Making Risk Management Work

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Motivation

- Traditional DOD Approach to Risk
  - Define Risk Statement
    - Risk event
    - Consequence
  - Evaluate probability of occurrence
  - Evaluate severity of consequence
  - Plan and execute mitigation
- Challenges
  - Impact of time
  - Cost of risk
  - Knowledge Gaps vs Uncertainties
  - Effective risk mitigation planning
  - Rolling up multiple lower level risks into composite risks
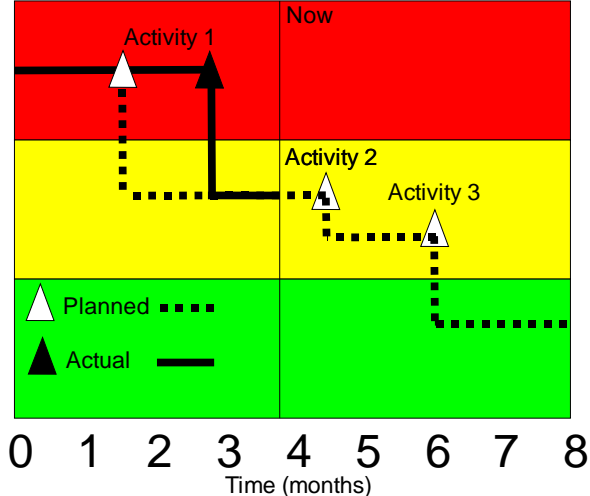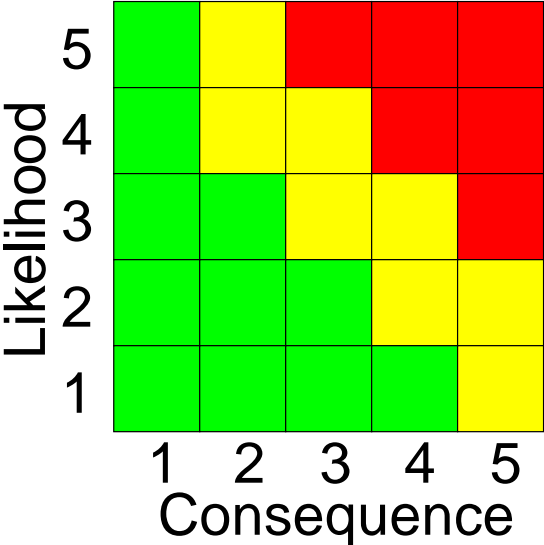
Impact of Time

- Risk statement often describes the discovery of a condition in the future rather than an event
- Severity of consequence depends on when the risk event is determined to have occurred or that it will occur with near certainty
  - Early determination can often be rectified with little consequence.
  - Late determination can be catastrophic.
- Probability of occurrence is hard to estimate early in the process because it depends often on engineering activities that haven't been planned in detail
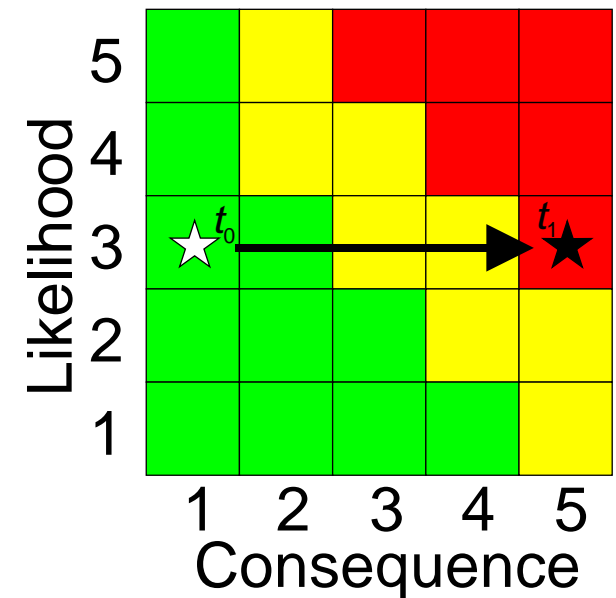
Cost of Risk

- Monetize Risk.
  - Enables consistent comparison of risks
  - Enables calculation of a return on investment of risk mitigation activities
- The cost of a risk is the required funds to address a risk event should it happen.
- Expected value of Risk is:
  - a real cost to a program and
  - should be incorporated into the program cost estimate

https://www.maxpixel.net/Money-Dollar-Seem-Franklin-Currency-Us-dollar-499481
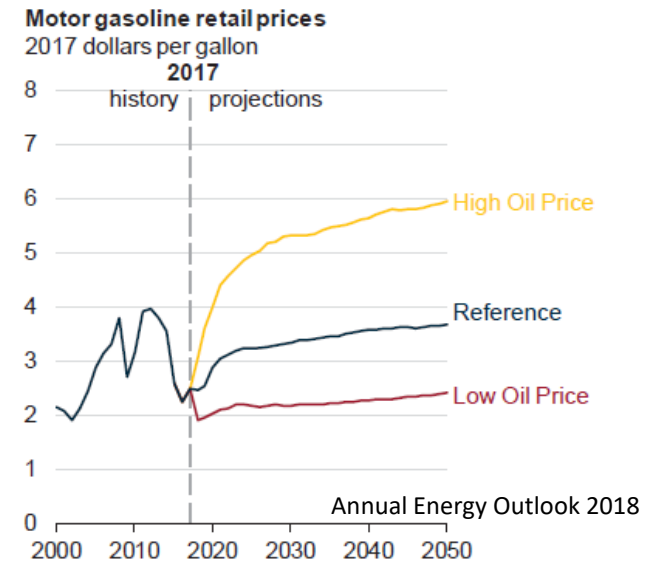
Knowledge Gaps vs Inherent Uncertainty

- Inherent Uncertainty
  - The condition cannot be resolved by an experiment today.
    - Repeating the experiment in the future may result in a different answer
  - The system should be robust to the expected range of the condition.
  - Examples
    - Price of gasoline in 30 years
    - Capability of a threat

- Knowledge Gap
  - Uncertainty due to a lack of knowledge
  - The condition can be resolved by an experiment today
    - The answer will likely not change if the experiment is repeated in the future
  - Usually there is great value in resolving the issue early
    - Cost of dealing with the issue if the knowledge gap is resolved late can be much greater than if the knowledge gap is resolved earlier.
  - Examples
    - Properties of a new material
    - Properties of a candidate component
    - Lack of a validated model
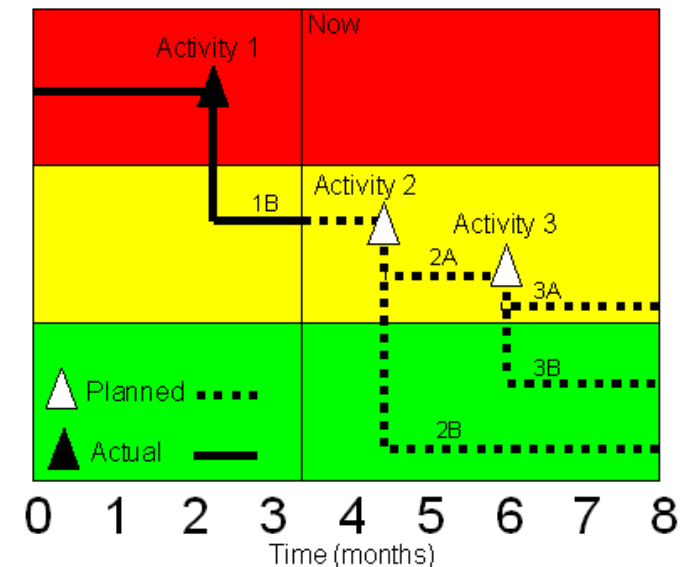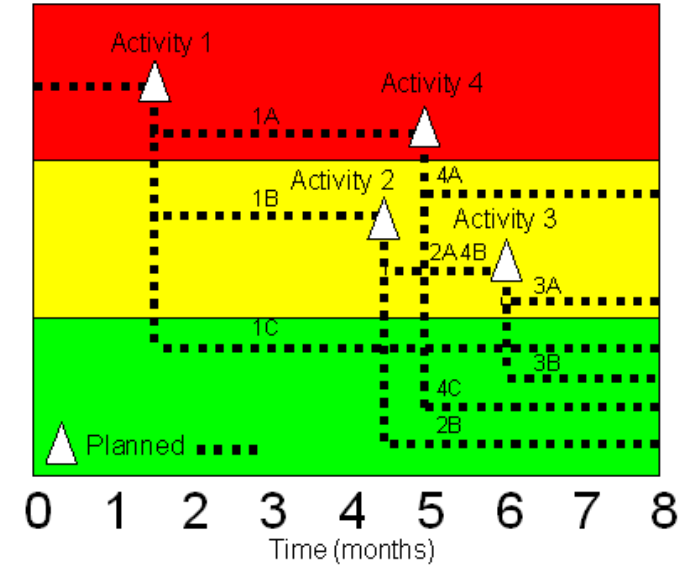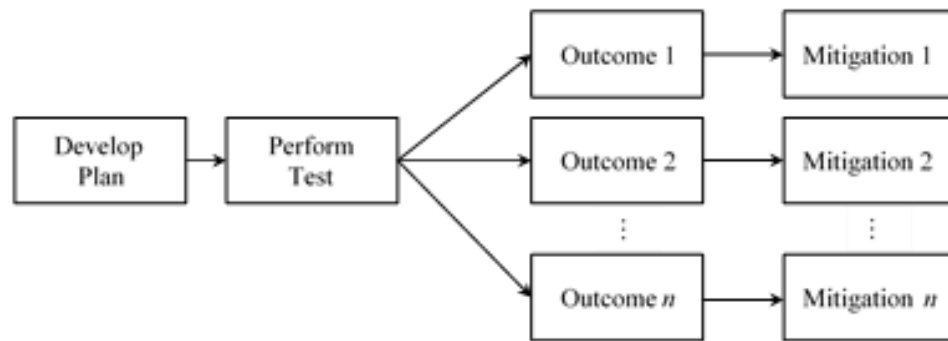   - Effectiveness of an algorithm
    - Performance undershock

Motor gasoline retail prices
2017 dollars per gallon
2017
history | projections
High Oil Price
Reference
Low Oil Price
Annual Energy Outlook 2018

U.S. Navy Photo by John F. Williams

Effective Risk Mitigation Planning

- Develop Plan

- Perform Test

- Determine Outcome

- Implement Mitigation

Risk Roll ups

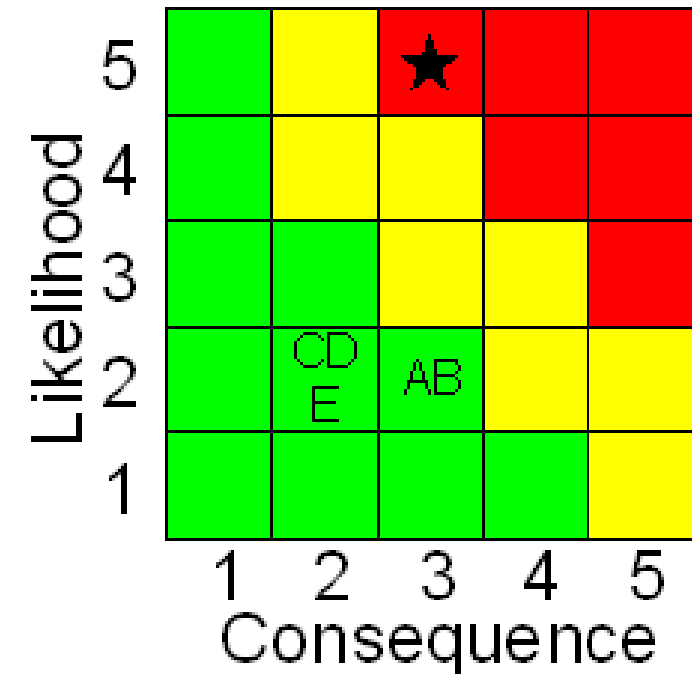| Risk	Likelihood	Consequence	Probability	Cost to Rectify	Expected Cost
A	2	3	0.3	25	7.5
B	2	3	0.3	25	7.5
C	2	2	0.3	5	1.5
D	2	2	0.3	5	1.5
E	2	2	0.3	5	1.5
Roll up	5	3	0.83	23.4	19.5

- Program Manager often desire to "roll up" a group of lower level risks into a single risk to simplify presentation

- "If one of the risks in this group of risks occurs, then there will be a negative consequence to the program."

- The expected value of the rolled up risk is the sum of the expected cost of all the risks in the group

- For independent Risks, the likelihood that one of the risks will occur can be calculated:

$$P(Z_{rolled}) = 1 - \prod_{i=1}^{n}(1 - P(Z_i))$$

- The cost of the rolled up risk can be calculated:

$$C(Z_{rolled}) = \frac{E_{Rolled}}{P(Z_{rolled})}$$

Summary

- Impact of time
- Cost of Risk
- Knowledge Gaps vs Uncertainties
- Effective risk mitigation planning
- Rolling up multiple lower level risks into composite risks