool			
Date TBA	Final Examination	Closed Book Exam	Essay Pool Exam	Date of final to be set by Registrar

POLITICAL ECONOMY -- MARKET FAILURE ⇔ INSTITUTIONAL FAILURE

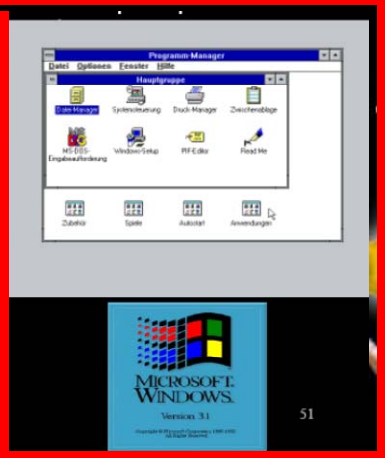
<u>Some Sources of Economic Market Failure</u>

Unstable Property Rights	Investment / diffusion of innovations
Monopoly-Monopsony-	Oligopoly, collusion, entry limits
External Costs and Benefits	Environment, security, health, knowledge
Imperfect Info and Consent	Risk acceptance
Adverse Selection	Insurance, investments under uncertainty
Coordination Problems	Technical protocols, regulatory harmonization

<u>Some Sources of Political and Institutional Failure</u>

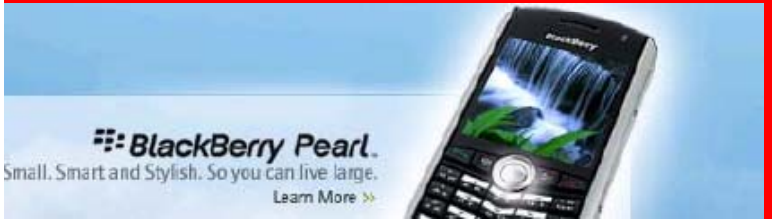
Olson	Collection action and free riding
Stigler	Regulatory capture
Milgrom and Roberts	Bargaining and influence costs
Allison	Organizational processes, bureaucratic politics

INTELLECTUAL PROPERTY RIGHTS CASES



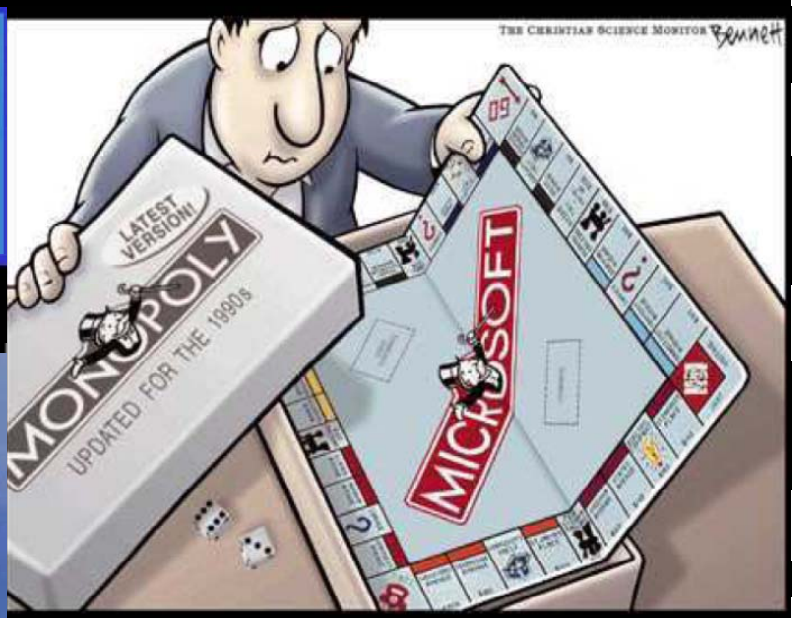
amazon.com

BARNES & NOBLE



MONOPOLY, OLIGOPOLY, MONOPSONY - ANTITRUST AND STRATEGIC TRADE

61



Regulatory Developments

1877-95 Bell patent Monopoly

Bell market share 50% local rates fall 50%

1913 Antitrust divest WU interconnect stop acquisit

Bell acquires rivals limits long dist buys audion patent Bell market share 82%

1926 Bell-RCA split

1927 Radio Act

1934 Communications Act

1956 Hush-a-phon

1956 ATT Antitrus no retail, dat keep WE

1959 Above 890

1870 1880 1890 1900 1910 1920 1930 1940 1950 1960

Technical Developments

1876 Telephone invented

1906 Deforest invents audion

TV

transistor microwave coax

data comm

Trudy Wilcox

Regulatory Developments

1968 Carterfone Case interconnection

1969 FCC grants MCI license protective connection attachment

1971 FCC Specialized common carrier

1974 Antitrust on ATT "network harm"

1977 FCC sets standards for connecting

1978 ATT refuses to connect with MCI Execunet II forces ATT sharing

1979 Codephone

1984 Greene ATT divest BOCs allow data trans allow processing

ATT divests 22 BOCs ATT keeps Bell Labs

1987 Greene allows ROCs to enter info services

1996 Telecomm Act

* local competition
* help interconnet
* no crosssubsides
* unbundle access
* unbundle pricing
* BOC freed to fight

1970 1975 1980 1985 1990 1995 2000

Technical Developments

1965 SPC Stored Program Control allows competition

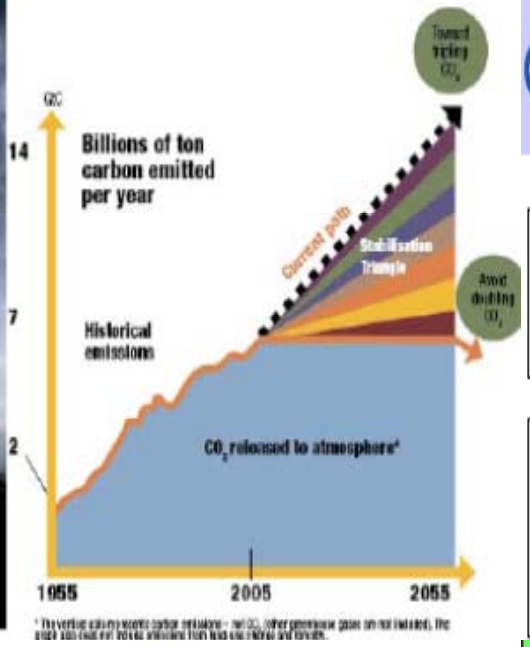
digital switching microprocessors fiber optics

cellular

bandwidth explosion

Trudy Wilcox

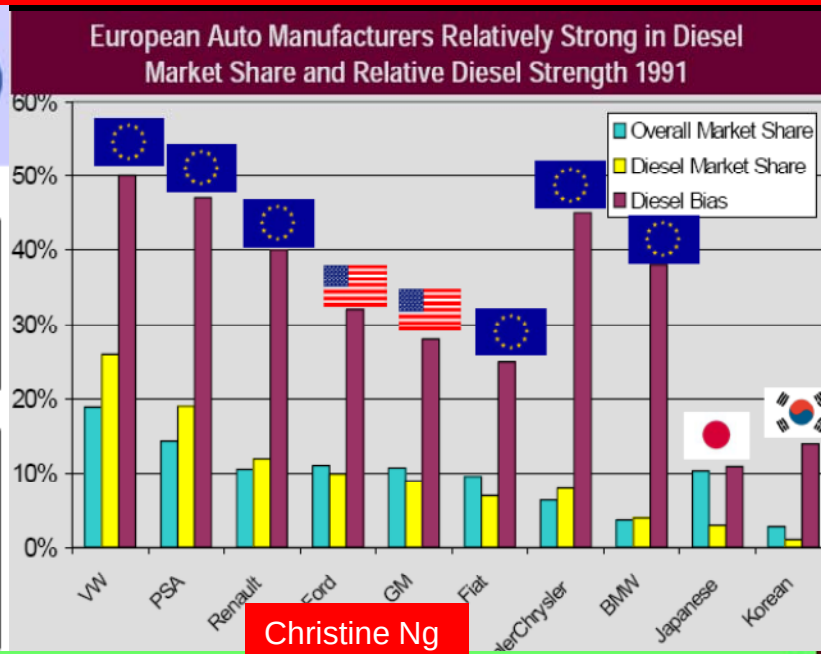
ENVIRONMENTAL EXTERNALITIES – COMPETITIVE REGULATORY BENEFITS



Carrier

TRANE
It's Hard To Stop A Trane

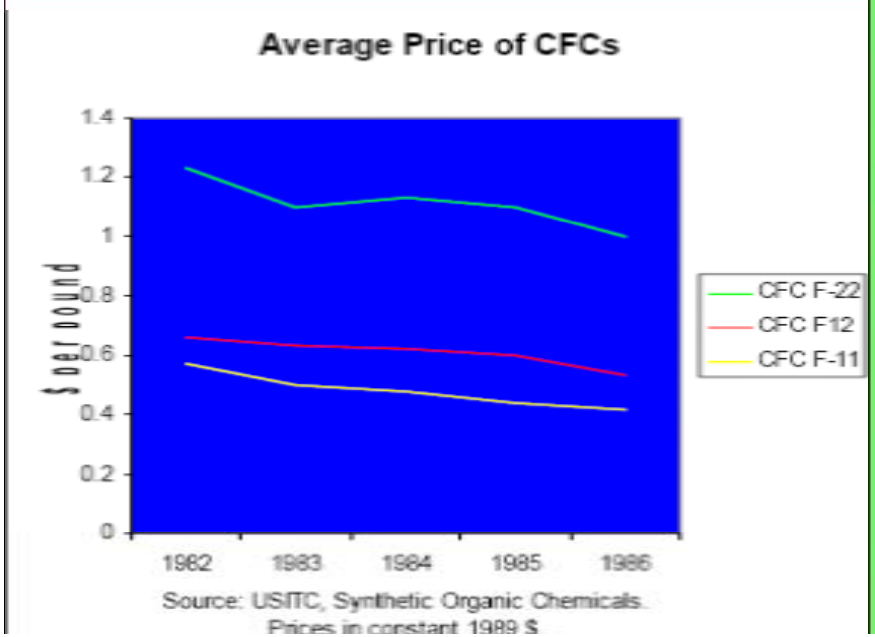
DAIKIN

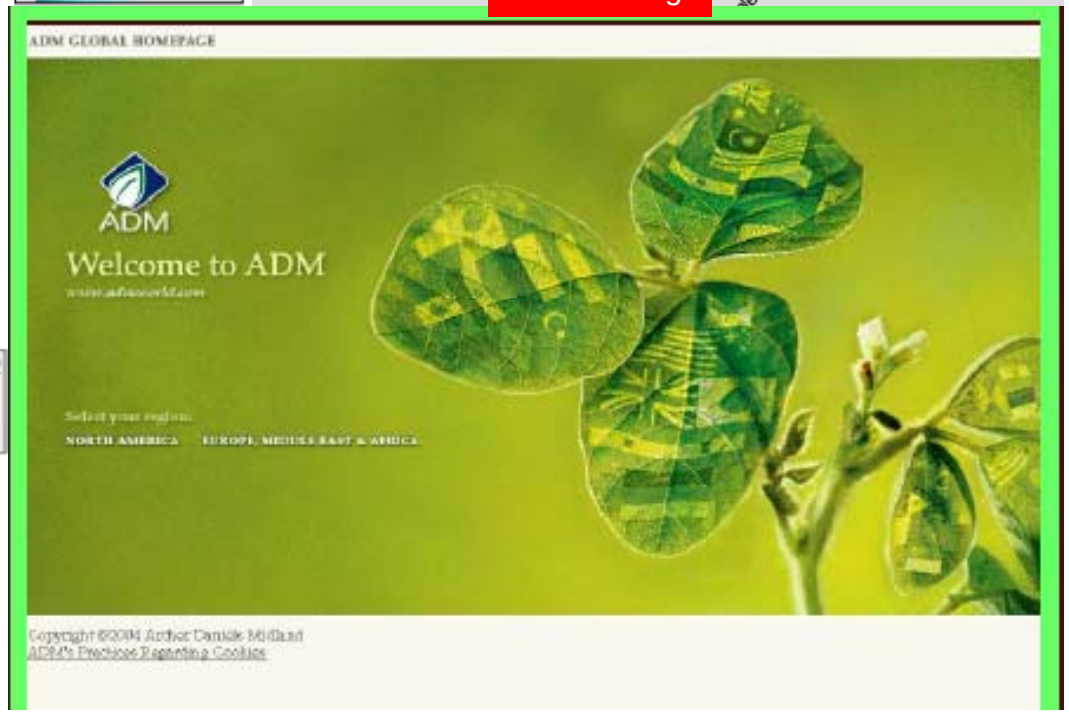


Christine Ng

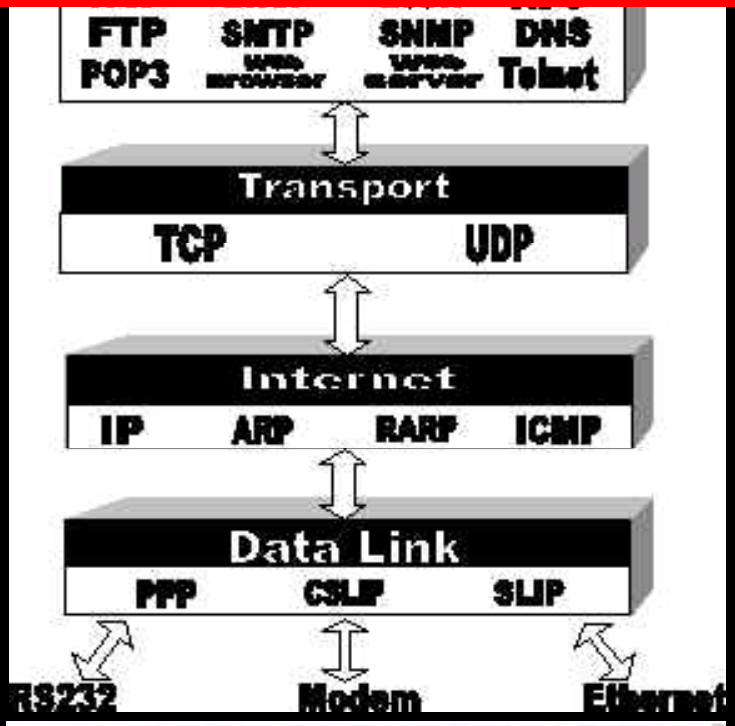
DUPONT The miracles of science

ICI The Vital Ingredient





TECHNICAL INTEROPERABILITY AND PERFORMANCE STANDARDS
Timing? Definition? Extent? By Whom? With what effects on competition?



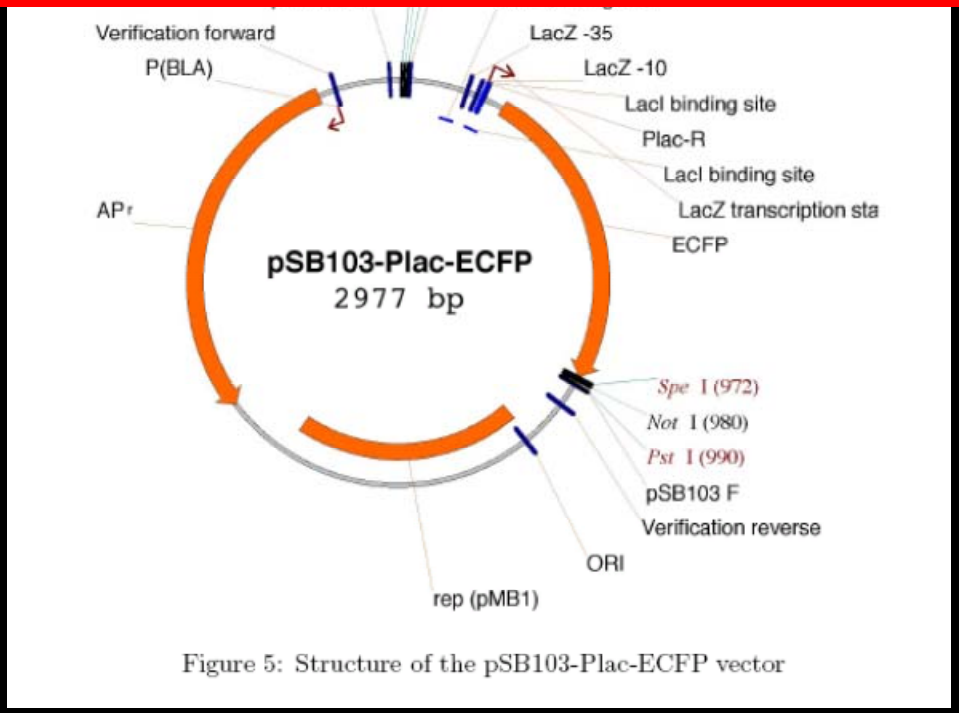
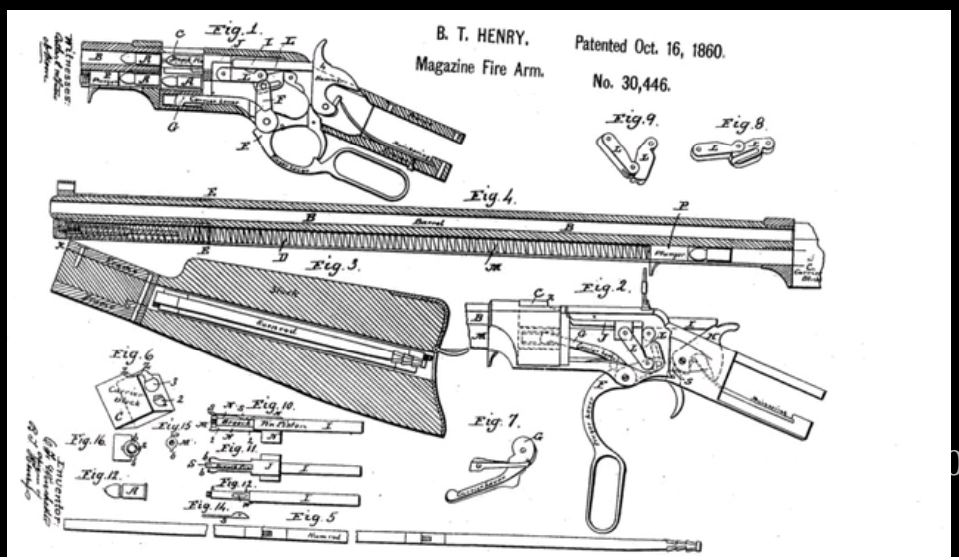


Figure 5: Structure of the pSB103-Plac-ECFP vector



KNOWLEDGE CREATION AND ASSESSMENT

Creating and Applying Knowledge Research and Education

Private vs public research funding of emerging technologies, procurement

Human capital and education

Ethical and economic issues

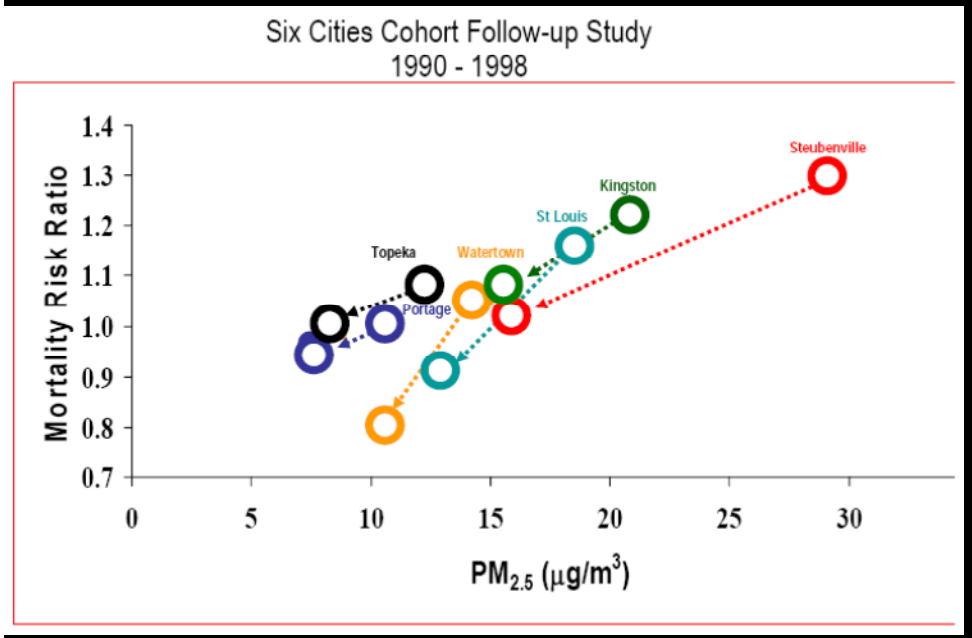
Controversies over scientific and technical knowledge

Focus on areas with genuine complexity and uncertainty and controversy

Technocratic and Adversarial Methods

Passive Smoking	Transfats	Implants
PM2.5	Methyl mercury	Climate Change
Halcion	Vioxx	Plan B
BU BSL4	Patriot	TRW/BMD
WMD Iraq	Korea	Iran

KNOWLEDGE ASSESSMENT - PM 2.5 AND DRUG SAFETY



HEI

HEALTH EFFECTS INSTITUTE

July 2000

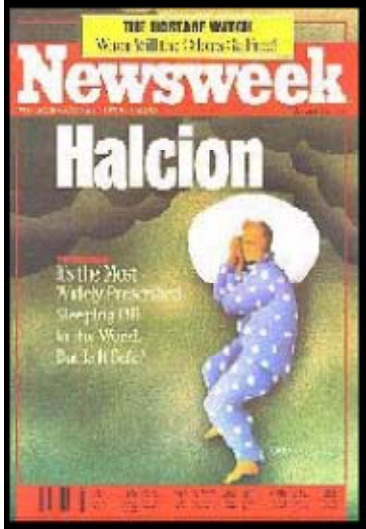
Includes Errata Sheet Of 11-01-01

SPECIAL REPORT

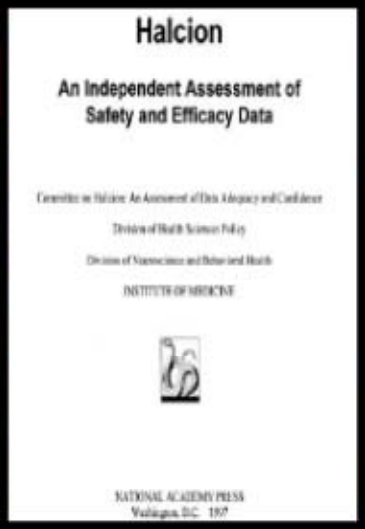
Reanalysis of the Harvard Six Cities Study and the American Cancer Society Study of Particulate Air Pollution and Mortality

A Special Report of the Institute's Particle Epidemiology Reanalysis Project

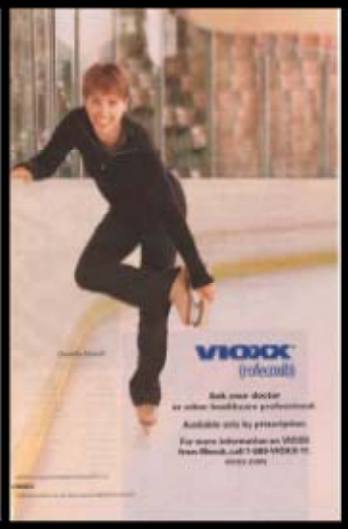
Executive Summaries and Commentary



August 19, 1991



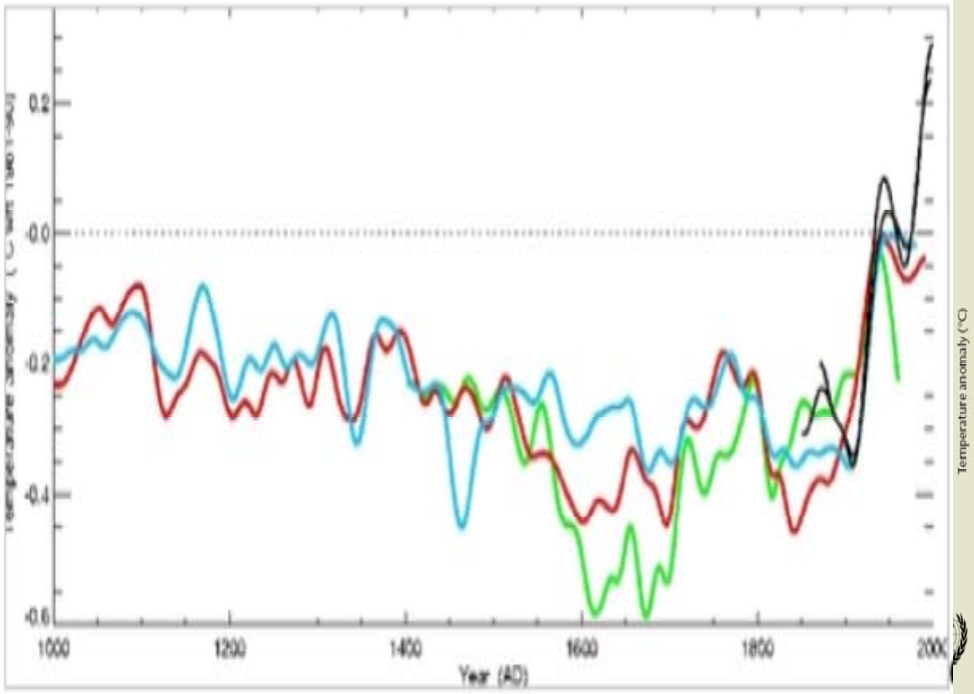
November 3, 1997

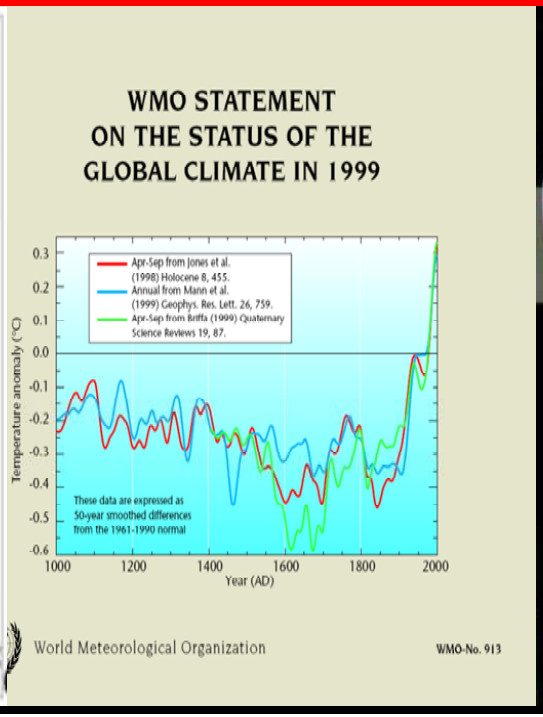


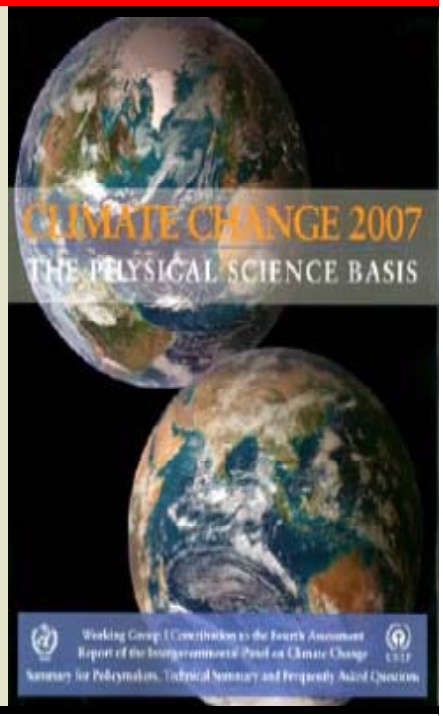
September 30, 2004

September 26, 2006

KNOWLEDGE ASSESSMENT - CLIMATE CHANGE

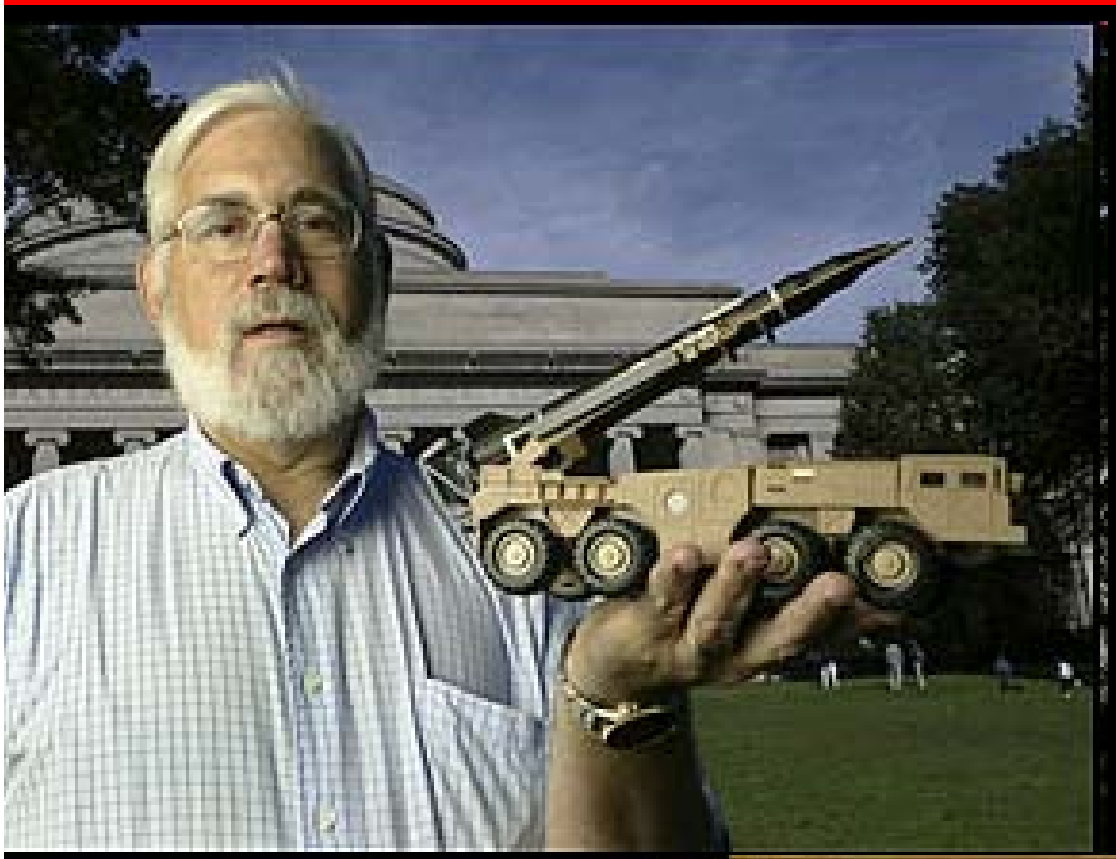






From: Phil Jones <p.jones@xxx.xxx>
To: ray bradley <rbradley@xxx.xxx>,mann@xxx.xxx, mhughes@xxx.xxx
Subject: Diagram for WMO Statement
Date: Tue, 16 Nov 1999 13:31:15 +0000
Dear Ray, Mike and Malcolm,
… I've just completed Mike's Nature trick of adding in the real temps to each series for the last 20 years (ie from 1981 onwards) and from1961 for Keith's to hide the decline.…
Cheers
Phil
University of East Anglia Norwich Email p.jones@xxxx.xxx NR4 7TJ UK

KNOWLEDGE ASSESSMENT – PATRIOT, MISSILE DEFENSE, IRAQ



Schwartz Podesta

United States General Accounting Office

GAO

Report to the Honorable Edward J. Markey, House of Representatives

February 2002

MISSILE DEFENSE

Review of Results an

KNOWLEDGE ASSESSMENT – PREDICTING NUCLEAR PROLIFERATION




Clockwise from upper left:
US, USSR, UK, France, China, India,
Israeli plant at Dimona, Pakistan,
North Korea, Iranian plant





IMPROVING POLICY

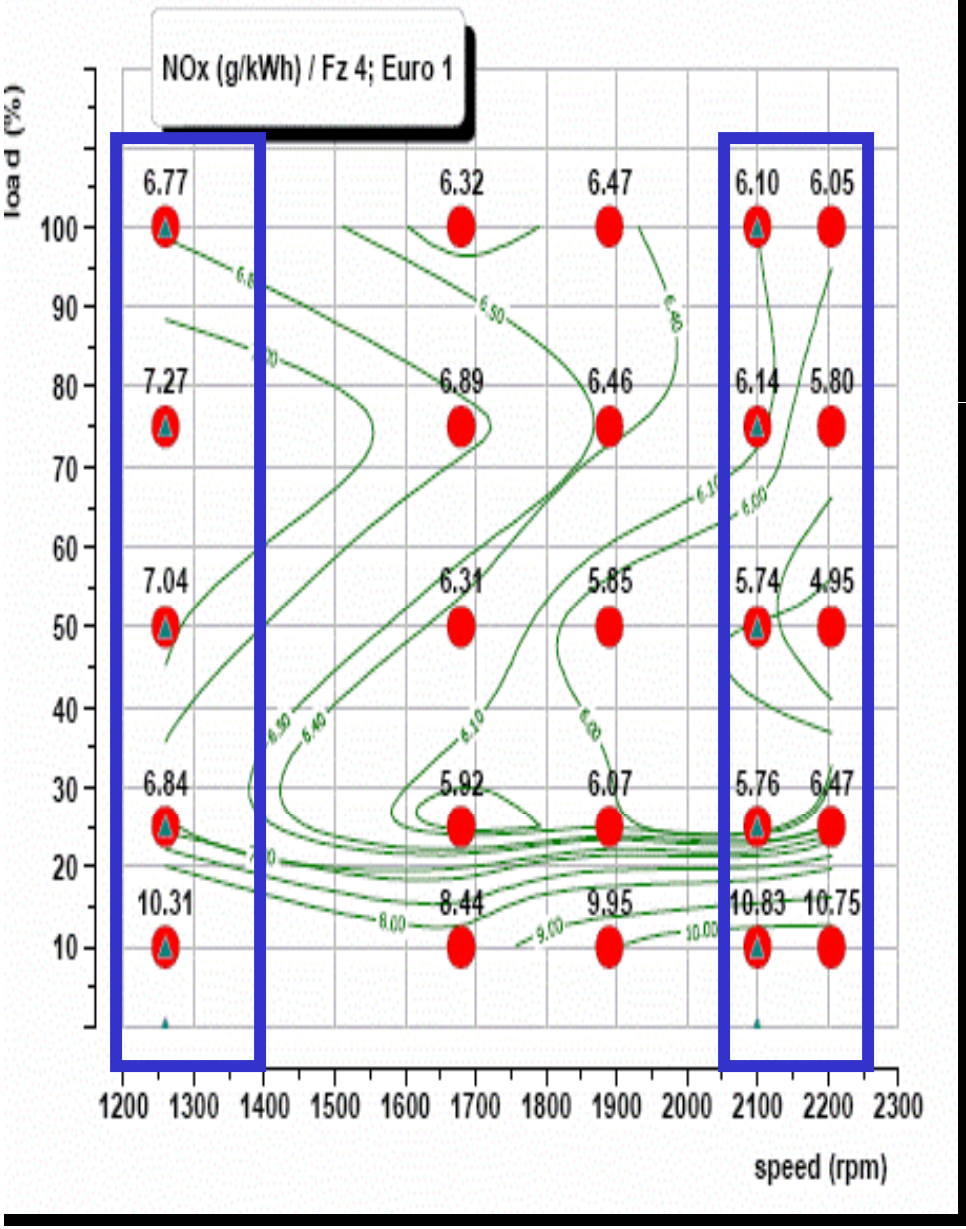
DEVELOPING PERFORMANCE INDICATORS
- US and EU emissions testing procedures
- US BSE testing procedures
- TRW Missile Testing

FOSTERING QUICK FIXES AND LONG TERM ADAPTATION AFTER DISASTER
- North Sea inundation Netherlands
- Kobe and seismic standards
- Shuttle Challenger Disaster and National Research Council proposal

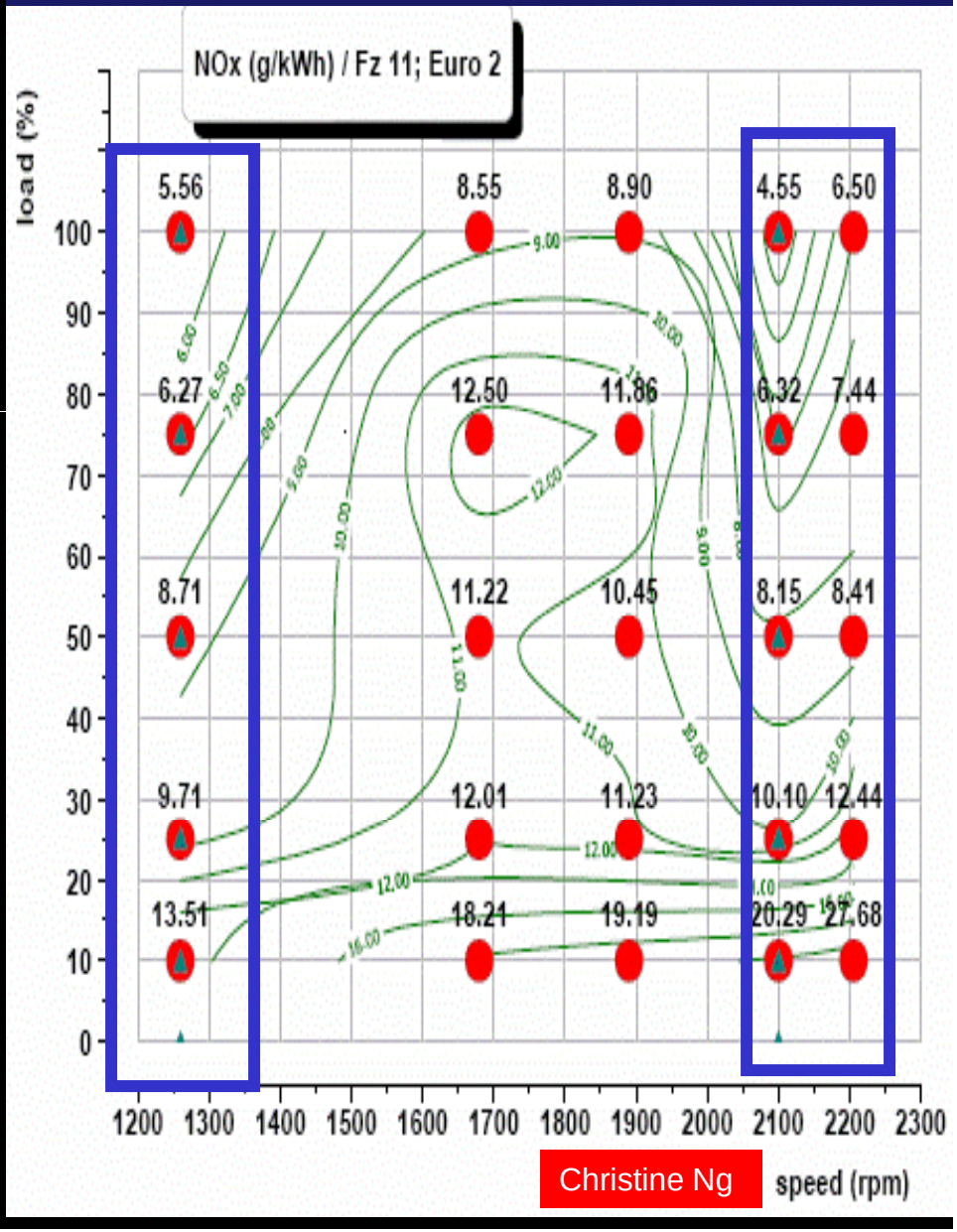
PLANNING ADAPTATION WITH ROUTINIZED OBSERVATION & FEEDBACK
- Airline accidents and near misses – NTSB/FAA separate functions
- Ambient air quality – US EPA NAAQS Harvard Six Cities NIEHS Mercury
- BSE and relaxation of controls -- EU TSE Roadmap
- Adaptive drug licensing - HealthCanada /IOM/EMA/HSA proposals

EVALUATING POLICY – GAMING OPERATIONAL TESTS

BEFORE ON BOARD COMPUTERS



AFTER ON BOARD COMPUTERS



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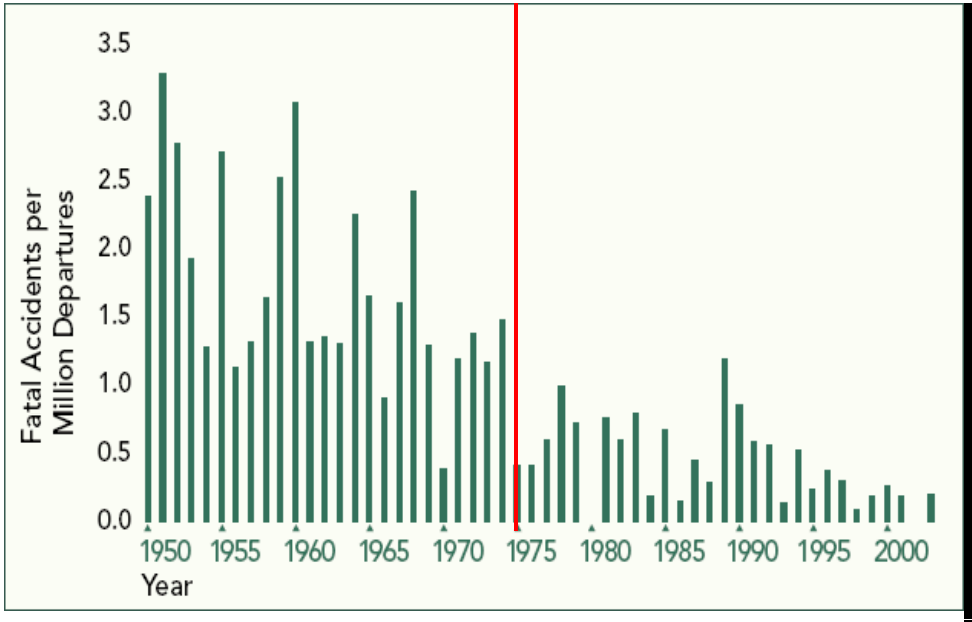

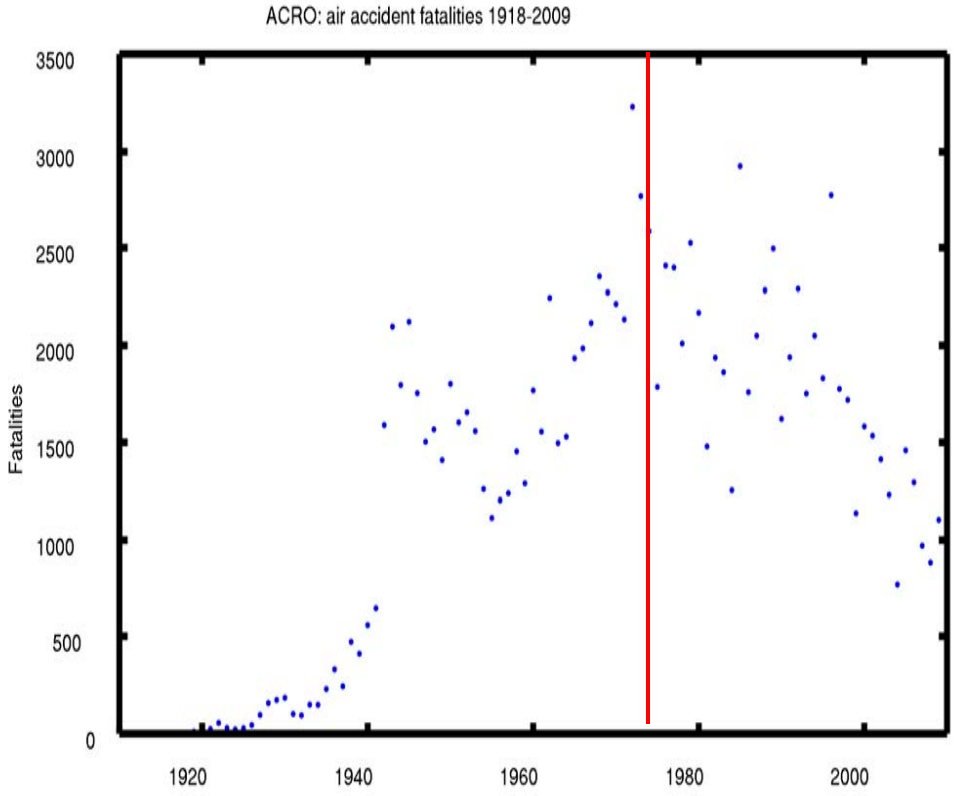

COMMERCIAL AVIATION SAFETY

Exemplary risk governance

- FAA certifies, NTSB investigates
- NTSB examines accidents near misses
- Carriers manufacturers cooperate
- NTSB recommends actions
- FAA accepts (most) recommendations

US Congress in 1975:

"No agency can properly perform such functions unless totally separate"

nature publishing group

Open

Adaptive Licensing: Taking the Next Step in the Evolution of Drug Approval

H-G Eichler[1,2], K Oye[2,3,4], LG Baird[2], E Abadie[5], J Brown[6], CL Drum[2], J Ferguson[7], S Garner[8,9], P Honig[10], M Hukkelhoven[11], JCW Lim[12], R Lim[13], MM Lumpkin[14], G Neil[15], B O'Rourke[16], E Pezalla[17], D Shoda[18], V Seyfert-Margolis[14], EV Sigal[19], J Sobotka[20], D Tan[12], TF Unger[18] and G Hirsch[2]

Traditional drug licensing approaches are based on binary decisions. At the moment of licensing, an experimental therapy is presumptively transformed into a fully vetted, safe, efficacious therapy. By contrast, adaptive licensing (AL) approaches are based on stepwise learning under conditions of acknowledged uncertainty, with iterative phases of data gathering and regulatory evaluation. This approach allows approval to align more closely with patient needs for timely access to new technologies and for data to inform medical decisions. The concept of AL embraces a range of perspectives. Some see AL as an evolutionary step, extending elements that are now in place. Others envision a transformative framework that may require legislative action before implementation. This article summarizes recent AL proposals; discusses how proposals might be translated into practice, with illustrations in different therapeutic areas; and identifies unresolved issues to inform decisions on the design and implementation of AL.

[1]European Medicines Agency, London, UK; [2]MIT Center for Biomedical Innovation, Cambridge, Massachusetts, USA; [3]MIT Department of Political Science, Cambridge, Massachusetts, USA; [4]MIT Division of Engineering Systems, Cambridge, Massachusetts, USA; [5]Agence Français de Sécurité Sanitaire des Produits de Santé, Saint Denis, France; [6]Department of Population Medicine, Harvard Medical School, Boston, Massachusetts, USA; [7]Novartis Vaccines & Diagnostics, Cambridge, Massachusetts, USA; [8]National Institute for Health and Clinical Excellence, London, UK; [9]Commonwealth Fund, New York, New York, USA; [10]AstraZeneca, London, UK; [11]Bristol-Myers Squibb, New York, New York, USA; [12]Singapore Health Sciences Authority, Singapore, Singapore; [13]Health Canada, Ottawa, Ontario, Canada; [14]US Food and Drug Administration, Silver Spring, Maryland, USA; [15]Johnson & Johnson, New Brunswick, New Jersey, USA; [16]Canadian Agency for Drugs and Technologies in Health, Ottawa, Ontario, Canada; [17]Aetna, Hartford, Connecticut, USA; [18]Pfizer, New York, New York, USA; [19]Friends of Cancer Research, Washington, DC, USA; [20]Ohio Northern University Raabe College of Pharmacy, Ada, Ohio, USA. Correspondence: K Oye (oye@mit.edu)

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Research & Thesis

- TPP is a research degree
  - Partner with MIT faculty as a Research Assistant (RA)
  - Thesis topic typically aligned with RA research
- Technology & Policy Thesis
  - Examines policy issue linked to technical concentration
  - Identifies technical and social context of problem
  - Evaluates options and offers appropriate responses

Examples of Theses

CCS: Assessing Early Investments In Low Carbon Technologies under Uncertainty

Solar-Driven Water Desalination for Potable Use in Haiti

Comparing Capacities and Delays at Major European and American Airports

Safe, Secure & Ethical: Assessing & Regulating Risks Associated with Synthetic Biology

INPUT / OUTPUT

INCOMING - CLASS OF 2013

38 students from 32 colleges and universities

Diverse majors in sciences and engineering

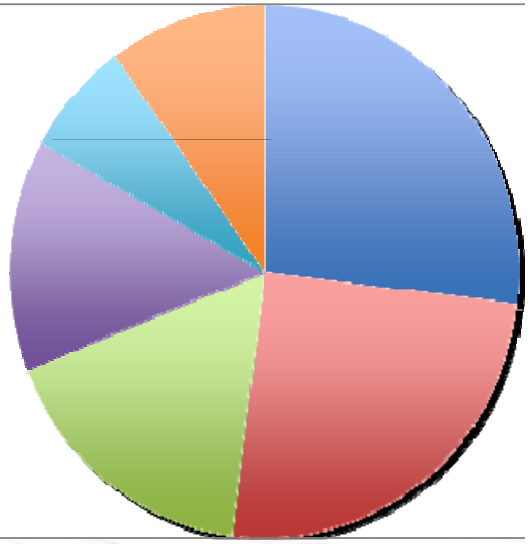
13 nations represented

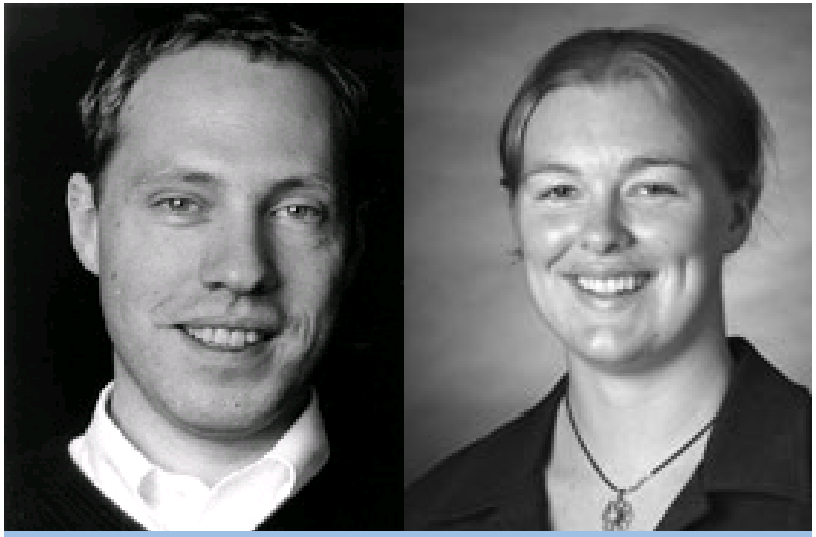
50% male; 50% female

Diverse types and years of work experience

OUTGOING – TPP GRADUATES SINCE 1976

- Industry 27%
- Consulting 25%
- Academia 17%
- Government 14%
- Finance 7%
- Other 10%

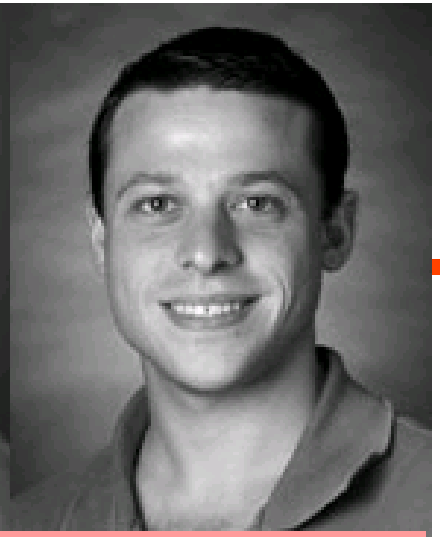




Matt Silver
Cambrian Innovation

Kate Martin
Chevron

Christine Ng
Environ



Mark Avnet
McKinsey

OUTGOING – TPP GRADUATES SINCE 1976

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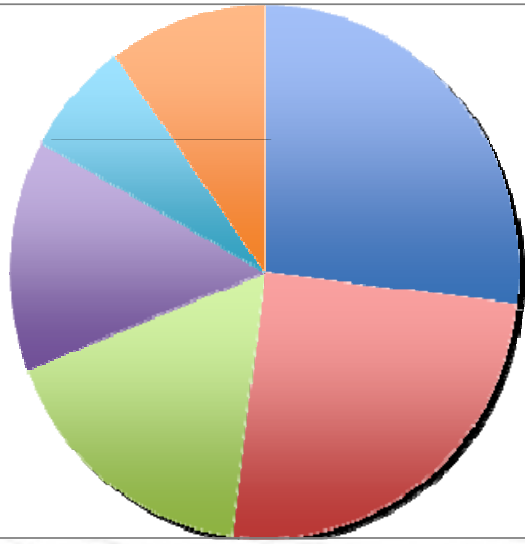
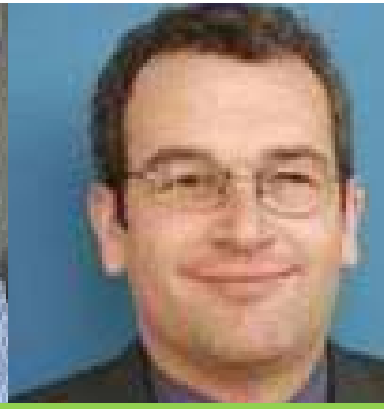


Erica Fuchs
Carnegie Mellon



David Reiner
Cambridge

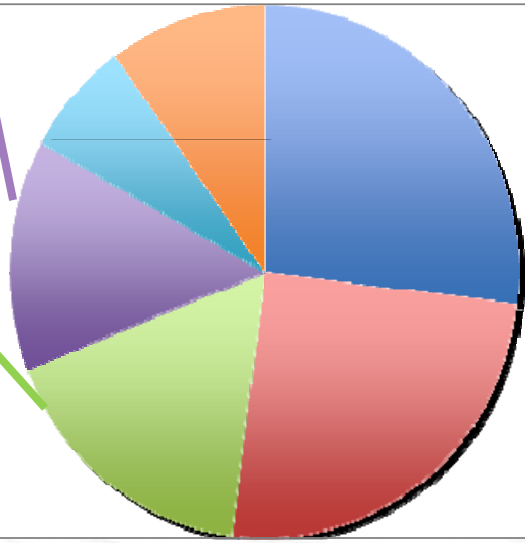
Jessica Stern
NSC / Harvard

Kate Steel
World Bank

Tatsujiro Suzuki
Todai - JAEC

OUTGOING – TPP GRADUATES SINCE 1976

- Industry 27%
- Consulting 25%
- Academia 17%
- Government 14%
- Finance 7%
- Other 10%



Basic Features of Some Technology Policy Programs

MIT Engineering Systems Division - Technology & Policy Program

- 2 year Masters for students with S&T backgrounds
- Core + social sciences + tech concentration + RA + thesis
- Dual degree option

Cambridge Judge Business School - Technology Policy Programme

- 1 year Masters for students with S&T backgrounds
- Professional Practice Stream and Research Stream

Princeton Woodrow Wilson School - STEP Certificate

- 4 courses + paper for WWS students
- 3 courses + paper for students in other graduate programs

MIT Science and Technology Policy Certificate (Proposed)

- 2 core courses + 2 electives for S&T PhD students
- Bottom up initiative from School of Science doctoral students