Outline

- **Definition of Risk**: What is risk?
- **Public Decision Making**: How decisions are made
- **Individual Decision Making**: How individuals make decisions
- **Value of Human Safety**: How human safety can be evaluated
- **Perceived risks**: Individuals perceive risks differently
- **Dilemmas in Risk Communication**: Can’t always give it straight
- **Message Mapping**: But you can be prepared
Motivation

Typical Mistakes

- Medical treatment mistakes
- Organizational mistakes
- No follow-up and no documentation
- *Information Deficit!*
- *Communication Deficit!*
AHCQ Report, 1991

• Most medical errors are due to system errors and organizational deficits

⇒ and thus can be avoided!!!!!!

* AHCQ = Agency of Healthcare Research and Quality

Example: System Error

“Just before the operation I received an injection of morphine. I then had to sit in the waiting room. After 20 minutes I suffered a circulatory collapse and fell to the floor.”

Patient testimonial
Example: Organizational Error

“On the day of my operation, Monday May 10th, 1999, a nurse of inner medicine took my (3rd) teeth while I was in the surgery room. He wrapped it in a paper towel. He then left it in my room, in the vomit tray…”

Patient testimony

Definition of Risk
What is Risk?

- **Uncertainty** (probability)
  - Aleatory (known)
  - Epistemic (unknown)

- **Hazard**
  - Undesirable outcomes (health, wealth)

- **Risk**: The probability and consequences of different outcome scenarios associated with a hazard

  ➔ What can go wrong?
  ➔ With what probability?
  ➔ Which consequences?

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Risk

- **Uncertainty** ➔ aleatory or epistemic
- **Outcome** ➔ reduction of welfare

<table>
<thead>
<tr>
<th>Probability</th>
<th>Aleatory</th>
<th>Epistemic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcome</strong></td>
<td>Known</td>
<td>Unknown</td>
</tr>
<tr>
<td>Life, auto, fire</td>
<td>Playground accidents</td>
<td></td>
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<tr>
<td>Satellite crash</td>
<td>Earthquake, bio-terrorism</td>
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Source: Kunreuther, 2002
Risk Management

- Risk = f(Uncertainty, Undesirable Outcome)

- Risk analysis
  - Quantification & analysis of risk
  - NO value judgment

- Mitigation of risk
  - Technical solutions
  - Management solutions

Key Points

- Risk = f(Uncertainty, Undesirable Outcome)
- Separation of analysis and value judgment
Public Decision Making

Framework

- There is no zero risk!
- How much risk is acceptable?
- Philosophies:
  - From a zero risk
  - To best practicable technology
  - To balance of risks and benefits
  - As low as reasonably possible
Issues in Public Decisions

- **Individual freedom vs. social justice** (e.g., seat belts)
- **What should be risk attitude of government?** (risk averse, neutral, prone?)
- **How should government manage trade-offs?**
- **What should be its willingness to pay for trade-offs among different attributes?**
- **Multiple decision makers: Arrow’s Impossibility Axiom** (Nobel, 1972)

Government Safety Goals

- **Dutch Government (1979)**
  - Max. individual risk to public: 1% of the lowest death rate for girls (10–14) or 0.0001% per year
- **USFDA Cancer Risk**
  - Max. individual risk 0.001% per life time

"De minimis lex non curat" Cost-Benefit Analysis Unacceptable

0 0.0001% 0.01% 100%

Annual individual risk Paté-Cornell, 1999
**Acceptable Decision Process**

- Sound legal basis
- Information system that includes uncertainties
- Communication system to inform & gather data
- Selection of experts and aggregation of opinions
- Public review process
- Clear but flexible decision criteria
- Conflict resolution mechanisms
- Involvement of stakeholders

Paté-Cornell, 1998

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**Key Points**

- Risk = f(Uncertainty, Undesirable Outcome)
- Separation of analysis and value judgment
- Public decision making difficult due to
  - Public exhibits complex preference profile
  - Impossibility axiom → cannot reconcile profiles
Individual Decision Making

Cognitive Psychology

- The rational actor does not exist
  - Simon ("bounded rationality", Nobel)
  - Tversky & Kahneman (Nobel)
  - Others
Risk Attitude of Public

![Risk Profile Diagram]

Lives Saved

Risk Averse Profile

Risk Prone Profile

- 500 persons
- 5,000 persons

Risk profile NOT constant!

Are we rational?

- Clearly, highly educated and culturally diverse individuals will be less prone to cognitive errors

- Some experiments to illustrate
INTERMISSION: EXPERIMENTS

Framing Fallacy (Exp. A)

Imagine that the EC is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimate of the consequences of the programs are as follows:

**Group I:**
If program A is adopted, 200 people will be saved. ➔ No risk ➔ generally this alternative preferred (risk averse)

If program B is adopted, there is a 1/3 probability that 600 people will be saved, and a 2/3 probability that no people will be saved. ➔ Same expected outcome, but with risk ➔ generally this alternative is avoided (risk adverse behavior)

**Group II:**
If program A is adopted, 400 people will die. ➔ Certain loss, no chance to avoid it

If program B is adopted, there is a 1/3 probability that nobody will die, and a 2/3 probability that 600 people will die. ➔ Same expected outcome, but with risk ➔ generally this alternative preferred (risk prone behavior)

Source: Tversky and Kahneman, 1981
Conjunction Fallacy (Exp. B)

**Group 1:** A massive flood somewhere in North America in 2005, with more than 1,000 people dead.

**Group 2:** An earthquake in California sometime in 2005, causing a flood with more than 1,000 people dead.

**Group 1:** A complete suspension of diplomatic relations between the USA and Russia, sometime in 2005

**Group 2:** A US invasion of Iran and a complete suspension of diplomatic relations between the USA and Russia, sometime in 2005

**Group 1:** A 30% drop in the consumption of oil in the US in 2005

**Group 2:** A dramatic increase in oil prices resulting in a 30% drop in the consumption of oil in the US in 2005

> People often attribute a higher probability to a story that has more bells & whistles – while less should be more [e.g., \( p(\text{next to enter is f}) \) vs. \( p(\text{next to enter is female and carries books}) \)]

Source: Tversky and Kahneman, 1983

Loss Aversion (Exp. C)

**Group 1:** You have been exposed to a rare fatal disease and now face a chance of 0.001 of quick and painless death within two weeks.

**Group 2:** You have been asked to participate in a medical experiment involving a new drug that will cure a deadly disease. There is a chance of 0.001 of quick and painless death in the course of this experiment.

> People are more sensitive to the dimension in which they are losing relative to their reference point. There is a great difference between willingness-to-accept (WTA) and willingness-to-pay (WTP) in situations with voluntary assumption of additional risk – and situations of failure to reduce or eliminate existing risk.

Thaler, 1980
Judgments of Fairness (Exp. D)

Group 1: A shortage has developed of a popular model of automobile, and customers must now wait two months for delivery. A dealer has been selling these cars at a discount €200 below list price. Now the dealer prices this model at list price.

Group 2: A shortage has developed of a popular model of automobile, and customers must now wait two months for delivery. A dealer has been selling these cars at list price. Now the dealer prices this model at €200 above list price.

Foregone gains are less painful than perceived losses. "Imposing a surcharge (which is likely to be judged a loss) is considered more unfair than eliminating a discount (a reduction of gain)."

Kahneman, Knetsch and Thaler, 1986

Heuristics and Biases I

• Availability
  – Bias due to retrievability of instances
  – Bias due to effectiveness of search set (–i–)
  – Illusory correlation (roulette)

• Adjustment and Anchoring
  – Insufficient adjustment
  – Conjunction fallacy
  – Anchoring of distributions
Heuristics and Biases II

- Representativeness
  - Insensitivity to priors (librarian; Exp. C)
  - Insensitivity to sample size (hospital, 60% boys)
  - Misconceptions of chance (London)
  - Insensitivity to predictability (hot hand in basketball)
  - Misconception of regression (pilot training)

Ambiguity Aversion

- Which lottery do you prefer:
  - 60% chance of having to pay €200
  - ? chance of having to pay €200

  Ellsberg Paradox

- Individuals often prefer a defined gamble to situations of ambiguity (even though under the latter the probability of positive outcome could be larger)
Risk Distortion

- Seat belts & air bags
- Pickups
- Airbus 320
- Extreme sports

→ Reducing risk in one area often displaces it to another area

Decision-Making

- Decision making is at the heart of most technical, business and government problems
- Decision-making requires the study of uncertainty
- Uncertainty can only be studied formally through probability theory
- Probability is a state of the mind, not of things
- Prior experience must be used in assessing probabilities
- Decision making requires the assessment of values as well as probabilities
- Decisions can only be made when a criterion is established for choosing among alternatives
- Implications of the present decision for future must be considered
- We must distinguish between a good decision and a good outcome

R. Howard, 1983
Preferences & Uncertainty

There is compelling evidence that the maintenance of coherent beliefs and preferences is too demanding a task for limited minds.

D. Kahneman, 1994

Key Points

- Risk = f(Uncertainty, Undesirable Outcome)
- Separation of analysis and value judgment
- Public decision making difficult
- We are subject to cognitive deficiencies
- Framing has a strong influence on decisions
Issues

• There is no “Value of Life”!

• If risk is in “tolerable range”:
  – Should all lives be treated equally?
  – Who should pay for whom?
  – What is the willingness to pay to reduce risk?
Different Systems

• Egalitarian approach
  – Government risk indifferent
  – Max. cost/life saved: average willingness to pay

• Free-Market Approach
  – Pareto optimality
  – Use individual’s willingness to pay

• Absolute safety approach
  – Economic issues irrelevant, requires 0 risk
  – Costs passed on to consumers

Micromorts (Howard, 1979)

• In “acceptable risk” region
• Risk of death of 1 in 1,000,000 (very small)
• To compare various courses of action, a person should compare death risk to him with other costs and benefits
  – $V_s = $3 (pay $3 to avoid risk of 0.0001%)
  – $p_{Risk} = 7$ micromorts $\Rightarrow V = $3 * 7 = $21
  – Individual would be willing to pay $21 to avoid this risk (or want $21 to accept it)
Price of Accepting Risk (Howard, 1979)

- Individual has to receive $x to accept risk of death $p$, based on micromorts

![Graph showing the price of accepting risk](image)

Willingness to Pay (Howard, 1979)

![Graph showing willingness to pay](image)
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- Separation of analysis and value judgment
- Public decision making difficult
- We are subject to cognitive deficiencies
- Framing has a strong influence on decisions
- We cannot put a value on human life
- In certain ranges it is possible to use (marginal) valuation principles

Perception of Risk
Perceived vs. Actual Risks

Estimated Number of Fatalities per Year

Actual Number of Fatalities per Year

Source: Slovic, Fischhoff, Lichtenstein, 1979

Ordering of Risks

- Risks are ordered differently by different groups (e.g., students vs. experts etc.)
- Disagreements about risk should not be expected to evaporate in the presence of evidence (which often cannot be obtained)
- Perceived risk is influenced by imaginability and memorability of hazard (terrorist threats)

Source: Slovic, Fischhoff, Lichtenstein, 1979
Communication of Risk

- "The risk of this pharmaceutical is 1 in 100,000 per year that you will die due to side effects."
  - small numbers and big outcomes
  - often comparisons are used
  - informed consent most important
  - make well informed decisions yourself

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- Public decision making difficult
- We are subject to cognitive deficiencies
- Framing has a strong influence on decisions
- We cannot put a value on human life
- In certain ranges it is possible to use valuation principles
- Risk comparisons difficult but helpful
Thank You.