Cognitive Aspects of Decision Making

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Workshop Goals

• Summarize state-of-the-science in areas related to Cognitive Aspects of Decision Making
  – Summary presentation during the workshop
  – WG papers after the workshop
  – Summary paper based on the workshop
• Identify problems and propose solutions/ analytical methods
  – Focus on individual and group decision making
  – Risk Assessment (ecological and human health)
  – Decision Analysis
• Establish collaborative teams and possible projects
• Have Fun!

Cognitive Aspects of Decision Making
22-24 September 2008, Washington, DC
Overview

- Why Cognitive Aspects?
- Why Decision Analysis?
- Why Risk Assessment?
- Why Us and Why Now?

- Agenda

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Actions for Change
Bottom Line Up Front

“The Corps is responsible for the projects we build and manage, and we are accountable to the American people … for those who doubt us, words alone will not restore confidence. We are mindful that the public trust is earned when we follow through on our actions.”

– Lieutenant General Carl A. Strock
Overcoming Impediments to Innovation & Transformation

Vision and Leadership are key to overcoming Impediments to Innovation

From J. Garstka, 2007

Chief’s 12 Actions ⇒ 4 Themes

Theme 1 - Comprehensive Systems Approach
- Action 1 - Employ integrated, comprehensive and systems-based approach
- Action 5 - Employ adaptive planning and engineering systems
- Action 6 - Focus on sustainability

Theme 2 - Risk Informed Decision Making
- Action 2 - Employ risk-based concepts in planning, design, construction, operations, and major maintenance
- Action 7 - Review and inspect completed works

Theme 3 - Communication of Risk to the Public
- Action 9 - Effectively communicate risk
- Action 10 - Establish public involvement risk reduction strategies

Theme 4 - Professional and Technical Expertise
- Action 3 - Continuously reassess and update policy for program development, planning guidance, design and construction standards
- Action 4 - Employ dynamic independent review
- Action 8 - Assess and modify organizational behavior
- Action 11 - Manage and enhance technical expertise and professionalism
- Action 12 - Invest in research
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22-24 September 2008, Washington, DC

Cognitive Aspects

Decision Analysis

Risk Assessment

After Smith, 2006

Why Decision Analysis?

Information gathering and decision-making are two separate cycles

After Roman, 1996

Source: Sullivan, Gordon R. and James M. Dubik, War in the Information Age.
Now-Technology-based Fix in Information Age

Need for Revolutionary Changes

Evolving Decision-Making Process

Military/DHS Decision-Maker(s)

Decision Analytical Frameworks
- Agency-relevant/Stakeholder-selected
- Currently available software
- Variety of structuring techniques
- Iteration/reflection encouraged
- Identify areas for discussion/compromise

Risk
Sensing
Intel Data
Resoures
Morale/Politics

Sharing Data, Concepts and Opinions

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Why Risk Assessment?

Risk as Descriptor for Physical Domain

- **Risk**: The likelihood or probability of an adverse outcome
- Examples
  - Being hit by a car while taking a walk
  - Structural failure of a dam
  - Breaching of a levee during a flood
  - Reduced performance of a lock measured in terms of tow transits per day
- For use in decision making, event probability is combined with a description of consequences

Risk-Based Decision-Making

- **Risk assessment**: A process for developing a quantitative understanding of the processes shaping the scope and nature of risks and uncertainties that is sufficient to support decision making
  - What is the risk?
  - Why and how are the risks occurring?
  - What is the uncertainty associated with the risk estimate?
  - How do the management alternatives differ in terms of risk reduction performance?
What can happen (go wrong)?

What are the consequences?

How likely is it?

Risk Assessment Formulation

Risk Assessment: Experts and Stakeholders

- Two types of “correct” risk assessment:
  - Expert: Risk = Hazard • Exposure • Magn • Prob
  - Layperson: R = Hazard • Perception

- For stakeholders, the root issue is: fear of becoming a victim to (uncompensated) loss
- Core concerns tend to be: trust, control, process, information and timing.
Why Us?

- ~40 scientists, by invitation only, leaders in the field
- Interdisciplinary
  - Engineering, physics, psychology, oceanography, biology, cognitive science, operations research, communications...
- Balanced representation from Academia, Government and Consulting

Agenda: Monday AM

**AM**

**Introduction**

8:00  Representatives from Sponsoring Organizations: Welcomes
8:15  Linkov: Scientific Background, Goals, and Workshop Overview

1. Needs and Desired Directions

8:45  Alberts: Collective C2 in a Network Centric Environment
9:05  Ritchie: Medical/Cognitive
9:25  Gabbrielli: Integrated Risk Management - DHS
9:45  Bridges: Civil Works (Infrastructure, Environmental, Ecological)
10:00 Coffee Break

2. Identifying Best Way Forward: Opportunities for Synergistic Cross-Discipline Collaboration?

Panelists: Lachow, Ross, Morel, Franz, Lemyre

10:30  Brief Presentation
11:10  Discussion
11:45  Lunch
Agenda: Monday PM

3. Cognition and Decision Making
   1:00  Gold: Mechanisms of learning a perceptual decision
   1:20  Braithwaite: Research from Non-primate Animals
   1:40  Wang: Evolutionary, ecological and social rationality of decision making under risk

4. Concepts, Methods and Tools
   2:00  Veinott: Ill-Defined Goals: Implications for Planning and Decision Making
   2:20  Bonnano: Resilience
   2:40  Silverman: Soci-cognitive agents for DIME-PMESII games
   3:00  Perlovsky: Cognitive Algorithms: Concepts, Emotions, Cultures
   3:30  Coffee Break

5. Opportunities for Cross Disciplinary Research (Panel Discussion)
   Panelists: Anderson, Kiker, Gonzales, Groeger, Ditmer
   4:00  Brief Presentation
   4:30  Discussion

5:00  Formation of Working Groups and Review Of Charge
   WG1: Cognitive aspects of risk-based decision making at the individual/small group level
   WG2: Cognitive aspects of risk-informed decision-making at the large group/societal level

6:00  SOCIAL HOUR (Sponsored by Decision Partners)

Working Group Organization

- WG1: Cognitive aspects of risk-based decision making at the individual/small group level
  - Co-Chairs: Anderson and Goodwin
  - Facilitator: TBA
  - Rapporteurs: Smith and Linthicum

- WG2: Cognitive aspects of risk-informed decision-making at the large group/societal level
  - Co-Chairs: Ditmer, Mukherjee, Linkov
  - Facilitator: Butte
  - Rapporteurs: Williams and Saner
Working Groups

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<td>Andrew.R.Goodwin@usace/army.mil</td>
<td>agent-based modeling, social network analysis</td>
<td>October only</td>
</tr>
<tr>
<td>Linkov</td>
<td>Igor</td>
<td>Igor.linkov@usace/army.mil</td>
<td>Network-centric operation, decision analysis, military programs</td>
<td>October only</td>
</tr>
<tr>
<td>Liberman</td>
<td>Steve</td>
<td><a href="mailto:stlieber@nps.edu">stlieber@nps.edu</a></td>
<td>cybersecurity, combat mental health</td>
<td>October only</td>
</tr>
</tbody>
</table>

Agenda: Tuesday

AM 8:00: Linkov and Goodwin: Brief Review of Day 1 Presentations

6. Working Groups Meeting 2

Work Group Tasks
Identify Issues and Challenges
Identify Needs and Opportunities for Research
Identify Value to DoD and Scientific Community

9:45 Coffee Break

5. Opportunities and the Future for Simple, Robust Tools of Decision Making

10:15 WG Chairs: Brief Reports and Coordination

10:35 Ginzburg: Dealing with Uncertainty: Cognitive Aspects

10:55 Butte and Mukherjee: Mental Modeling

11:15 Lambert: Multi-criteria Decision Analysis

11:35 Anderson: Agent-Based Modeling: Modeling between reflex and cognition

12:00 Lunch

PM Working Groups Meeting 3

3:00 Coffee Break

3:30 Working Groups

7:00 DINNER (TBD)
Agenda: Wednesday

8:00  Working Groups Reports/Coordination

7.  Preparation of Work Group Summary Presentations

8:30  Preparation of Work Group Summary Presentations

10:00  Coffee Break

8.  Summary Presentations

10:30  Summary Presentations from Work Groups

12:00  Lunch

PM

9.  Discussion

1:00  Where are We Now and Where Can DoD Go in Coming 5-10 Years

10.  Wrap-up & Next Steps

2:00  Linkov: Summary of Key Results and Research Needs

2:15  Discussion

3:00  Adjourn