



Advanced Research Workshop



Decision Analysis Tools for Risk Management of Industrial Ports and Harbors



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Decision Analysis Society

Agenda

- **Challenges**
- **Definitions**
 - **Risk analysis**
 - **Decision analysis**
- **Risk analysis frameworks**
- **Decision analysis techniques**
- **Conclusions**

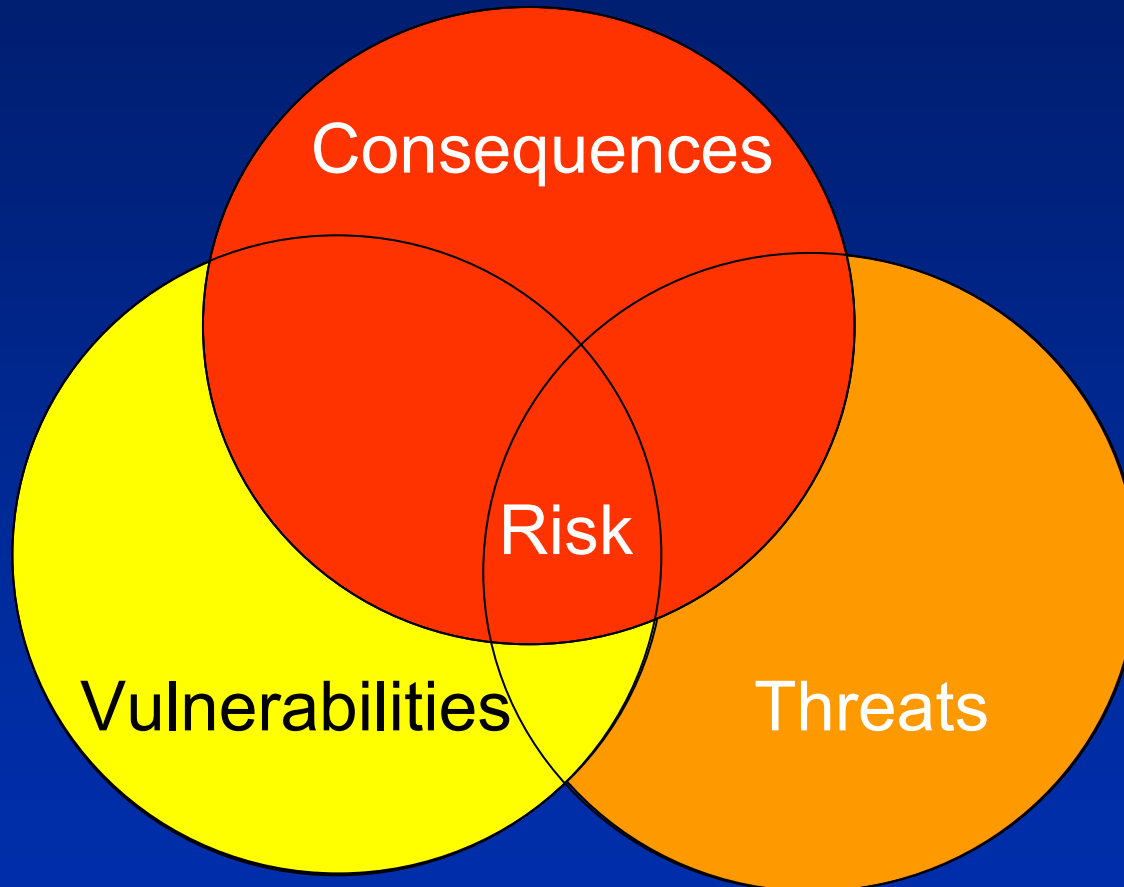
Challenges for industrial ports and harbors

- Support national economic trade
- Make a profit
- Involve international, national, local, and private stakeholders
- Assess all risks in port and harbor operations
 - Counter an intelligent, resourceful, adaptive adversaries
- Spend risk management funds wisely



Decision analysis has 3+ decades of successful applications in private and public sector.

Elements of Risk



Risk = f(Threats, Vulnerabilities, Consequences)

Risk Analysis = Risk Assessment + Risk Management



Risk Assessment Questions:

What can go wrong?

What is the likelihood that it would go wrong?

What are the consequences?

Risk Management Questions:

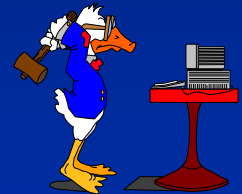
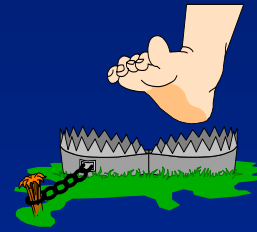
What can be done now?

What future options are available and what are their associated trade-offs in terms of all costs, benefits, and risks?

What are the impacts of current management decisions on future options?

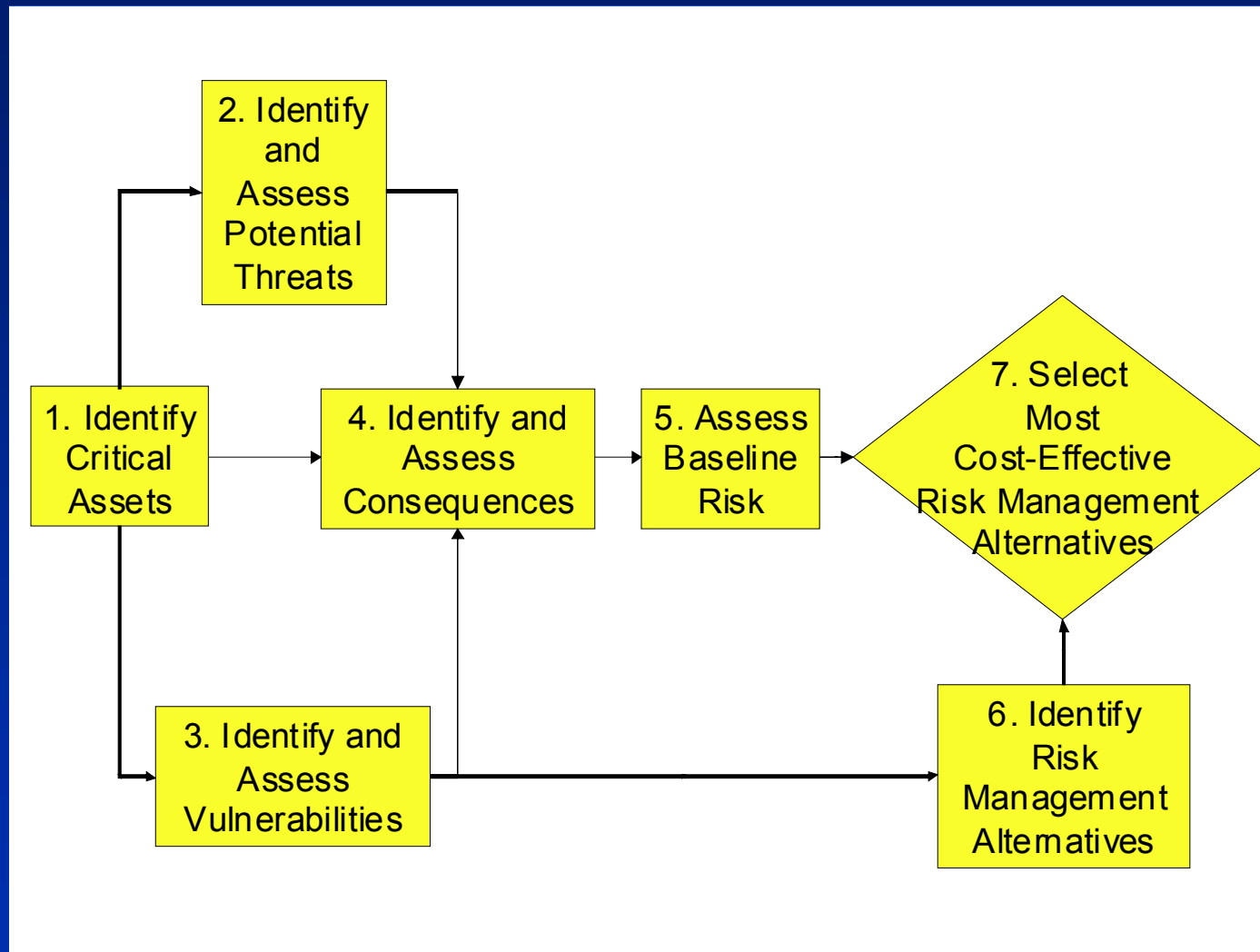
Sources Of Failure:

System Failure
Process Failure
Organization Failure
Human Failure



Risk analysis has been used since mid 1970s. Early applications were nuclear power and spacecraft safety. Successful applications include medicine, business, natural disasters, environment, and industrial safety.

We developed a methodology for integrating risk management and resource allocation.

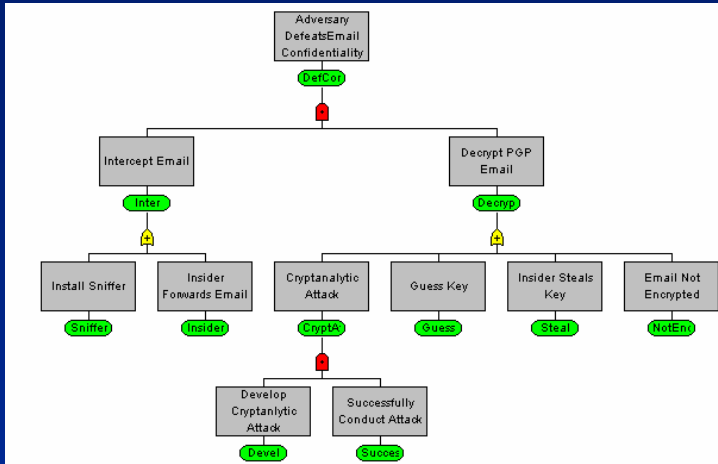


Parnell, G. S., Dillon-Merrill, R. L., and Bresnick, T. A., 2005, *Integrating Risk Management with Homeland Security and Antiterrorism Resource Allocation Decision-Making*, The McGraw-Hill Handbook of Homeland Security, David Kamien, Editor, pp. 431-461

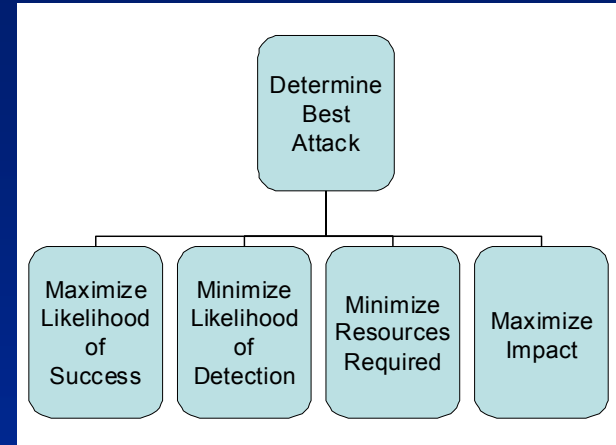
We reviewed techniques from many disciplines.

- Systems engineering
- Risk analysis
 - Risk assessment
 - Risk management
- Decision analysis
- Game theory
- Benefit-cost analysis

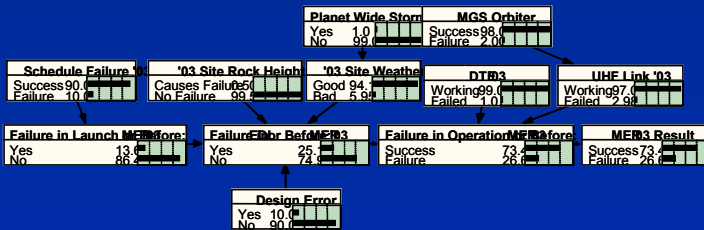
We discussed the advantages and disadvantages of several techniques.



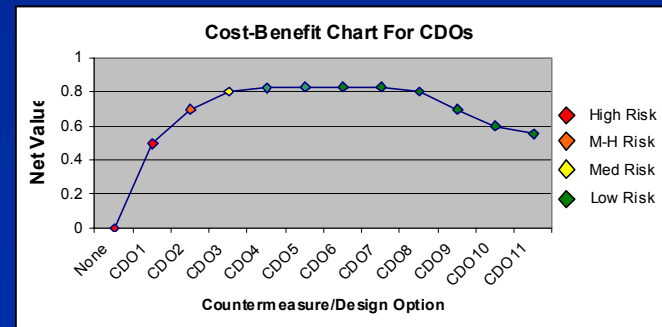
Fault/Attack Tree*



Adversary Value Hierarchy*



Probabilistic Analysis of Failure Risk of Mars Rover (Paté-Cornell, Dillon, and Guikema, 2003)



Cost Benefit Curve for Information System Countermeasures*

Buckshaw, D. L., Parnell, G. S., Unkenholz, W. L., Parks, D. L., Wallner, J. M. and Saydjari, O. S., "Mission Oriented Risk and Design Analysis of Critical Information Systems," *Military Operations Research*, 2005, Vol 10, No 2, pp. 19-38.

We identified techniques that would be applicable for each step. This presentation focuses on decision analysis.

Techniques	Risk Assessment and Risk Management Tasks						
	1. Identify Critical Assets	2. Identify and Assess Potential Threats	3. Identify & Assess Vulnerabilities	4. Identify & Assess Consequences	5. Assess Baseline Risk	6. Identify Risk Management Alternatives	7. Select the Most Cost-Effective Risk Management Alternatives
Scenario Analysis							
Fault trees							
Threat, Vulnerability, Consequence Tables							
Risk Matrices							
Failure Modes & Effects Analysis							
Probabilistic Risk Analysis							
Alternative Generation Table							
Decision Analysis							
Benefit-Cost Analysis							

What is decision analysis?

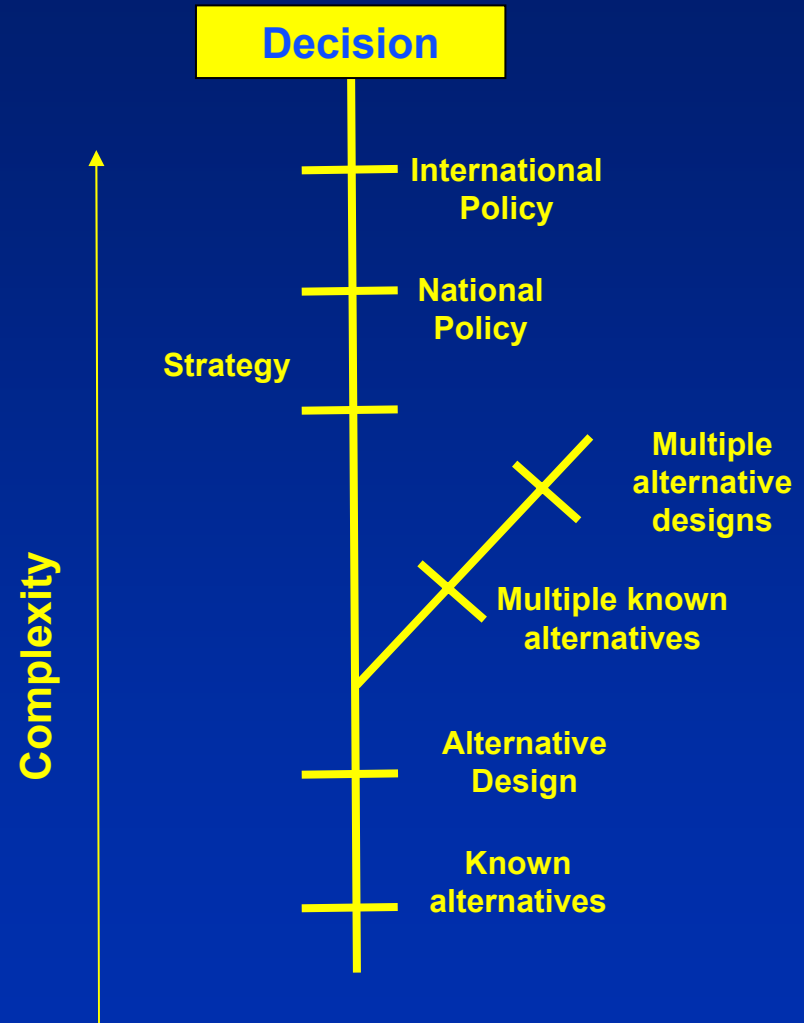
- **Decision:** An irrevocable allocation of resources
- **Decision Analysis:** Discipline for evaluating complex alternatives by systematically examining
 - Decisions
 - Uncertain variables
 - Preferences (value, risk, & time)
- **Purpose:** Provide insight to decision-makers faced with hard problems

Decision analysis asks the right questions.

- What is the decision?
- How should we involve decision-makers and stakeholders?
- What is a good decision?
- Are major uncertainties involved?
- What are our preferences?

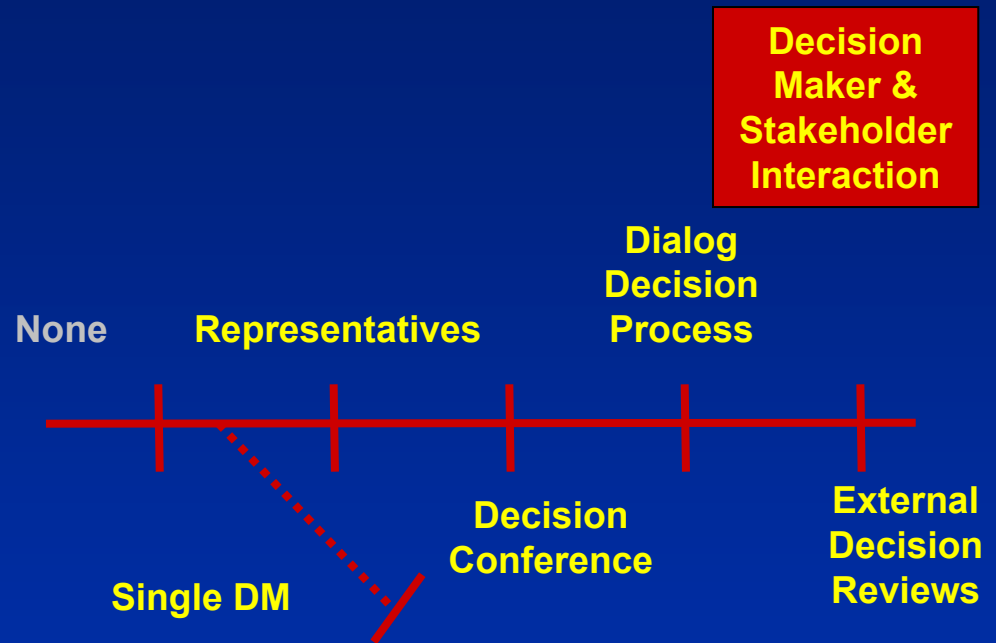
First Dimension: Type of Decision

- Varying degrees of complexity
- Many types of alternatives
 - Systems
 - Architectures
- Multiple alternative branch has many names
 - Capital budget
 - Resource allocation
 - R&D portfolio



Second Dimension: Decision-maker & stakeholder interaction (Most critical)

- Interaction determines:
 - Working the right problem?
 - Considering all political, organizational, and emotional issues?
 - Including all key perspectives?
- Techniques to integrate with organizational decision processes
 - Decision Conferences
 - Dialog Decision Process
- Internal/external reviews require justification of decisions

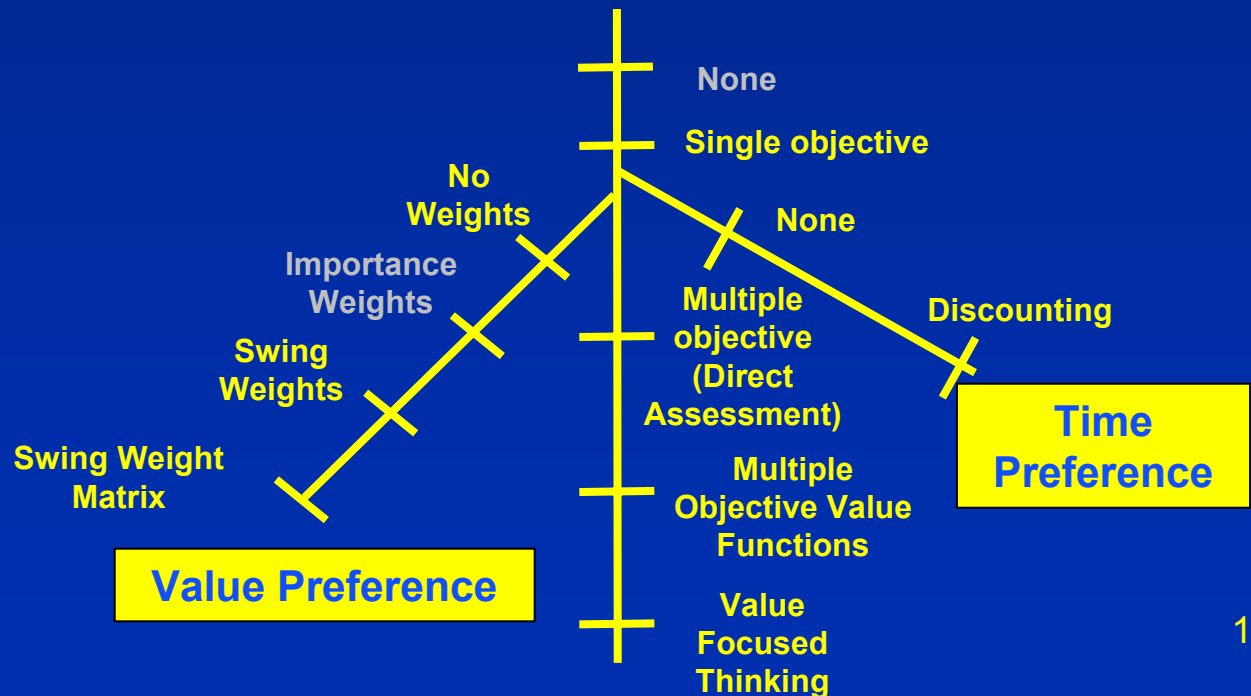


Third Dimension: Definition of a good decision

- Two types of models for objectives
 - **Single objective**: usually dollars in commercial applications or cost in public applications
 - **Multiple objectives**: usually conflicting objectives of various stakeholders
- Value preference has two dimensions
 - **Value** means returns to scale on objective measure scale
 - **Weight** of each objective depends on importance and variation on measure scale

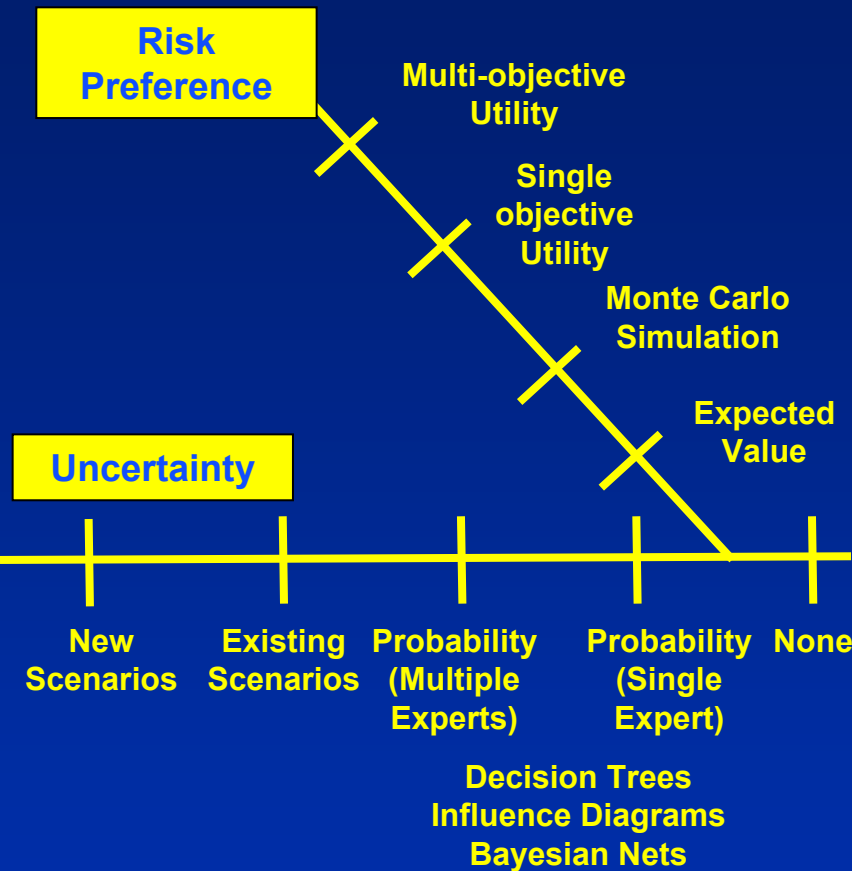
• Time preference is also an issue

- Net Present Value/cost is most common tool



Not recommended.

Fourth Dimension: Uncertainty



- Is uncertainty important in decision?
- Most common modeling approaches
 - Probability
 - Scenarios
- If we model uncertainty, risk preference becomes an issue
 - Risk neutral (expected value)
 - Risk adverse
 - Risk seeking
- For most practical applications, utility assessment may not be feasible/required

A comprehensive DA framework.



Conclusions

- **Decision analysis asks the right questions for complex security challenges**
 - **Decisions**
 - **Decision Makers**
 - **Stakeholders**
 - **Values**
 - **Uncertainties**
 - **Risk preference**
- **Decision analysis offers proven processes and powerful techniques to help decision makers achieve and balance stakeholder objectives**
- **Training and experience will be required to develop expertise required for successful security applications**