Appreciating the Value of Information in the Age of Risk Management

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Topics

• Welcome to the Age of Risk Management
• Key concepts
• Valuing information in the context of decisions
• Insights

Note: All cartoons in this talk used with permission of artists and appear in *Risk In Perspective: Insight and Humor in the Age of Risk Management* (Thompson, 2004)
Premises

• Dealing with risk is part of life, and how you manage risk matters

• You must make decisions in the face of uncertainty

• Doing nothing is a decision

• “All decisions are based on models… and all models are wrong” John Sterman, 2002

• “All models are wrong but some are useful” George Box, 1979
Types of enterprise risks....

- Entry
- Financial
- Competitor
- Material
- Regulatory/Legal/Political
- Market
- Social
- Sovereign/Governmental
- Environmental
- Supply
- Technical
- Construction
- Operational
- Infrastructure
- Human resource
Age of Risk Management

• A time in human history where we recognize that
  – life is full of risks and tough choices
  – good data and analysis play a critical role in decisions (individual and collective)

• Enormous advancements in science and technology
  – high-quality information
  – a large spectrum of management choices (new opportunities)
  – computational tools that support analysis of complex systems
  – better understanding of problems and solutions
State of Fear?

“The politico-legal-media complex… is dedicated to promoting fear in the population under the guise of promoting safety.” “Politicians need fears to control the population. Lawyers need dangers to litigate, and make money. The media need scare stories to capture an audience. Together, these three estates are so compelling that they can go about their businesses even if the scare is totally groundless. If it has no basis in fact at all.”
Risk Analysis

• Risk Perception
  – What are the risks?
  – What are our mental models?

• Risk Assessment – Use mathematical models to characterize information and answer:
  – What can happen?
  – How likely is it?
  – If it happens, what are the consequences?

• Risk Communication
  – Who are key the stakeholders?
  – How can we put risk in perspective?

• Risk Management – Use models to evaluate options/weigh trade-offs:
  – What can we do?
  – What happens if we do it?
  – What is the best option (given what we know and our values)?
Key concepts

• Uncertainty – true lack of perfect information
• Variability – real differences between individuals
• Time & system dynamics
  – Understand the parts and how they connect
    • Structure
    • Stocks and flows
    • Feedback
  – Questions
    • What are the causal relationships that determine how things move and change with time?
    • How does the structure influence behavior?
  – Amplification of risk
Life in the supply chain

- Many permutations of numbers of suppliers, customers, products, actors, competitors
- Delay and capacity constraints
Valuing information

• Does information really help?
• How do people make choices in the face of uncertainty?
• What is the value of information in the context of a particular decision?
Information is critical in managing risks well

• Nokia (Finland) vs. L M Ericsson (Sweden) - Almar Latour, Wall Street Journal, 1/29/2001
  – Phillips Electronics - cell phone microchips
  – Lightning caused a fire in fabrication plant in Albuquerque, NM: Friday, March 17, 2000, 8 pm, fire out in 10 minutes, but damage significant
  – Outcome of management of information and situation:
    • Nokia launch successful… gains 3% market share for cell phones
    • Ericsson announced $400 million (insurable) loss leading to drop in stock price … 3% drop in market share… abandons cell phone production

• More examples in The Resilient Enterprise (Sheffi, MIT Press, 2005)

• …but, information only matters IF YOU USE IT
Different strategies for making choices given uncertainty

• Pessimistic approach - Determine the worst outcome for each action (smallest reward) and choose the action with the “best” worst outcome (Maximin)

• Optimistic approach - Determine the best outcome for each action (largest reward) and choose the action with the “best” best outcome (Maximax)
Even more strategies

• Regret approach - Determine the best outcome for each state and find the “regret” as the difference between that value and the value obtained for each combination, choose the action that minimizes the maximum regret to avoid disappointment over what might have been (Minimax regret)

• Expected value approach - Choose the action that yields the largest expected reward
Example

- Consider a newspaper vendor who knows she will sell $j = 1, 2, \text{ or } 3$ copies of a paper for 25 cents each.
- She buys $i$ papers for 20 cents each, unsold papers are worthless.
- Dominated actions
- Reward matrix
- **Maximin**
  - Choose 1
- **Maximax**
  - Choose 3

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Example (continued)

- Minimax regret
- Choose 1

Regret matrix

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Expected value (EV)

• EV and optimal act depend on probabilities
  – If equal (each=1/3), choose 1 (5 vs. 5/3 vs. -10)
  – If p=0.1, 0.4, 0.5 for j=1,2,3 respectively choose 2

\[
5 \text{ vs. } \\
0.1*(-15)+0.9*10=7.5 \text{ vs. } \\
0.1*(-35)+0.4*(-10)+0.5*15=0
\]

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• Information would help this decision maker
Value of information example

- You might be able to use an innovative new technology to reduce the generation of emissions in one of your production operations.

- If the technology works, this might reduce the need for personal protective equipment (PPE) use by employees in the facility.

- The innovative technology is specialized for production in only one plant, and it will cost $1 million (NPV) to implement.

- The proposal for the project promises that the technology will work, but facility experts believe that there is only a 60% probability that it will work.
Value of information example

• If it works, you save an estimated $2 million dollars (NPV) in PPE over the remaining live of the plant and produce the maximum possible amount of engineering protection possible (net savings of $1 million)

• If it would work and you do not install it, then there is some small chance that an OSHA inspector could fine your company $10,000 for failing to use the best possible technology and possibly require that you install it if you cannot demonstrate equivalent protection with the current PPE

• If it doesn’t work, it still costs $1 million and it saves nothing
Choices

$\text{Install}$
- \text{Probability: } p
- \text{Truly works: } y
- \text{Truly doesn’t work: } n

- \text{Outcome: } $1 \text{ million}

$\text{Don’t install}$
- \text{Truly works: } p
- \text{Truly doesn’t work: } 1-p

- \text{Outcome: } 0

$\text{Truly works: } y$

$p = \text{probability that the new device works}$

$y = \text{truly works, } n = \text{truly doesn’t work}$
Best option assuming $p=0.6$

$p = \text{probability that the new device works} = 0.6$

$y = \text{truly works, n = truly doesn’t work}$

```
  Install
   v
---
0.6
  y
  $\$1 \text{ million}$

0.4
  n
  $\$1 \text{ million}$

Don’t install

0.6
  y
  $\$10,000$

0.4
  n
  0

EV = $200,000$
EV = $-6,000$
```
Tough choice

• Uncertainty in this case is clearly a big issue
• If we’ve misjudged the probability, then the new technology could waste a lot of money (real opportunity cost)
• What to do?
• Ask: How much should we be willing to pay to eliminate the uncertainty BEFORE we have to decide about whether or not to invest the $1 million in the new technology?
Expected values of the two options as a function of $p$
Expected values of the two options as a function of $p$

Best decision changes as a function of $p$
Best choice once we know whether it works – Perfect info

Deciding after you have perfect information means you find out whether it truly works or not and then decide whether to install the technology
Valuing free, perfect information given assumption of $p=0.6$

Insight: Free and perfect information means that we always do the best thing (i.e., don’t install the technology if it won’t work, and do install it if it will work)
Computing the value of information (assuming p=0.6)

• Expected value of the choice given free and perfect information = $600,000 (This is equal to 0.6*$1 million + 0.4*0)

• Expected value with no information = $200,000 (This is the expected value of the best choice of installing the technology without any additional information)

• Thus, the expected value of perfect information = $600,000-200,000 = $400,000

• If we can pay less than $400,000 for a perfect test, then we should do so
Option to buy $100,000 perfect test

Test

$500,000

0.6

y

Install

$900,000

0.4

n

Don’t install

-$100,000

$200,000

Don’t test

Install

0.6

y

$1 million

0.4

n

-$1 million

Don’t install

0.6

y

-$10,000

0.4

n

0
Asking the key questions

• How might actions change if we obtain additional information?
• Is it worthwhile to invest in efforts to get more information prior to making a final choice?
Incentives....

- and from the perspective of the person who has to make the decision

- $0 to -10,000 +small unnoticeable potential loss, no career impact
- $1,000,000 +promoted
- -$1,000,000 +fired
Incentives....

• But wait, here’s another look at our choice from the perspective of the enterprise, assuming a $100 M asset position

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How well do enterprises do?

- Risk management (crisis prevention) tends to be undervalued
- People in many organizations fail to work as a team and toward shared objectives
- Value often difficult to assess, particularly given broader system
Insights

• Uncertainty means you don’t know what will happen – this is good because it means your choices matter!

• Variability means that the “right” decision in one case may not be “right” in another case

• Although analysis/discussion of variability and uncertainty adds complexity, it also increases the opportunity for improving risk management and talking within the team and with different stakeholders more effectively
Insights

• Information has value in the context of making decisions – use and collect data to your advantage!
• Need to understand the system
• Value of information “thinking” is critical, particularly given many, many risks
• Many interesting topics…
Actions

• Ask the key questions:
  – How might actions change if we obtain additional information?
  – Is it worthwhile to invest in efforts to get more information prior to making a final choice?

• Collect the information that you need, stop worrying about things that don’t matter
Thank you