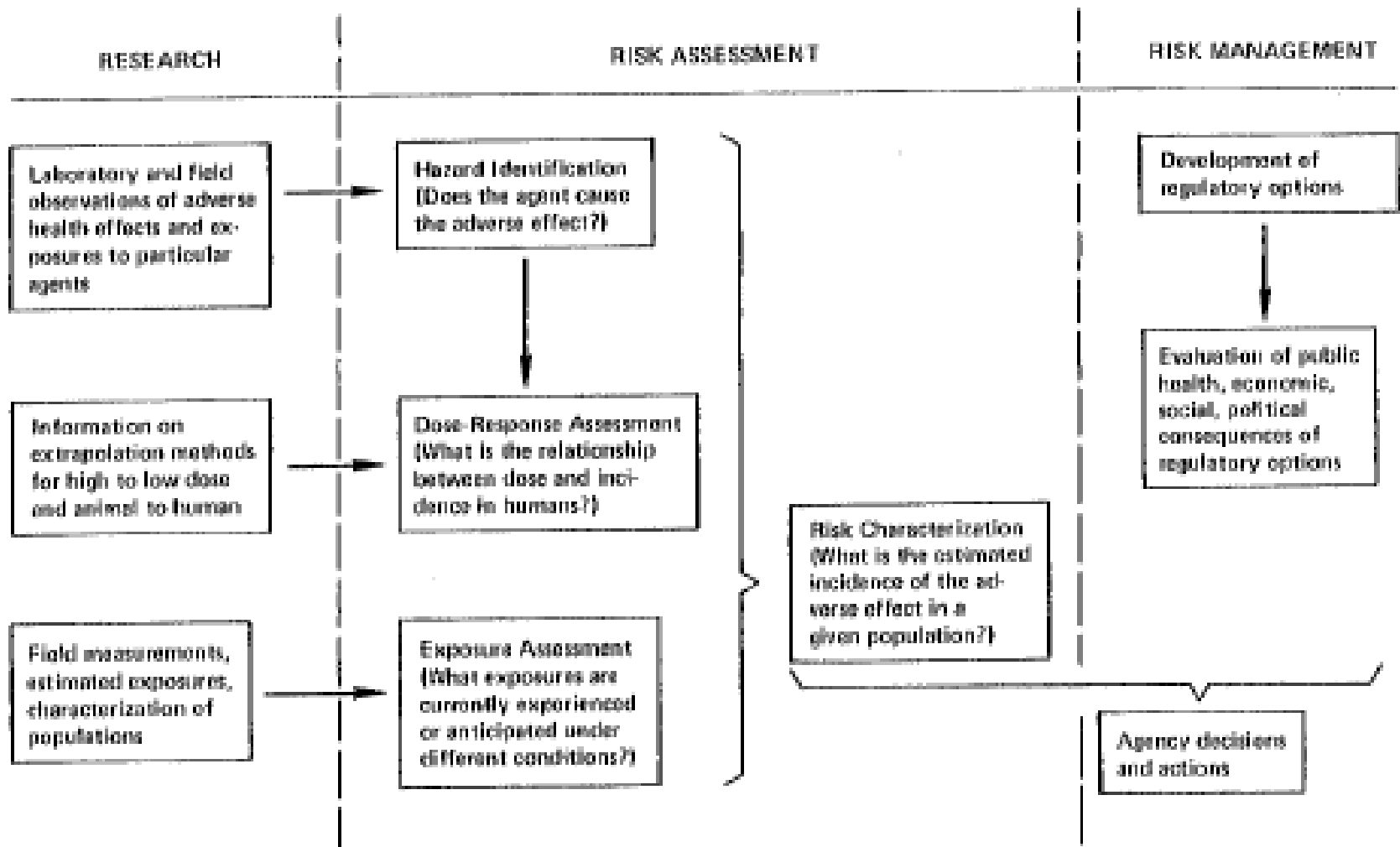# Recap of Day 1 and Instructions for Day 2

Igor Linkov, Ph.D.

Risk and Decision Science Focus Area Lead, US Army Engineer Research and Development Center, Department of Defense
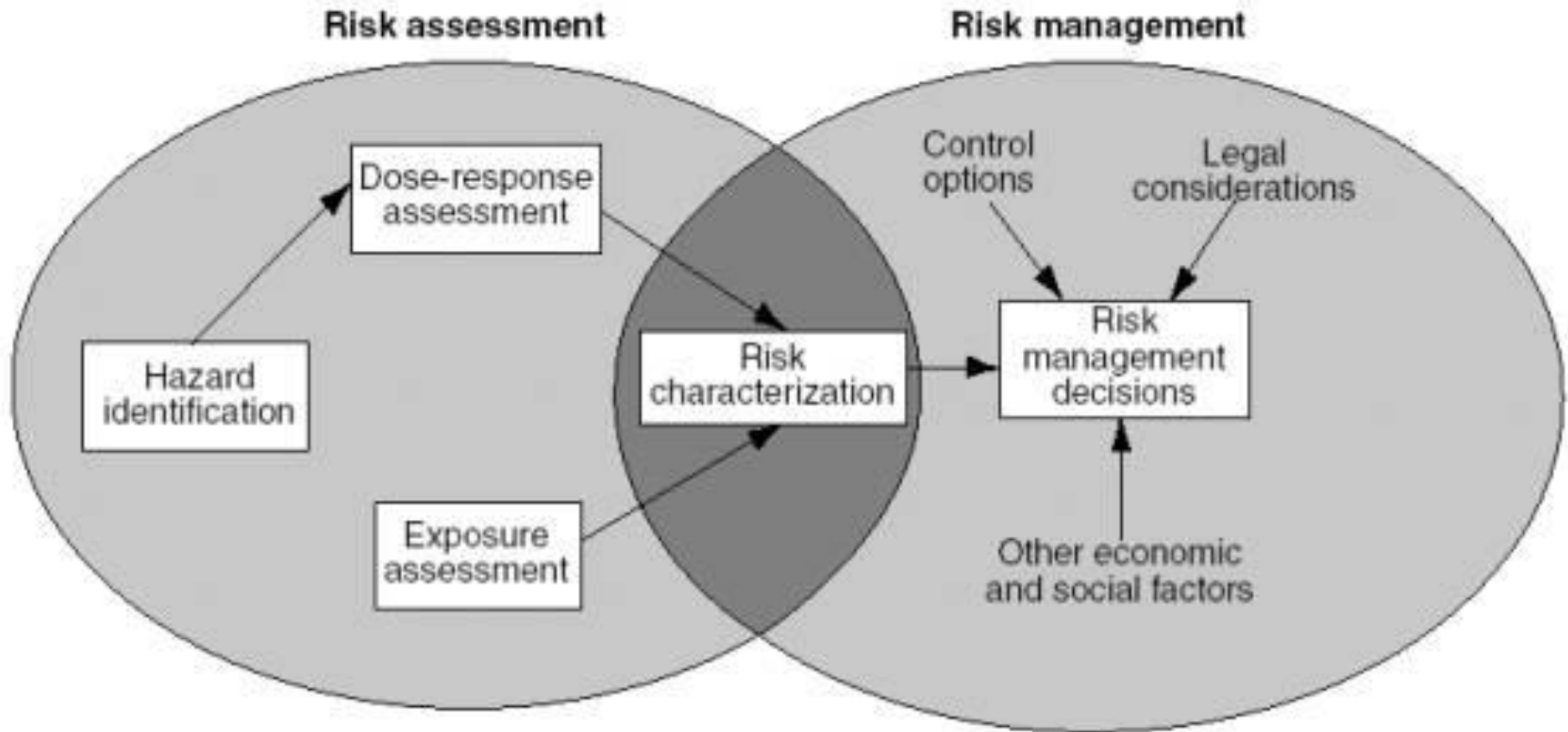
Igor.Linkov@usace.army.mil

Risk Assessment and Risk Management

RESEARCH	RISK ASSESSMENT	RISK MANAGEMENT

Laboratory and field observations of adverse health effects and exposures to particular agents

Hazard Identification (Does the agent cause the adverse effect?)

Development of regulatory options

Information on extrapolation methods for high to low dose and animal to human

Dose-Response Assessment (What is the relationship between dose and incidence in humans?)

Evaluation of public health, economic, social, political consequences of regulatory options

Risk Characterization (What is the estimated incidence of the adverse effect in a given population?)

Field measurements, estimated exposures, characterization of populations

Exposure Assessment (What exposures are currently experienced or anticipated under different conditions?)
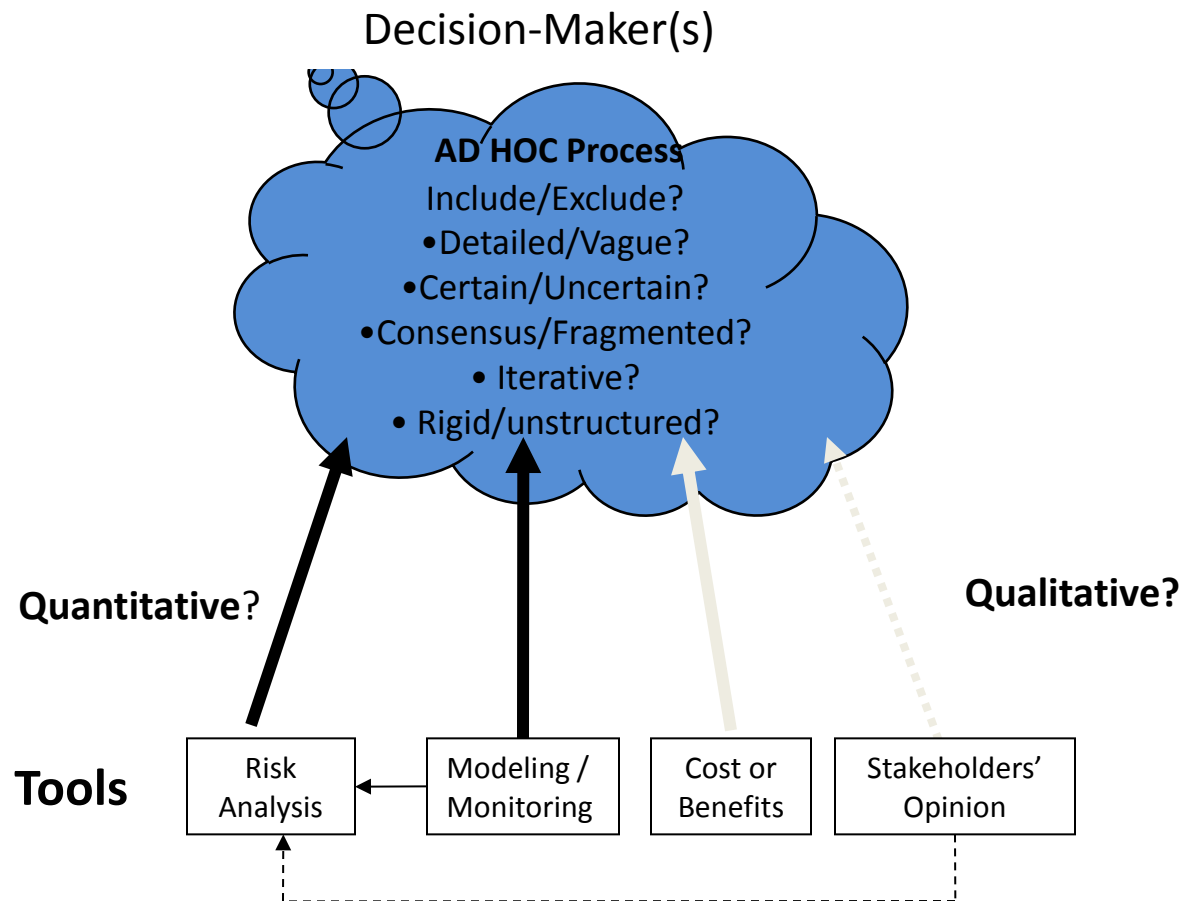
Agency decisions and actions

NRC 1983 (Red Book)

Risk Assessment vs. Risk Management?

Source: EPA Office of Research and Development.

# Current Risk Management Processes: Bottom-up Approach

Decision-Maker(s)

AD HOC Process
Include/Exclude?
•Detailed/Vague?
•Certain/Uncertain?
•Consensus/Fragmented?
• Iterative?
• Rigid/unstructured?

Quantitative?

Qualitative?

Tools

Risk Analysis	Modeling / Monitoring	Cost or Benefits	Stakeholders' Opinion

Challenge: Multiple & Uncertain Criteria

Challenge 1: Emergence of New Technologies and Delays in Generated Risk Data
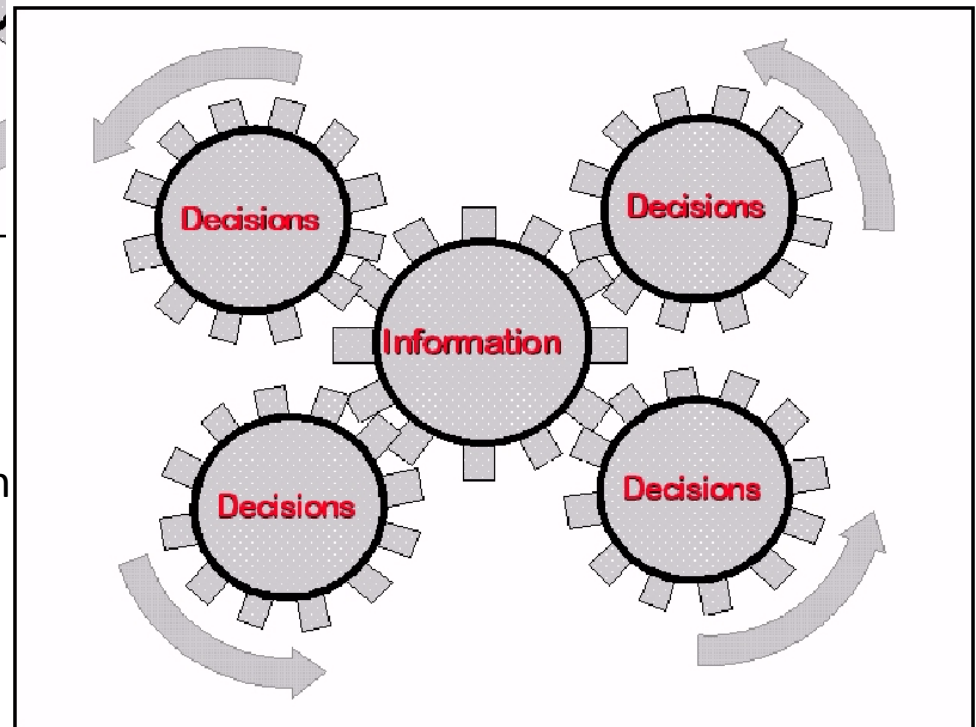

from Linkov and Satterstrom, 2008
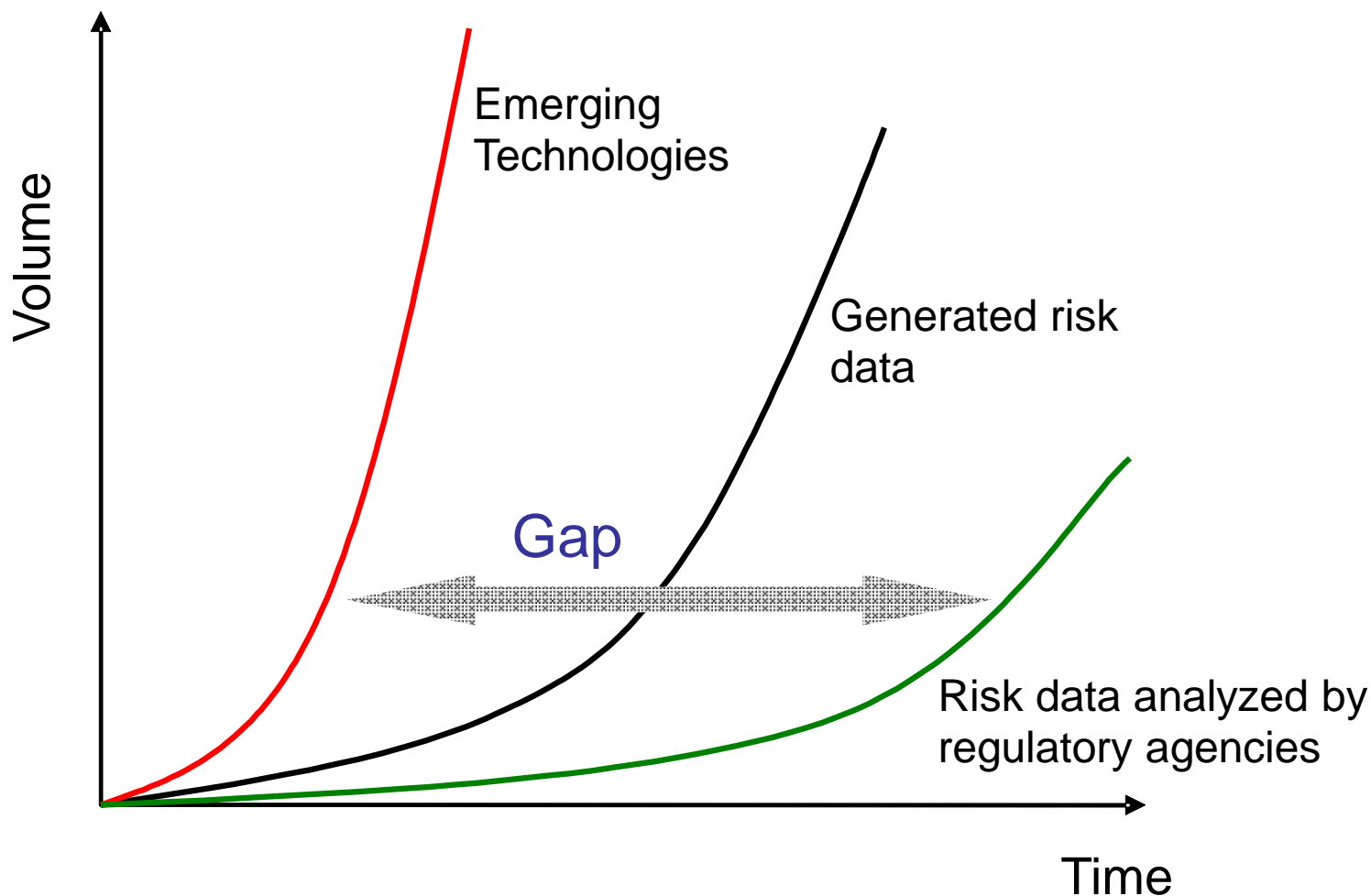
Challenge 2: Needs for Real Time Decisions
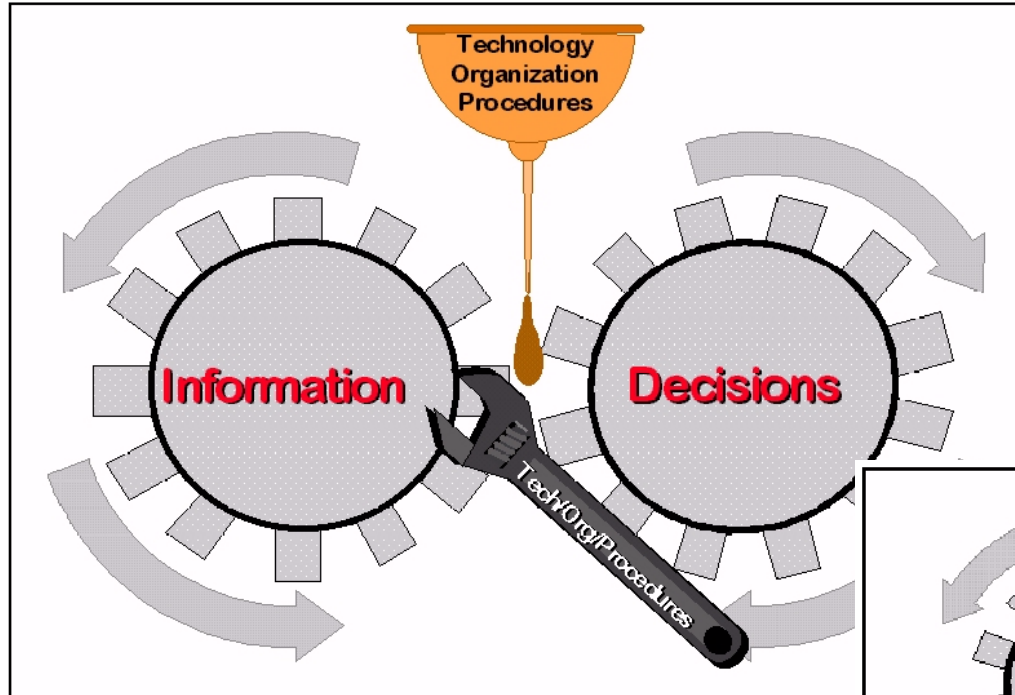
**What Can Be Done to
Help in Decision Making?**

Increased information availability may result in
information overload.

Need for Revolutionary Changes: Fusion of information and decisions reflecting stakeholder values.

After Roman, 1996

Challenge 3: Cognitive Limitations of Decision Makers

- **"Humans are quite bad at making complex, unaided decisions" (Slovic et al., 1977).**

- **Individuals respond to complex challenges by using intuition and/or personal experience to find the easiest solution.**

- **At best, groups can do about as well as a well-informed individuals if the group has some natural systems thinkers within it.**

- **Groups can devolve into entrenched positions resistant to compromise**

Challenge 4: Increasing Stakeholder Concerns and Influence

Two types of "correct" risk assessment:

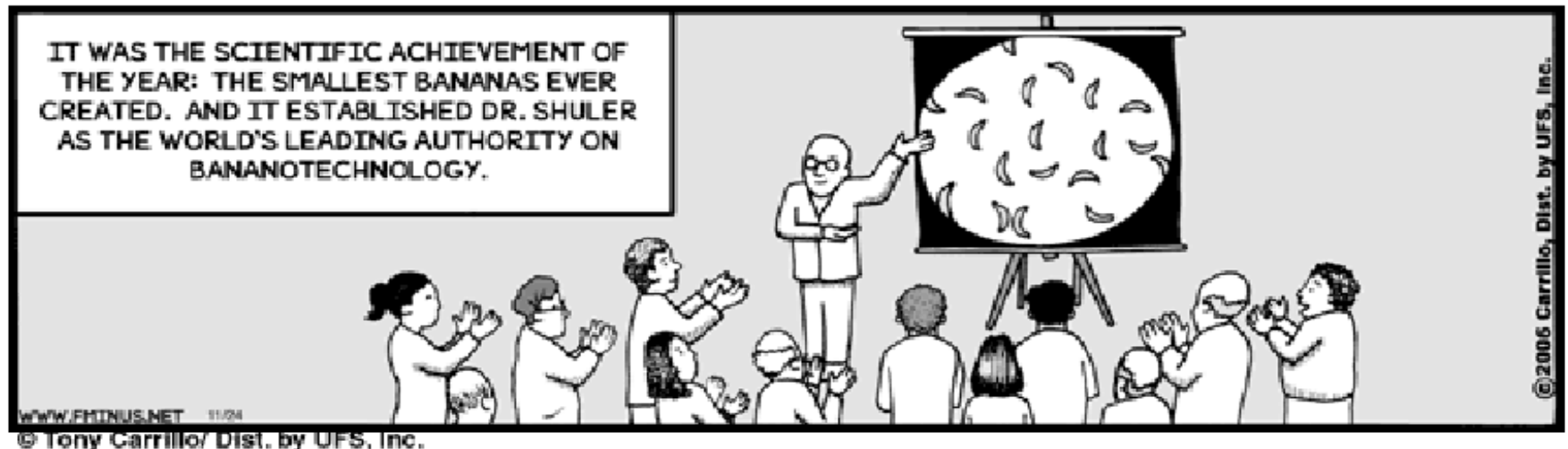**Expert: Risk = Hazard · Exposure · Effects**

Layperson: Risk = 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.

Comic Strip "F Minus," 11/24/06

Approach: Physical and Social Science Integration

Stakeholders

Criteria for decision

Manufacturers
Consumers
Regulators
Environmentalists
Balanced

Value judgments

Energy yield
Health risks...

Experts Provide Probabilistic Assessments

Thermodynamic & chemical data

Nano toxicology

Environmental media

Product & technology development

0.05 0.21 0.36

0.05 0.21 0.36

0.05 0.21 0.36

0.05 0.21 0.36

Uncertain Scores for Each Alternative on Each Criterion Metric

EXPERIMENTAL SCIENCE

VALUE OF INFORMATION

Designers and Developers Provide Technological Alternatives

Percent of Time Ranked First

Manufacturers | Consumers | Regulators | Environmentalists | Balanced

Laser
Arc
CVD
HiPco

MCDA to Compare Alternatives

after Linkov, 2011 (NatureNanotechnology)

osal

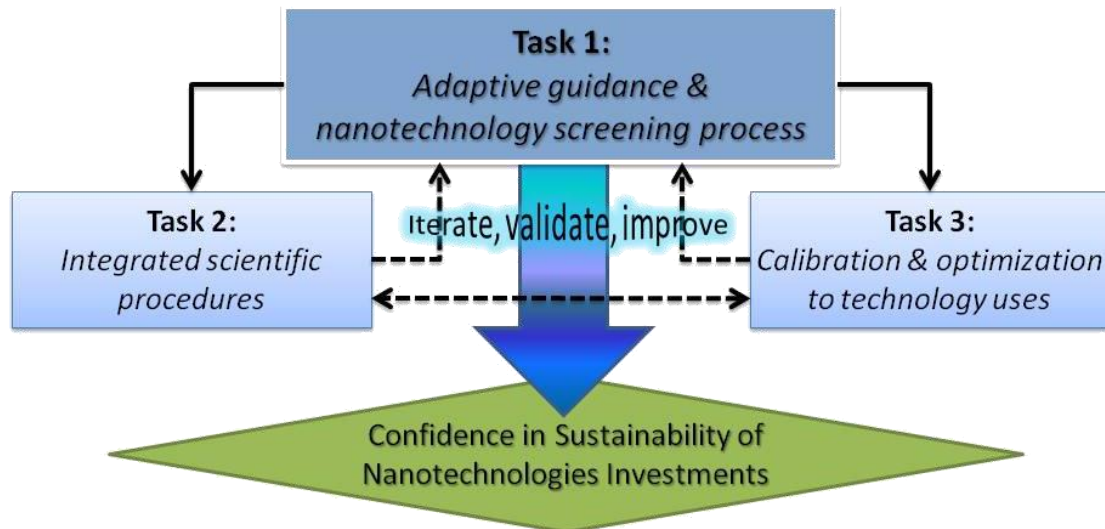# Value of Information Analysis

A decision-directed approach for prioritizing research into the impact of nanomaterials on the environment and human health
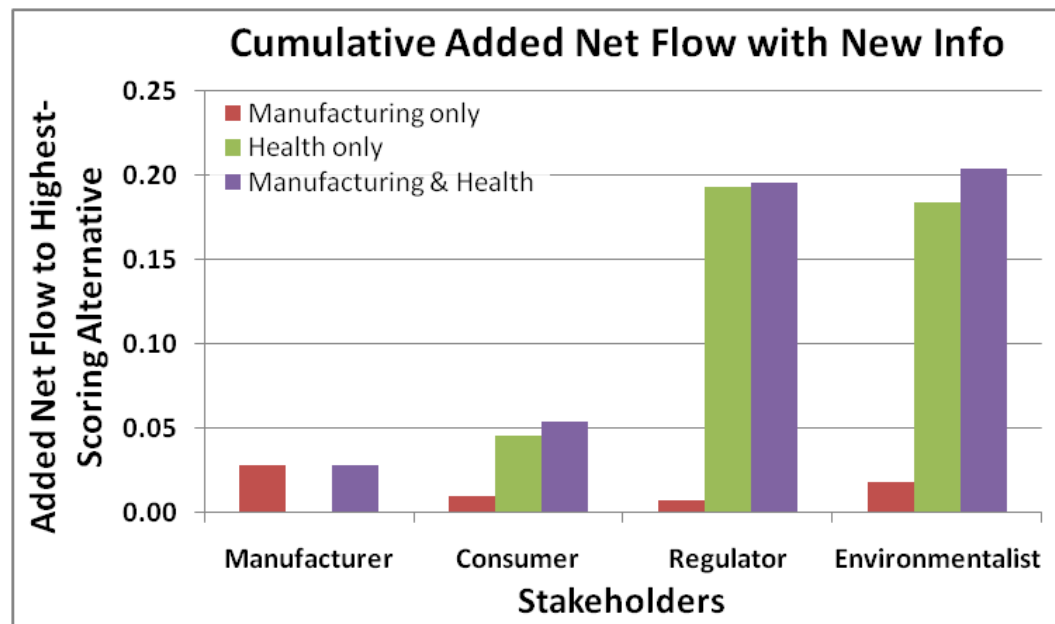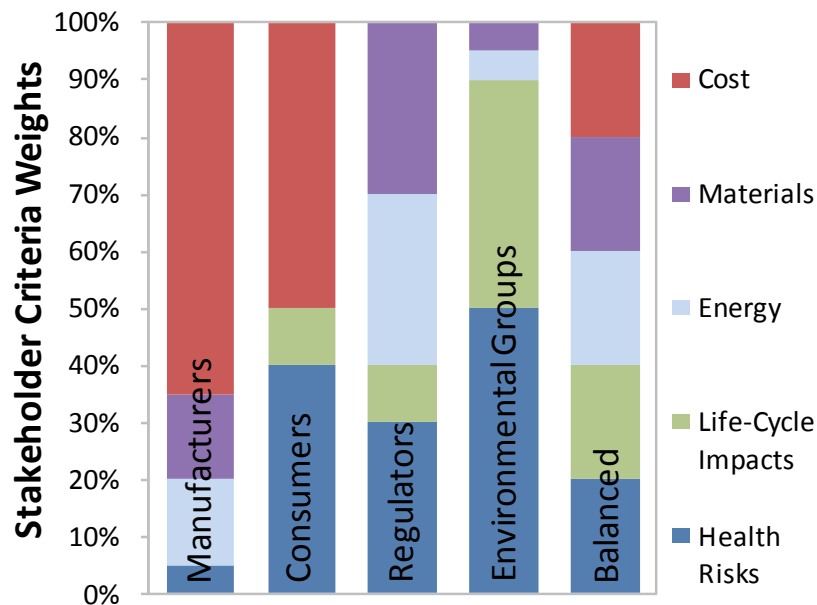
USA Example: ERDC Nanotechnology Focus Area ($9.5M/5yrs, starts 1 Oct 2013)

Adaptive tools for developing, transitioning and sustaining Army nanotechnologies

- **Life Cycle Approach:** use a life cycle approach to identify likely sources of nanoparticle release and sources of uncertainty
- **Framework:** an adaptive, stepwise process assessing the EHS of nanotechnologies (provides a single set of rules)
- **Case specific calibrations:** validate screening procedures and improve the framework using Army relevant technologies

EU EXAMPLE: SUSTAINABLE NANOTECHNOLOGY (SUN) ($14M/4YRS, STARTS 1 OCT 2013)

BOTTOM-UP DATA PRODUCTION → **MODELLING** → **TOP-DOWN DATA INTEGRATION**

- **characterization**
- **(eco)-toxiciity**
- **environmental behavior/fate**
- **exposure**
- **effects on ecosystem services**

- **LCA**
- **Risk assessment**

- **Value of Information**
- **Weight of evidence**

Guidelines and methods for safe production, handling and disposal

Synthetic routes and production processes

DECISION SUPPORT SYSTEM

Cost

Env. impact

Risk

Benefit
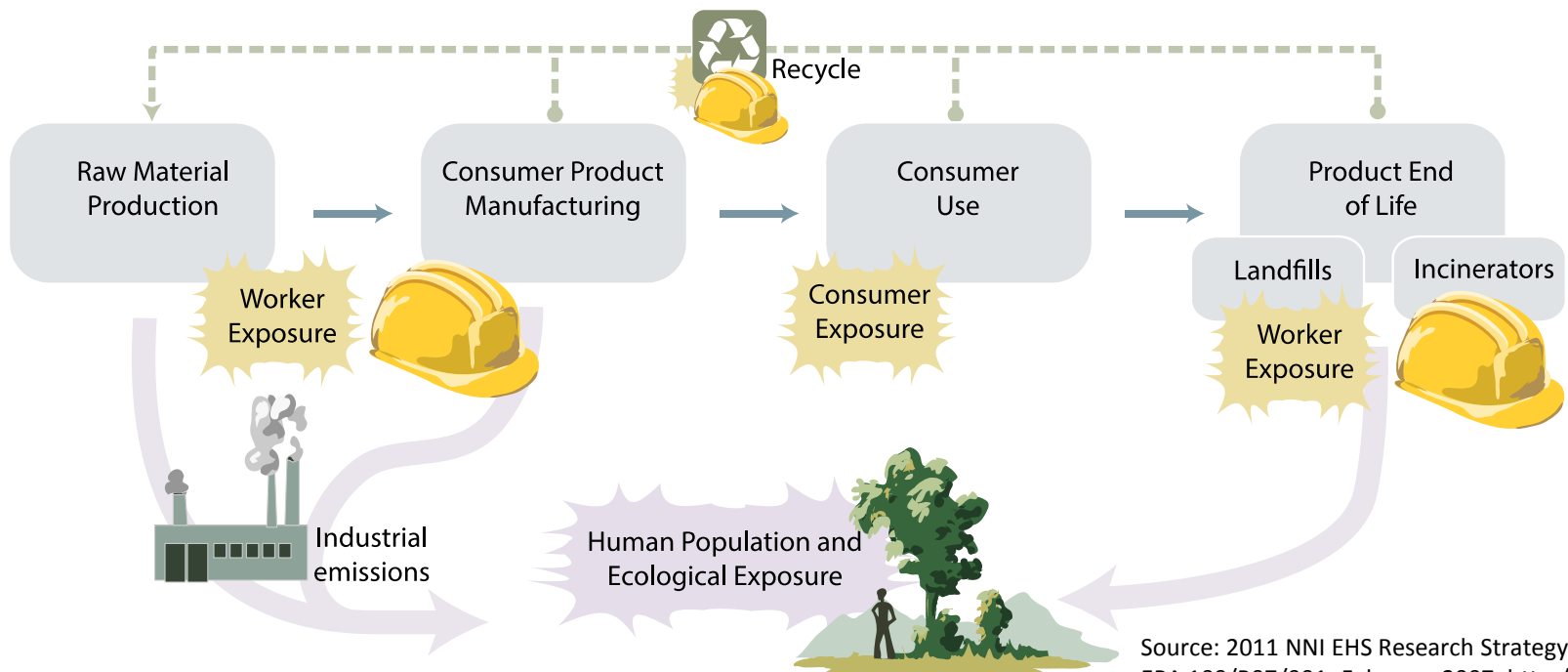
Day 1 Recap

➢ …

➢ Keep in mind:

    ➢ Commonalities in Types of decisions?

    ➢ Key linkages between R/A, R/M and R/C?

Breakout Session for Today: The Decision Makers

➢ Communities: research, regulatory, nanomanufacturing, small business, financial risk, NGO, and other public communities

➢ Breakouts: same structure as yesterday (case studies + vignettes)

Recycle

| Raw Material Production | → | Consumer Product Manufacturing | → | Consumer Use | → | Product End of Life |

Worker Exposure

Consumer Exposure

Landfills   Incinerators

Worker Exposure

Industrial emissions

Human Population and Ecological Exposure

Source: 2011 NNI EHS Research Strategy, adapted from EPA 100/B07/001, February 2007, http://epa.gov/osa

AGAIN, **PLEASE REMEMBER…**

➢ **Focus the discussion:** be concrete, use real-life examples, and keep in mind what is needed to move risk-based decision making forward.

➢ **The Four overarching questions:** what risk-based information is needed, what tools/methods are available, how you make/communicate decisions, and how can the NNI help.

➢ **It is OK to have overlaps with other groups** (i.e., capture issues that are common across various breakout groups)