

Decision Science

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<http://www.cmu.edu/epp/people/faculty/baruch-fischhoff.html>

Mad Scientist Conference 2016

Strategic Security Environment in 2025 and Beyond

Washington, DC

August 8-9, 2016

Decision Science

Analysis: What decisions do people face?

Description: How do people deal with those decisions?

Intervention: How can people be helped to make better decisions?

A multi-disciplinary field, with contributions from

psychology

economics

philosophy

management science

operations research

neuroscience

political science

...

Intellectual Roots

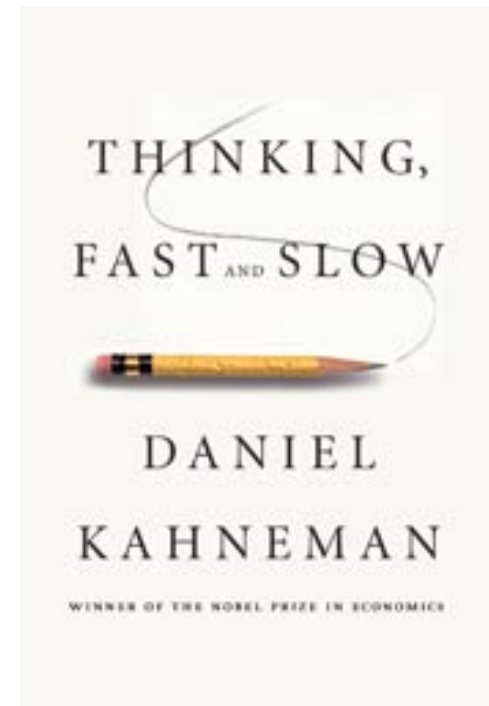
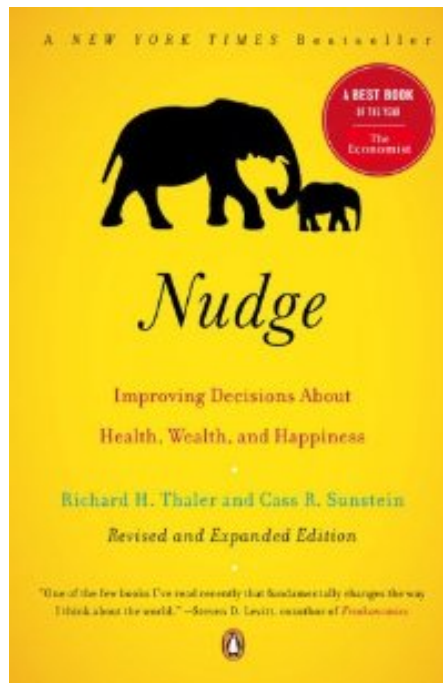
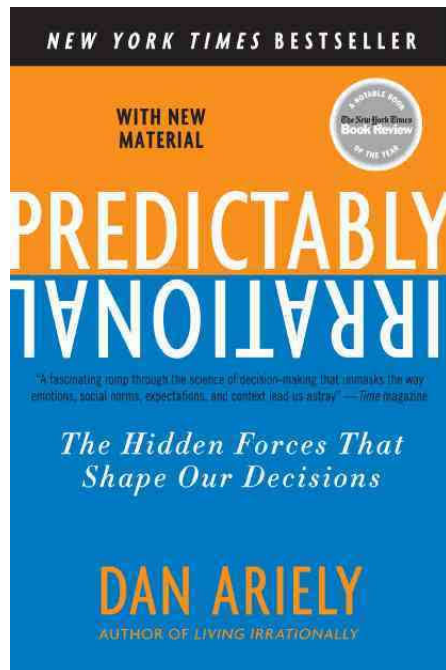
von Neumann & Morgenstern (Princeton)
formal models of rationality

Raiffa/Edwards (Michigan)
rational solutions to applied problems

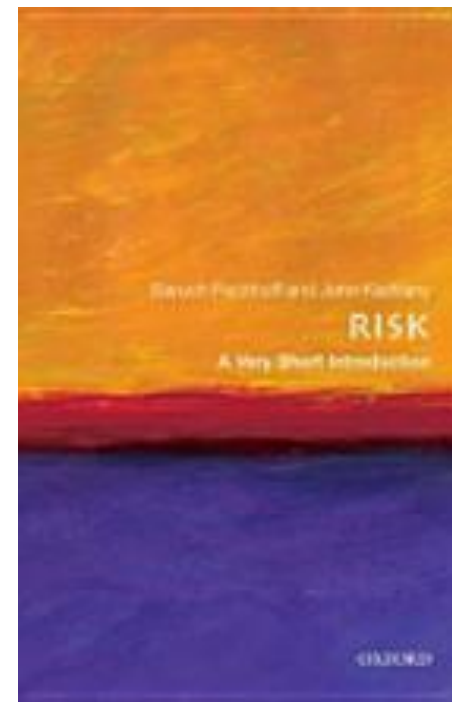
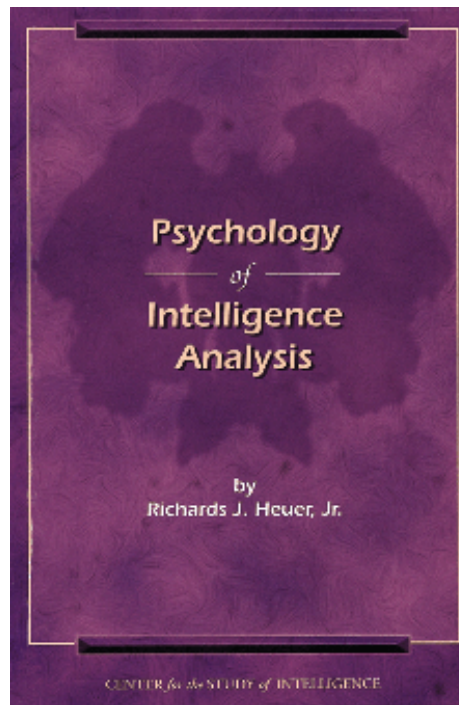
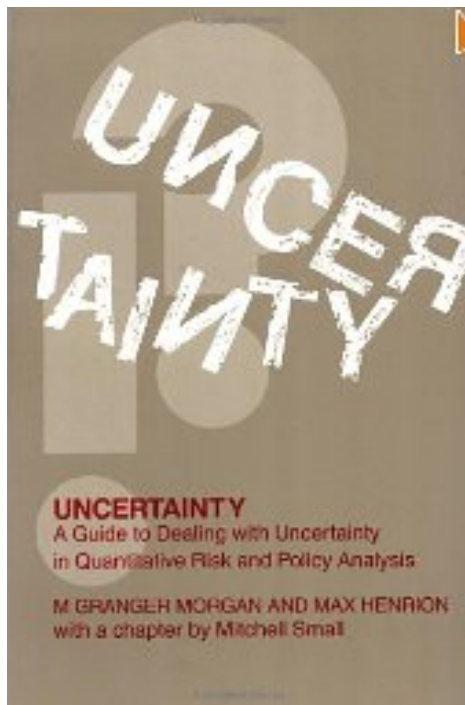
Simon/March/Cyert (Carnegie Mellon)
boundedly rational strategies for complex
problems

Tversky & Kahneman (Hebrew University)
heuristics and biases (limits to judgment)
prospect theory (limits to rational choice)

Basic Science



Applied Science



Some Applications

energy conservation

sexual assault

plague

climate change

detergent

breast cancer

tornadoes

herpes (stigma)

xenotransplantation

emergency medicine

...

domestic radon

solvents

EMF

UXO

violent radicalization

phishing

nuclear power (in space)

Plan B (morning after pill)

neonates

vaccines

...

Some Defense-Related Applications

ARPA decision analysis (1974-1979)

DHS STAC (2004-2009)

EPA HSAC (2006-2009)

CIFA violent radicalization (2007-2009)

DRDC emotions and judgment (2007-2009)

ODNI Futures for Afghanistan (2008)

Artis Research “sacred values” (2009-present)

NAS (for ODNI) analytical methods (2009-11)

The White House

Office of the Press Secretary

For Immediate Release

September 15, 2015

Executive Order -- Using Behavioral Science Insights to Better Serve the American People

[https://www.whitehouse.gov/the-press-office/2015/09/15/
/executive-order-using-behavioral-science-insights-better-serve-american](https://www.whitehouse.gov/the-press-office/2015/09/15/executive-order-using-behavioral-science-insights-better-serve-american)

Scientific Landscape

Large, largely parallel advances in

- Analytical methods
- Judgment and decision making
- Economics (relaxing rationality assumptions)
- Statistical analysis (big data, data mining)
- Organizational behavior (innovation)

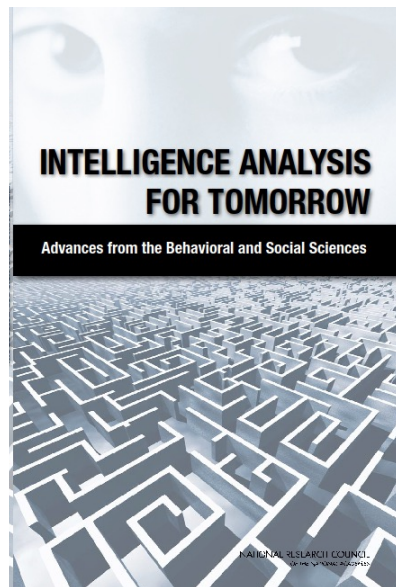
Application Landscape

- Uneven execution (single discipline, limited subject matter expertise)
- Poorly calibrated claims
- Poorly integrated within organizations
- Largely manipulative
- Largely for repeated decisions

NRC Committee on Behavioral Science for Intelligence Analysis

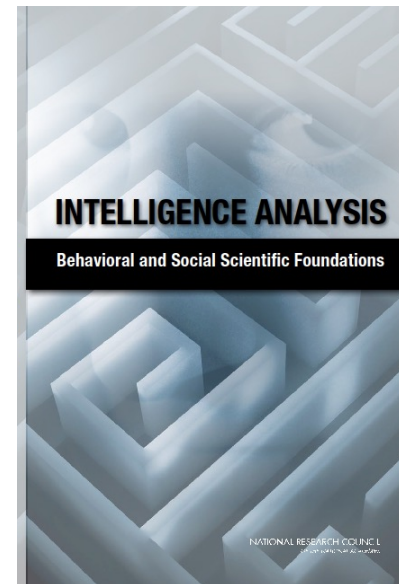
Sponsored by the Office of the Director of National Intelligence

Consensus Report



http://www.nap.edu/catalog.php?record_id=13040

Edited Readings



http://www.nap.edu/catalog.php?record_id=13062

Decision Science

Analysis: What decisions do people face?

Description: How do people deal with those decisions?

Intervention: How can people be helped to make better decisions?

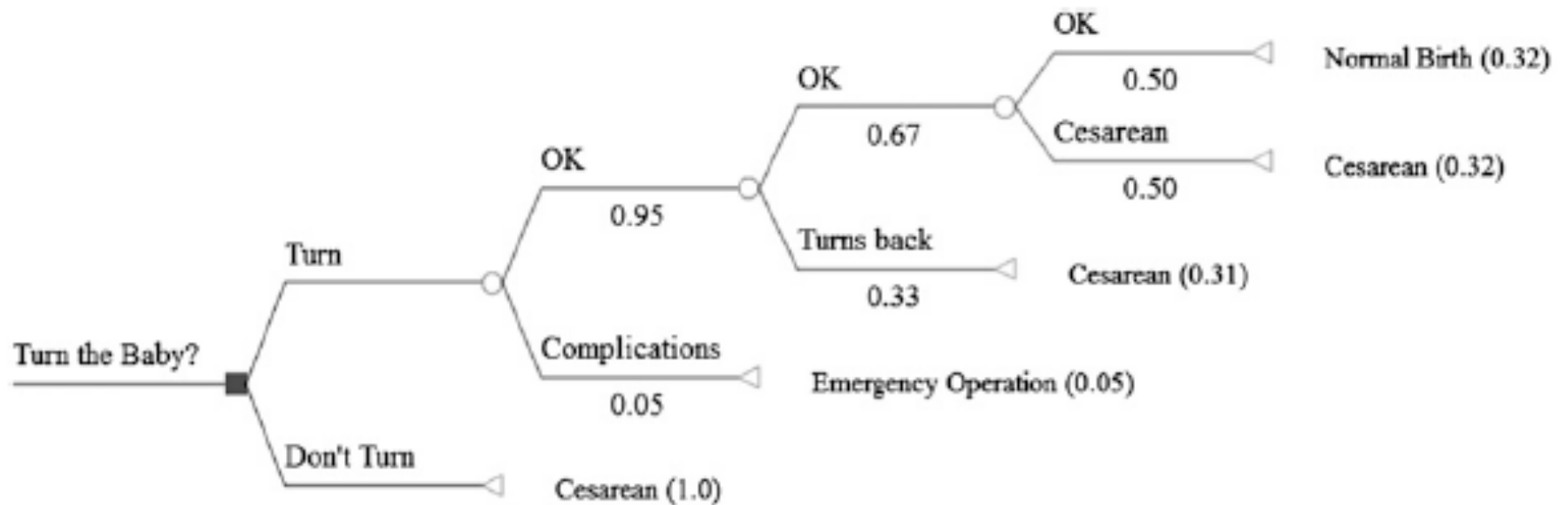
Decision Science

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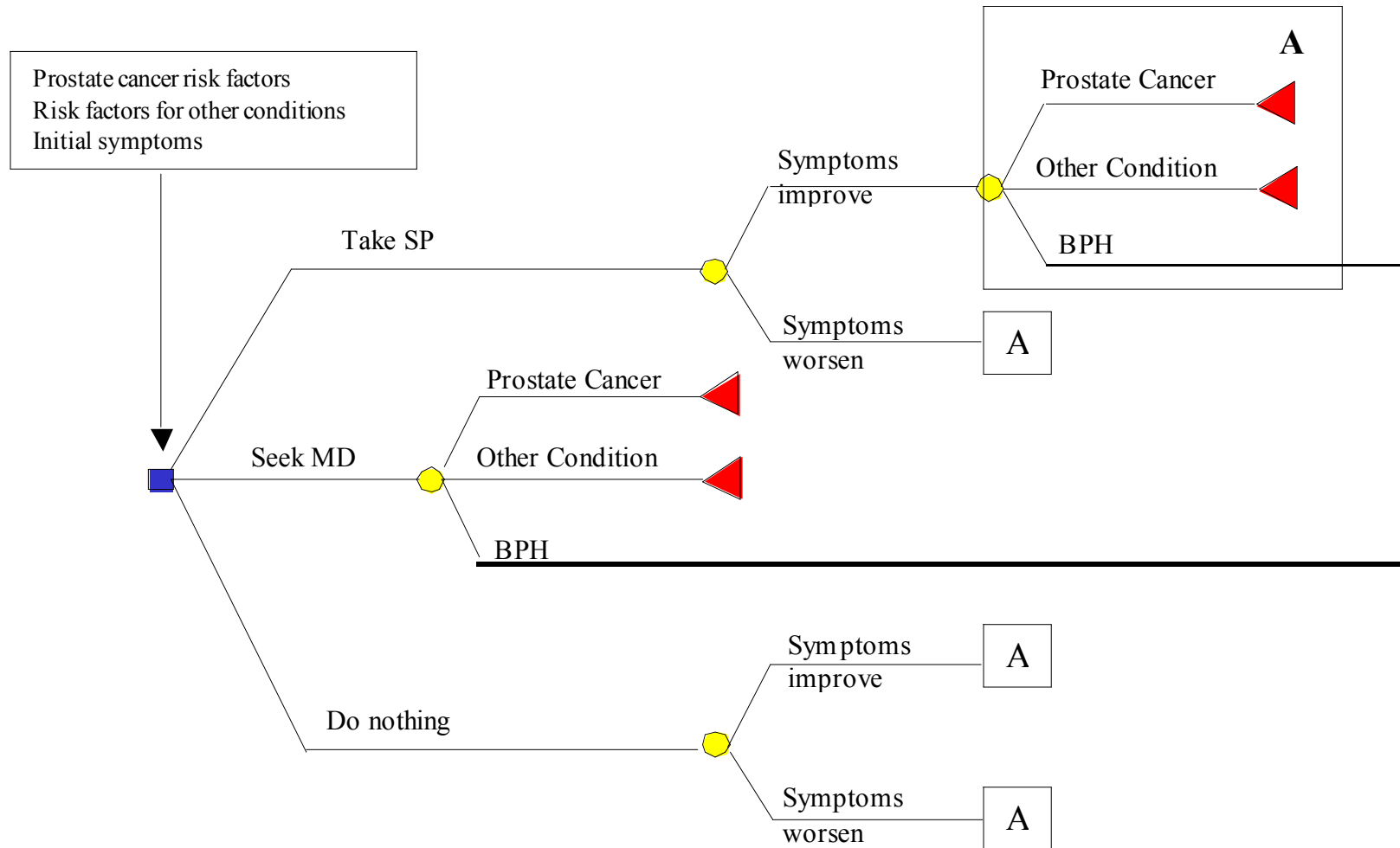
Intervention: How can people be helped to make better decisions?

A Decision about a Breech Birth



vonWinterfeldt, D. (2013). Bridging the gap between science and decision making. *PNAS*, 110, 14055-14061

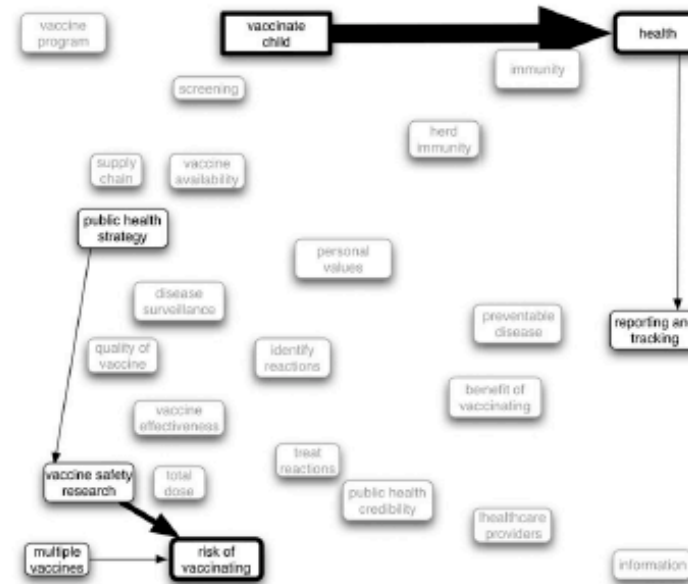
Decisions to Take Saw Palmetto



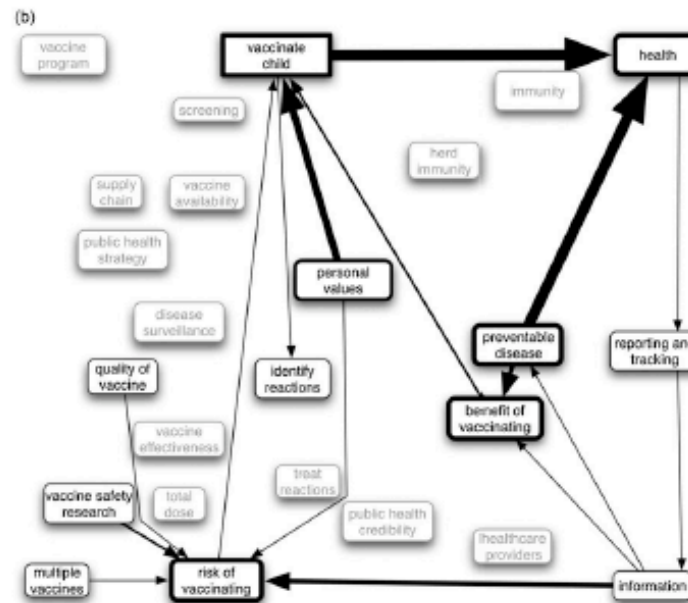
Eggers, S.L., & Fischhoff, B. (2004). A defensible claim? Behaviorally realistic evaluation standards. *Journal of Public Policy and Marketing*, 23(1), 14-27.

Communications about MMR Vaccine

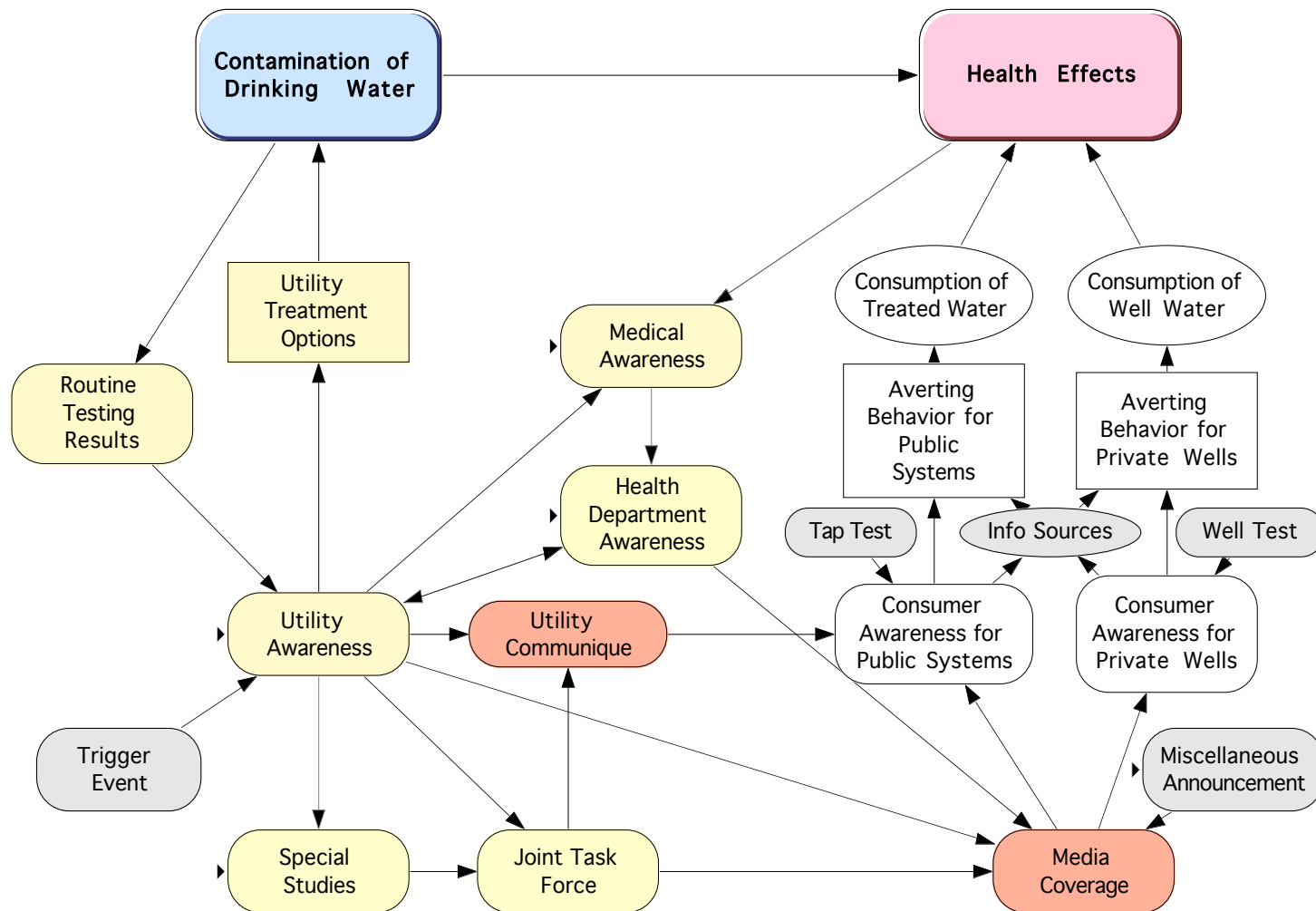
Official communication



Skeptic communication



Decisions about Cryptosporidium Intrusions



Casman, E., Fischhoff, B., Palmgren, C., Small, M., & Wu, F. (2000). Integrated risk model of a drinking waterborne Cryptosporidiosis outbreak. *Risk Analysis*, 20, 493-509

INDUSTRIAL FATIGUE AND EFFICIENCY

BY

H. M. VERNON, {M.A., M.D.

*Investigator for the Industrial Fatigue
Research Board ;*

Late Fellow of Magdalen College, Oxford.

London: George Routledge & Sons, 1921

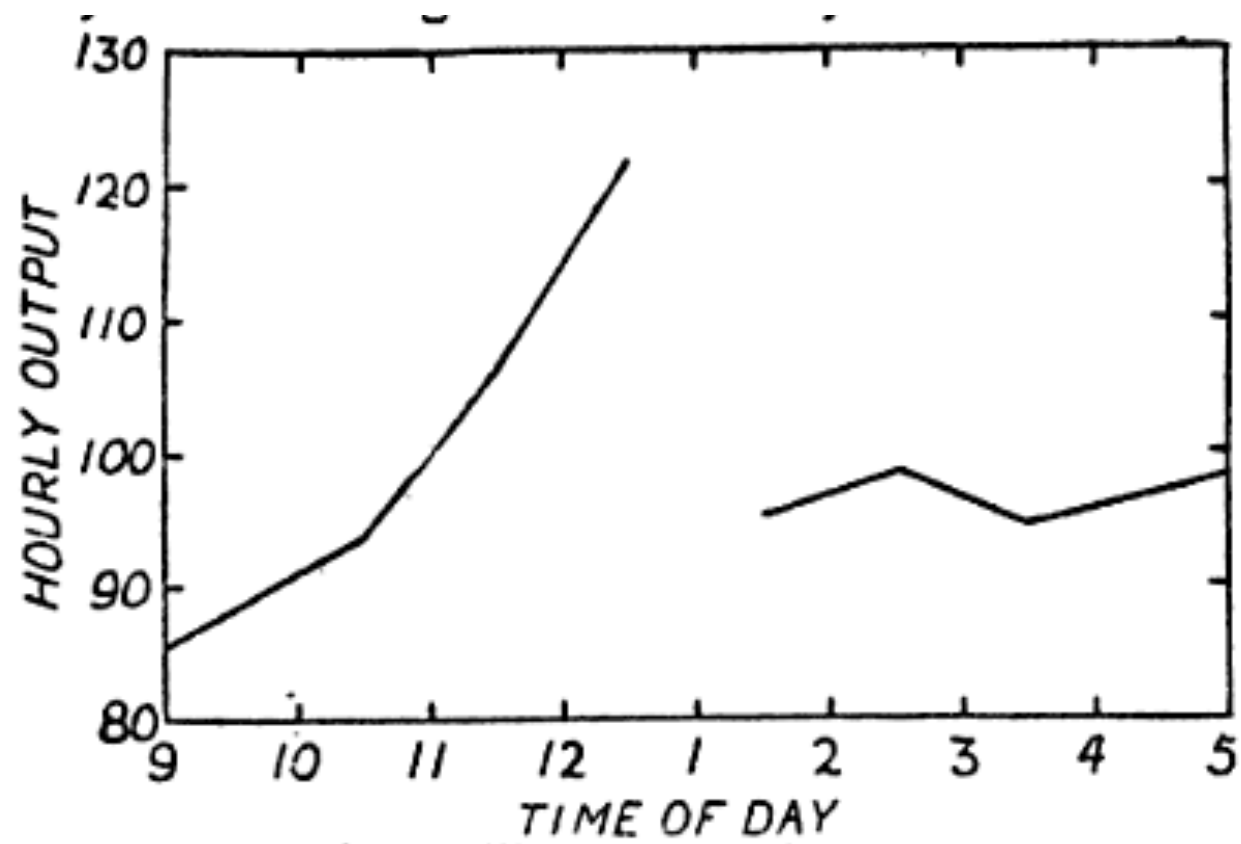


Fig. 4. - Women covering chocolates

Use (and abuse) of expert elicitation in support of decision making for public policy

M. Granger Morgan¹

Department of Engineering and Public Policy, Carnegie Mellon University, Pittsburgh, PA 15213

Representing Uncertainty

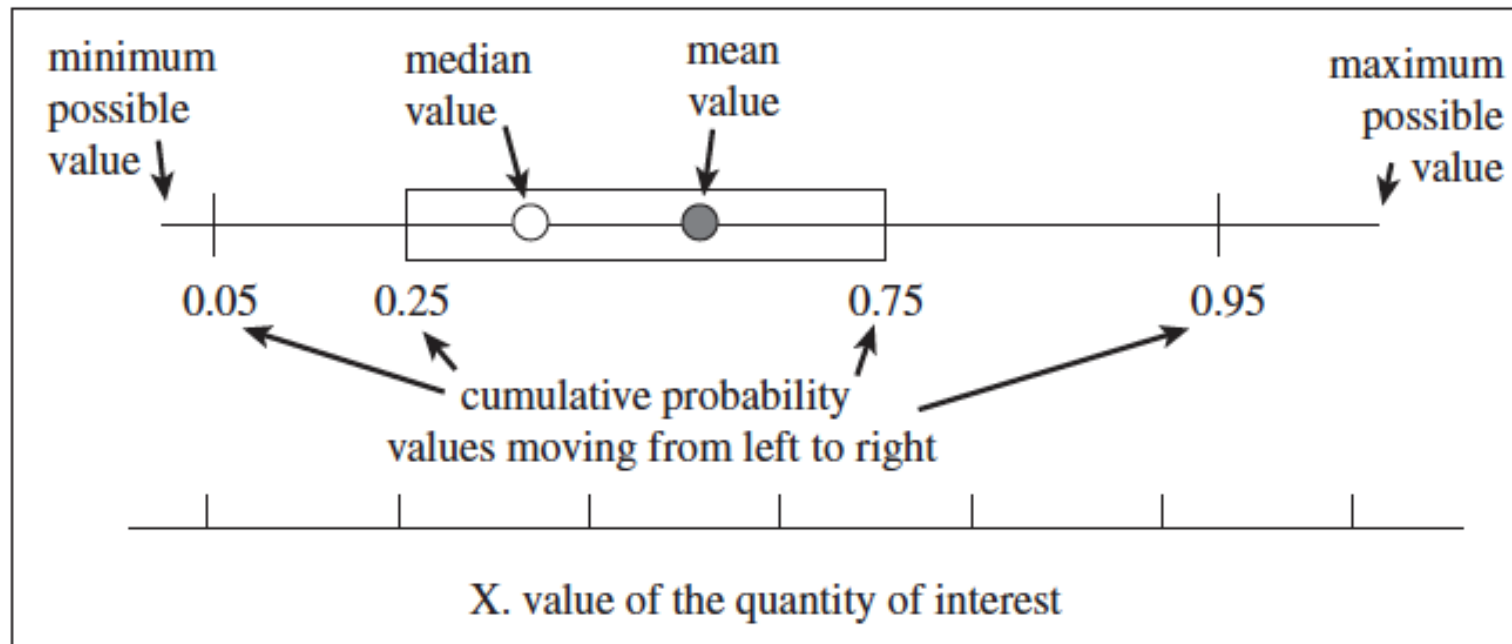


Figure 4. Recommended format for a box plot. When many uncertain results are to be reported, box plots can be stacked more compactly than probability distributions [18].

Campbell, P. (2011). Understanding the receivers and the receptions of science's uncertain messages. *Philosophical Transactions of the Royal Society*, 369, 4891-4912.

Uncertain Economic Knowledge

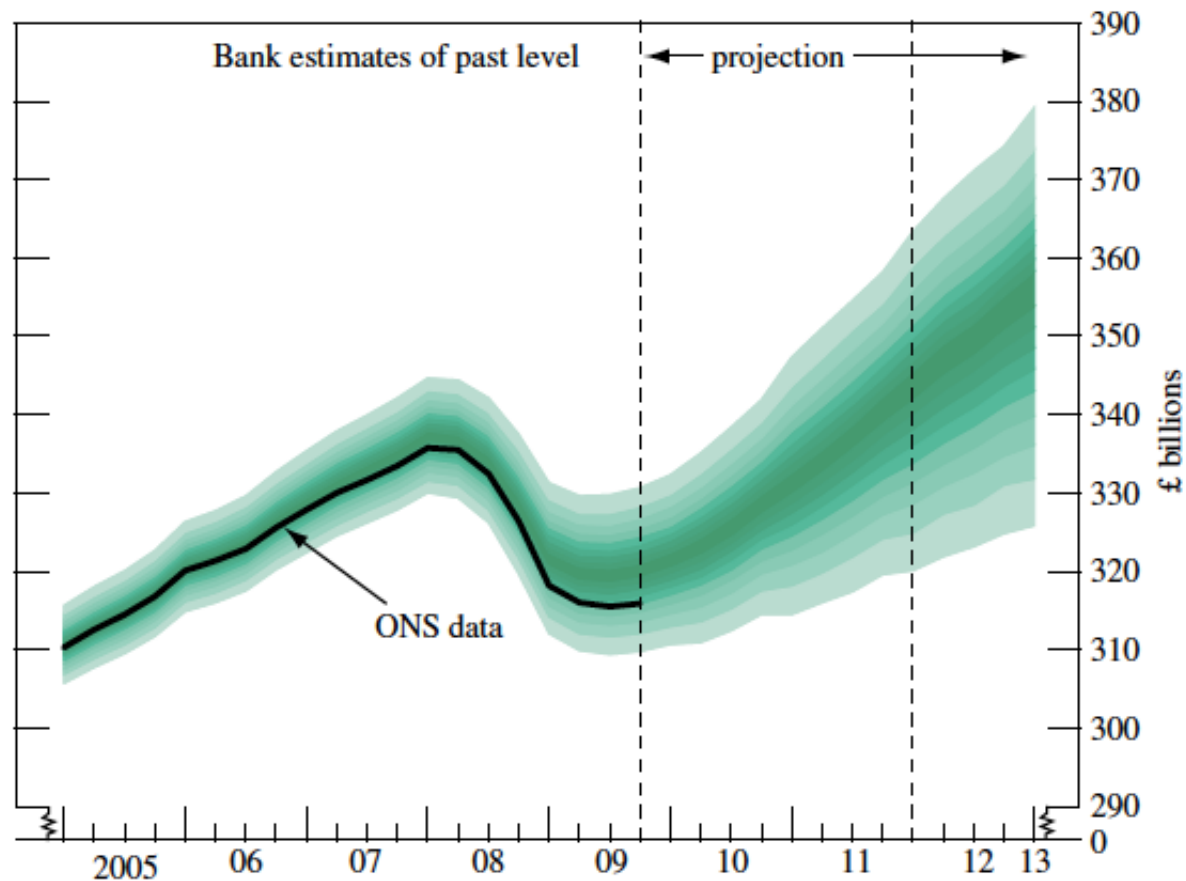


Figure 7. GDP level fan chart. February 2010 *Inflation Report*.

Aikman, D., Barrett, P., et al. (2011). Uncertainty in macroeconomic policy-making: art or science. *Philosophical Transactions of the Royal Society*, 369, 4798-4817.

RESEARCH

REVIEW

RISK ASSESSMENT

The realities of risk-cost-benefit analysis

Baruch Fischhoff

<http://dx.doi.org/10.1126/science.aaa6516>

“Computable” Models

Could run the numbers if data needs could be satisfied.

Forces precision in definition of variables and relationships.

Does not privilege more quantifiable concerns

“Computable” Models

Common platform for data aggregation

Focus for group discussion

Audit for requisite expertise

Structure scenario generation

Computationally tractable sub-models

Decision Science

Analysis: What decisions do people face?

***Description:* How do people deal with those decisions?**

Intervention: How can people be helped to make better decisions?

Behavior Follows Simple Principles

Some Simple Principles of Judgment

People are good at tracking what they see,
but not at detecting sample bias.

People have limited ability to evaluate the
extent of their own knowledge.

People have difficulty imagining themselves
in other visceral states.

People have difficulty projecting non-
linear trends.

People confuse ignorance and stupidity.

Some Simple Principles of Choice

People are insensitive to opportunity costs.

People are prisoners to sunk costs,
hating to recognize losses.

People may not know what they want,
especially with novel questions.

People consider the return on their
investment in making decisions.

People dislike uncertainty,
but can live with it.

Behavior Follows Simple Principles

However,

the set of principles is large,
the contextual triggers are subtle, and
the interactions are complex

As a result, research is needed for each
decision.

Decision Science

Analysis: What decisions do people face?

Description: How do people deal with those decisions?

***Intervention:* How can people be helped to make better decisions?**

Prescription Drug Facts: Lunesta (Eszopiclone)

What is this drug for?	To make it easier to fall or to stay asleep
Who might consider taking it?	Adults age 18 and older with insomnia for at least 1 month
Who should NOT take it?	People under age 18
Recommended testing	No blood tests, watch out for abnormal behavior
Other things to consider doing	Reducing caffeine (especially at night), exercise, regular bedtime, avoid daytime naps

LUNESTA STUDY FINDINGS

788 healthy adults with insomnia for at least 1 month -- sleeping less than 6.5 hours per night and/or taking more than 30 minutes to fall asleep-- were given LUNESTA or a sugar pill nightly for 6 months. Here's what happened:

What difference did LUNESTA make?	People given a sugar pill	People given LUNESTA (3 mg each night)
Did LUNESTA help? LUNESTA users fell asleep faster (15 minutes faster)	45 minutes to fall asleep	30 minutes to fall asleep
LUNESTA users slept longer (37 minutes longer)	5 hours 45 minutes	6 hours 22 minutes
Did LUNESTA have side effects? <i>Life threatening side effects</i> No difference between LUNESTA and a sugar pill	None observed	
<i>Symptom side effects</i>		
More had unpleasant taste in their mouth (additional 20% due to drug)	6% 6 in 100	26% 26 in 100
More had dizziness (additional 7% due to drug)	3% 3 in 100	10% 10 in 100
More had drowsiness (additional 6% due to drug)	3% 3 in 100	9% 9 in 100
More had dry mouth (additional 5% due to drug)	2% 2 in 100	7% 7 in 100
More had nausea (additional 5% due to drug)	6% 6 in 100	11% 11 in 100

How long has the drug been in use?

Lunesta was approved by FDA in 2005. As with all new drugs we simply don't know how its safety record will hold up over time. In general, if there are unforeseen, serious drug side effects, they emerge after the drug is on the market (when a large enough number of people have used the drug).

Schwartz, L., & Woloshin, S. (2013). The Drug Facts Box: Improving the communication of prescription drug information. *PNAS*, 110, 14069-14074.

**FDA'S
STRATEGIC PLAN
FOR
RISK COMMUNICATION**

Fall, 2009

FDA Risk Communication Advisory Committee (RCAC)

Charter of the Risk Communication Advisory Committee to the Food and Drug Administration

Authority:

The Advisory Committee on Risk Communication, referred to herein as the Risk Communication Advisory Committee, was established by 21 U.S.C. 360bbb-6, as added by section 917 of the Food and Drug Administration Amendments Act of 2007. The Committee is also governed by 21 CFR Part 14 and Pub. L. 92-463 (5 U.S.C. App.), the Federal Advisory Committee Act, which sets forth standards for the formation and use of advisory committees.

RCAC Recommendations

Communication for Emerging Events

Have a consistent policy in all domains

Provide useful, timely information

Address: risks and benefits, uncertainty,
personal actions, FDA actions

Audience needs should drive agency
analyses

Use standard formats; evaluate routinely

Consider needs of diverse populations



Structured Approach to Benefit-Risk Assessment in Drug Regulatory Decision-Making

Draft PDUFA V Implementation Plan - February 2013
Fiscal Years 2013-2017



Figure 1: FDA Benefit-Risk Framework

Decision Factor	Evidence and Uncertainties	Conclusions and Reasons
Analysis of Condition		
Current Treatment Options		
Benefit		
Risk		
Risk Management		
Benefit-Risk Summary Assessment		

FDA. (2013). *Structured approach to benefit-risk assessment for drug regulatory decision making*. Draft PDUFA V implementation plan (2/13). FY2013-2017.

Decision Science Principles in FDA's Benefit-Risk Framework

Recognizes scientific and policy judgment
in all analyses

Quantifies the quantifiable, without ignoring
other concerns

Highlights ethical and political tradeoffs,
rather than burying them in a metric

Supports risk management

The Voice of the Patient

A series of reports from the U.S. Food and Drug Administration's (FDA's)
Patient-Focused Drug Development Initiative

Chronic Fatigue Syndrome and Myalgic Encephalomyelitis

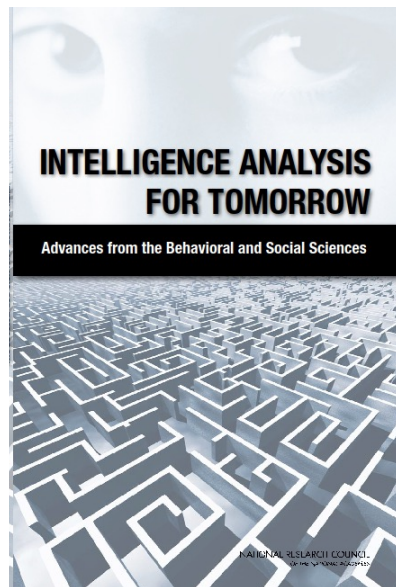
Public Meeting: April 25, 2013

Report Date: September 2013

NRC Committee on Behavioral Science for Intelligence Analysis

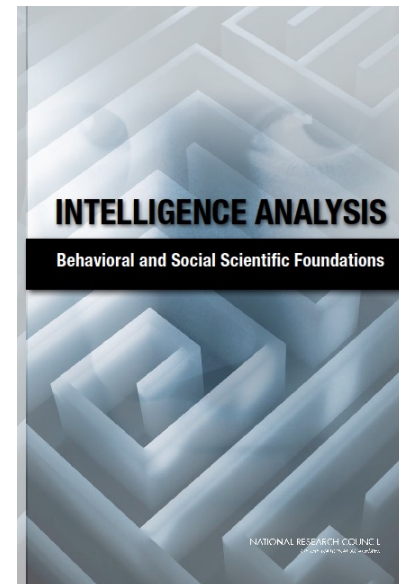
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Consensus Report



http://www.nap.edu/catalog.php?record_id=13040

Edited Readings



http://www.nap.edu/catalog.php?record_id=13062

Objective

Enhance the human capital of the
intelligence community

Recommendations

Everyone should have conceptual mastery of basic analytical methods.

Organizational processes should support sound decision making.

Rely on established science.

Evaluate everything.

Develop research collaboratively.

Established Science (Analysis)

Operations research

Game theory

Signal detection theory

Political theory

Reasoning

Judgment under uncertainty

Communication with stakeholders

Group processes

Workforce development

Accountability systems

Organizational change

Established Science (Process)

Operations research

Game theory

Signal detection theory

Political theory

Reasoning

Judgment under uncertainty

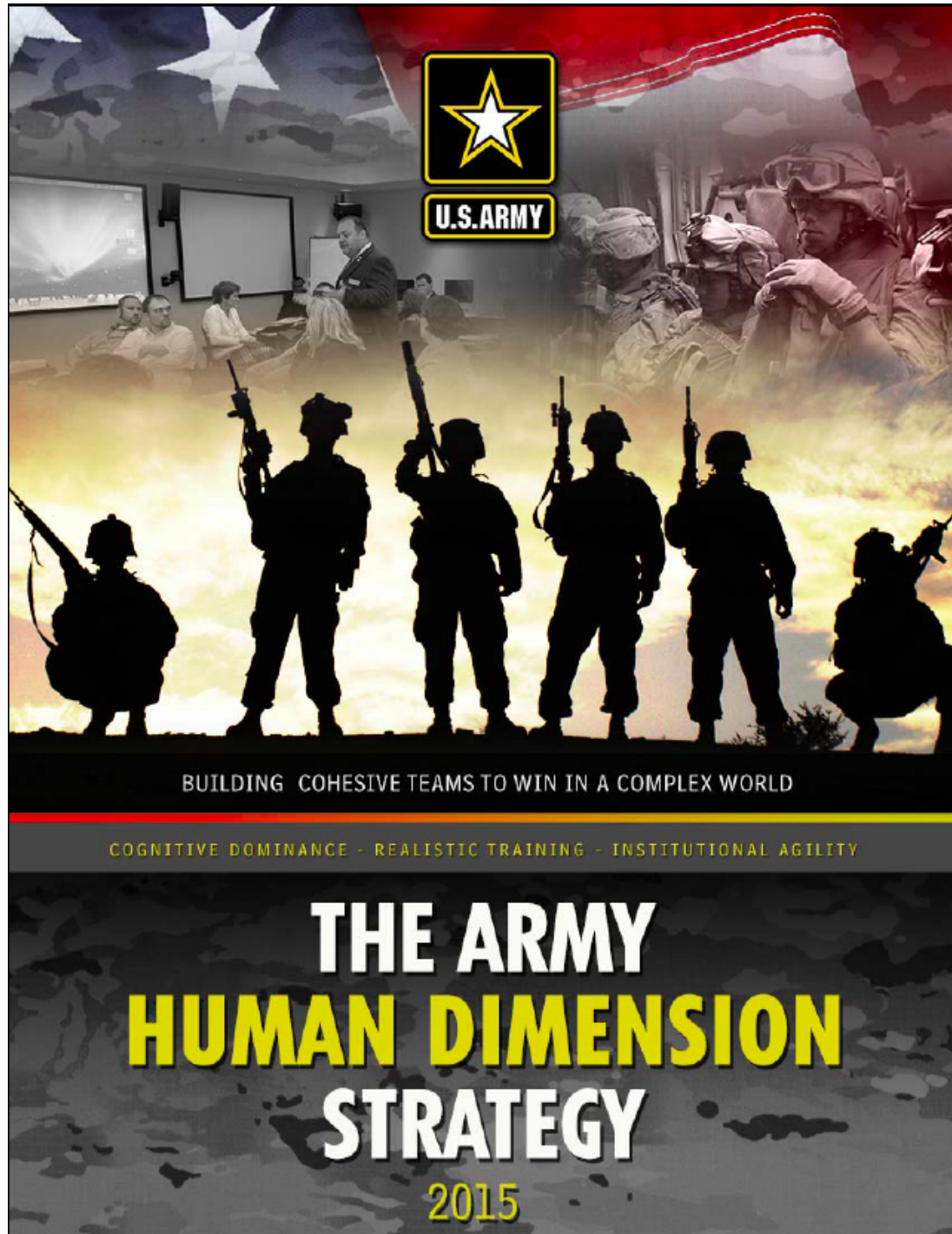
Communication with stakeholders

Group processes

Workforce development

Accountability systems

Organizational change



U.S. ARMY

BUILDING COHESIVE TEAMS TO WIN IN A COMPLEX WORLD

COGNITIVE DOMINANCE - REALISTIC TRAINING - INSTITUTIONAL AGILITY

THE ARMY HUMAN DIMENSION STRATEGY

2015

VISION FOR
2025 AND BEYOND

- **Optimize the human performance of every Soldier and Civilian in the Total Force**
- **Build cohesive teams of trusted professionals who thrive in ambiguity and chaos**

Two Possible Collaboration Models

Episodic Mobilization

The American Soldier— An Expository Review

BY PAUL F. LAZARSFELD

PUBLICATION of *The American Soldier* constitutes an event of first importance in the world of social research. Although the studies on which the book is based were made in response to military needs, they contain a mine of information and insights for all persons concerned with human behavior. Many of the findings are of direct relevance to the industrial psychologist, the educator, and the public relations specialist, as well as to the social theoretician, the opinion researcher, and the military policy maker.

At the request of the QUARTERLY, Professor

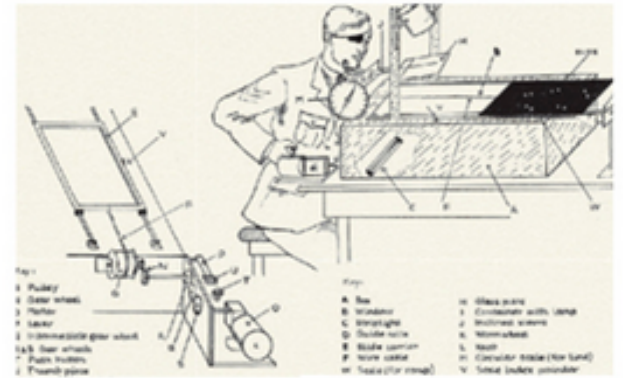
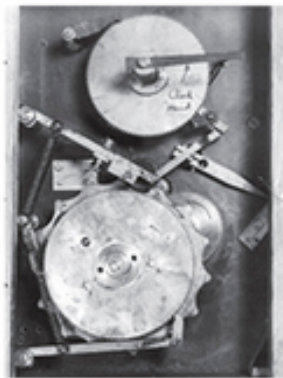
Lazarsfeld has provided a brief guide to the first two of these four encyclopedic volumes, and has highlighted the significance of many of the findings reported therein. Contributions to such key concepts of sociology and psychology as the primary group, frame of reference, and the influence of role and position are discussed, and a bird's-eye view of the major experiments and findings is given, together with some of their major implications.

The author is Professor of Sociology at Columbia University, and President of the American Association for Public Opinion Research.

Dedicated Resource Centers

Medical Research Council
Applied Psychology Unit
(15 Chaucer Road, Cambridge, UK
(1944-1998)





War time research (left to right) : SMA-3 pilot Aptitude test, Cambridge Cockpit, Mackworth Clock, Fighter Control Rooms, Bomb-aiming Apparatus

Led by Senior Scientists

Kenneth Craik

Sir Frederick Bartlett

Norman Mackworth

Donald Broadbent

Christopher Poulton

Alan Baddeley



Aligned Incentives

Publish in top journals
Demonstrate usefulness

Collaboration Seen as Essential

Applied basic science

-- evaluating accepted science in applied contexts

Basic applied science

-- pursuing fundamental topics arising in applied contexts

Alan Baddeley

Books

- Fischhoff, B., Brewer, N., & Downs, J.S. (eds.). (2011). *Communicating risks and benefits: An evidence-based user's guide*. Washington, DC: Food and Drug Administration.
<http://www.fda.gov/AboutFDA/ReportsManualsForms/Reports/ucm268078.htm>
- Fischhoff, B., & Chauvin, C. (eds.). (2011). *Intelligence analysis: Behavioral and social science foundations*. Washington, DC: National Academy Press
http://www.nap.edu/catalog.php?record_id=13062
- Fischhoff, B., & Kadvany, J. (2011). *Risk: A very short introduction*. Oxford: Oxford University Press.
- Fischhoff, B., Lichtenstein, S., Slovic, P., Derby, S. L. & Keeney, R. L. (1981). *Acceptable risk*. New York: Cambridge University Press. (NUREG/CR-1614).
- Kahneman, D. (2011). *Thinking, fast and slow*. New York: Farrar Giroux & Strauss.
- Morgan, M.G., Henrion, M. (1990). *Uncertainty*. New York: Cambridge University Press.
- Slovic, P. (ed.) (2000). *Perception of risk*. London: Earthscan.

Research Articles

- Bruine de Bruin, W., Parker, A., & Fischhoff, B. (2007) Individual differences in adult decision-making competence (A-DMC). *Journal of Personality and Social Psychology*. 92, 938-956.
- Fischhoff, B. (1992). Giving advice: Decision theory perspectives on sexual assault. *American Psychologist*, 47, 577-588.
- Fischhoff, B. (2011). Communicating the risks of terrorism (and anything else). *American Psychologist*, 66, 520-531.
- Fischhoff, B. (2015). The realities of risk-cost-benefit analysis. *Science*, 350(6260), 527.
<http://dx.doi.org/10.1126/science.aaa6516>
- Fischhoff, B., Bruine de Bruin, W., Guvenc, U., Caruso, D., & Brilliant, L. (2006). Analyzing disaster risks and plans: An avian flu example. *Journal of Risk and Uncertainty*, 33, 133-151.

<http://www.cmu.edu/epp/people/faculty/baruch-fischhoff.html>

Carnegie Mellon Electricity Center: <http://wpweb2.tepper.cmu.edu/ceic/>

Center for Climate and Environmental Decision Making: <http://cedm.epp.cmu.edu/index.php>

Behavior Decision Policy Working Group: <http://www.cmu.edu/epp/behavior-decision-policy>

Center for Human Rights Science: <http://www.cmu.edu/chrs/>