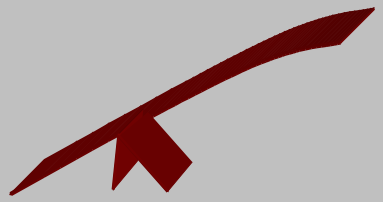

Risk Management for Systems Engineering

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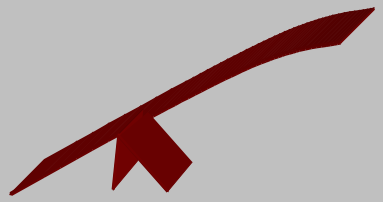

Risk Management Concepts

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Definition of Risk

- What is a risk?
  - Brainstorm items that you consider risks
  - List some of the attributes of those risks

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Risk

- Risk as a science was born in the sixteenth century Renaissance, a time of discovery
- The word ***risk*** is derived from the early Italian ***risicare*** which means “to dare”
- Today, risk is defined as the possibility of ***loss***
- Loss – Unless there is potential for loss, there is no risk
  - The loss can be either a bad outcome or a lost opportunity
- Choice – Unless there is a choice, there is no risk management

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Risk - 2

- Risk can be described in terms of probability (**the possibility of risk**), consequence (**the loss**), and time frame
- **Probability** is the likelihood that the consequence will occur
- **Consequence** is the effect of an unsatisfactory outcome
- **Time Frame** refers to when the risk will occur during the product lifecycle

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Risk - 3

- Risks are future events with a probability of occurrence and a potential for loss
- Many problems that arise in software development efforts were first known as risks by someone on the project staff
- Caught in time, risks can be avoided, negated or have their impacts reduced
- Problem: A risk whose time has come

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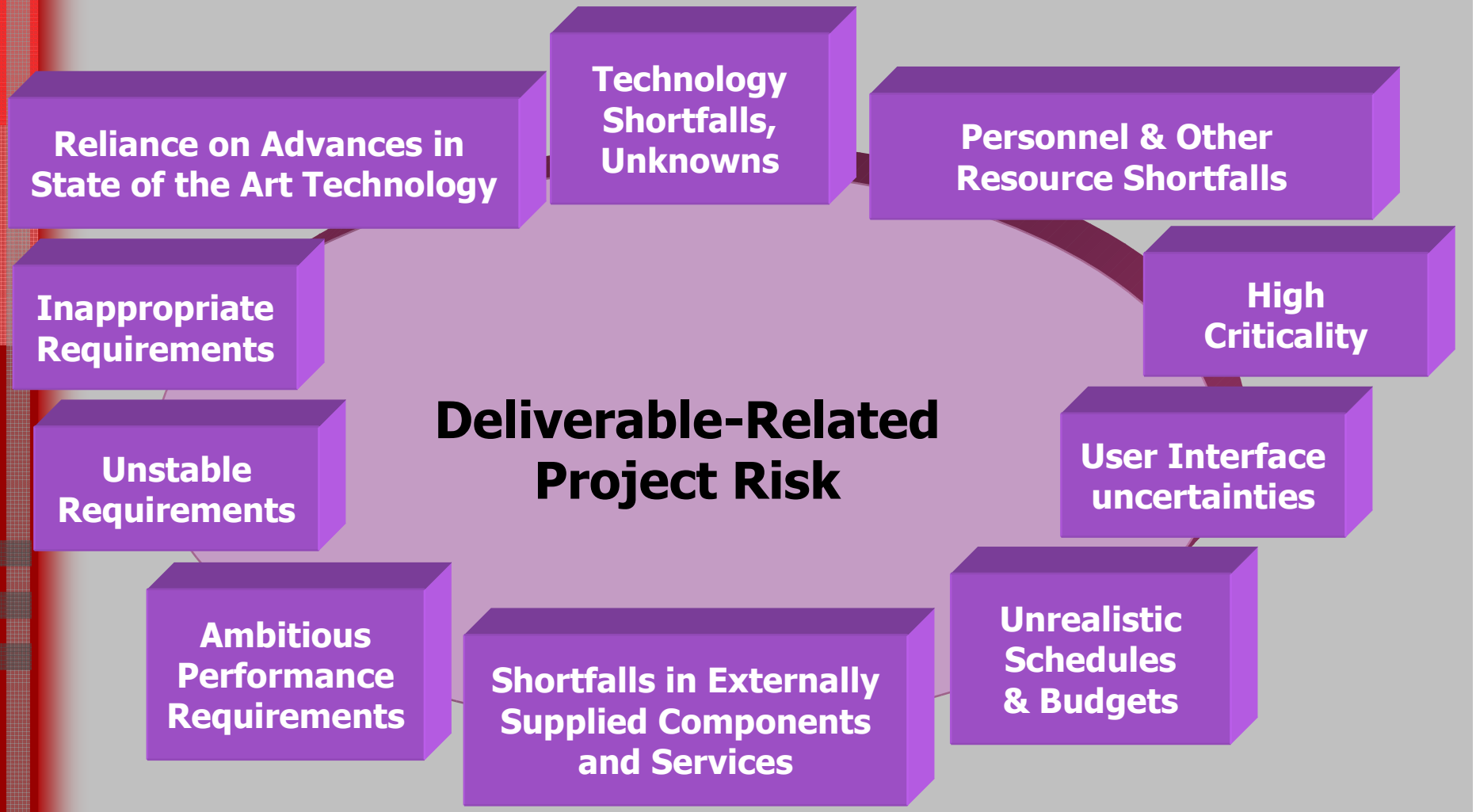
Common Sources of Project Risk



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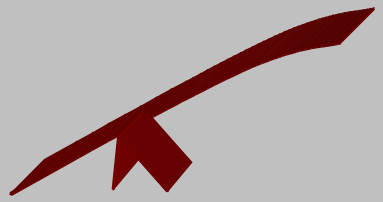

Risk Management for Systems Engineering

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Risk-based Decision Making

- Risk-based decision making and risk-based approaches in decision making are terms frequently used to indicate that some systematic process is in place that deals with uncertainties
  - Decision making under uncertainty literally encompasses every aspect of our lives:
    - at the personal, corporate, and governmental levels
    - During the planning, developing, design, operation, and management phases of a project

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Risk-based Decision Making - 2

- Uncertainty is inherent when the process attempts to answer the questions:
  - Who should decide on the acceptability of risk?
  - What risk should be taken into consideration?
  - Whom does or will the risk affect?
  - What conditions must be present for the decision on the acceptability or unacceptability of risk to be made?
  - Why would this risk be acceptable?

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Risk-based Decision Making - 3

- Engineering systems are almost always designed, constructed, and operated under unavoidable conditions of risk and uncertainty
  - Multiple and conflicting objectives are expected to be achieved
- The identification, quantification, evaluation, and trading off of risks, benefits, and costs must become an integral and explicit component of the overall managerial decision making process
  - Cannot be a cosmetic afterthought!

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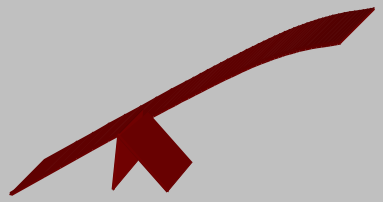

Risk Management

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What Is Risk Management?

- Decision making under conditions of uncertainty
- Making informed decisions by consciously assessing what can go wrong and the resulting impact
- Risk management is
  - Identification
  - Communication
  - Resolution

"Risk engineering [management] does not deal with future decisions, but with the future of present decisions." - Robert Charette

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What Is Risk Management? - 2

- Risk Management involves
  - Identifying risks,
  - Analyzing their probability and potential impact,
  - Determining and evaluating risk contingencies,
  - Tracing risks, and
  - Proactively managing the risks

A risk is a potential problem. Proactively managing the risk implies determining a risk management strategy and risk contingencies that will prevent the risk from becoming a problem or limit its impact if it does

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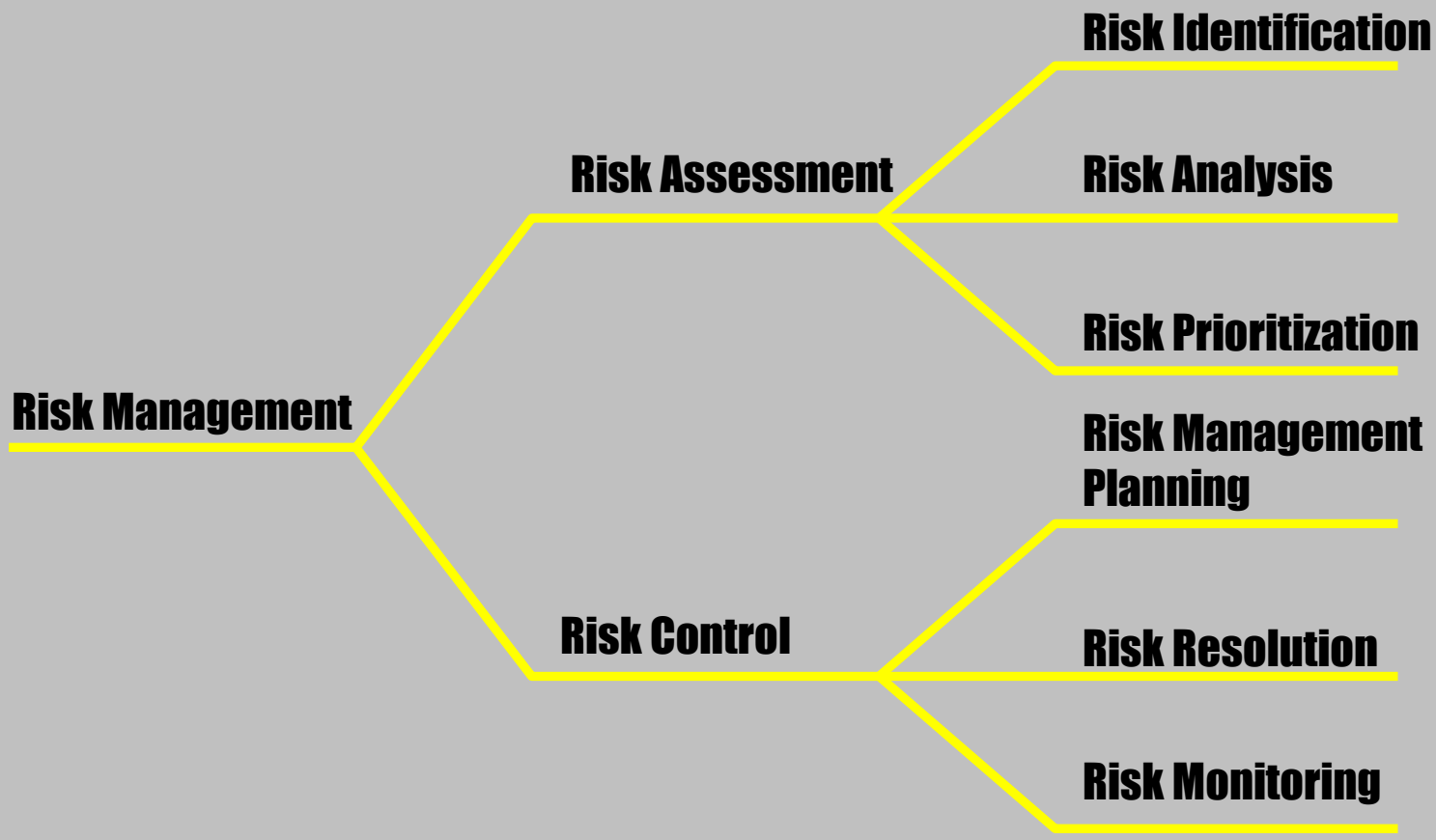
Elements of Risk Management



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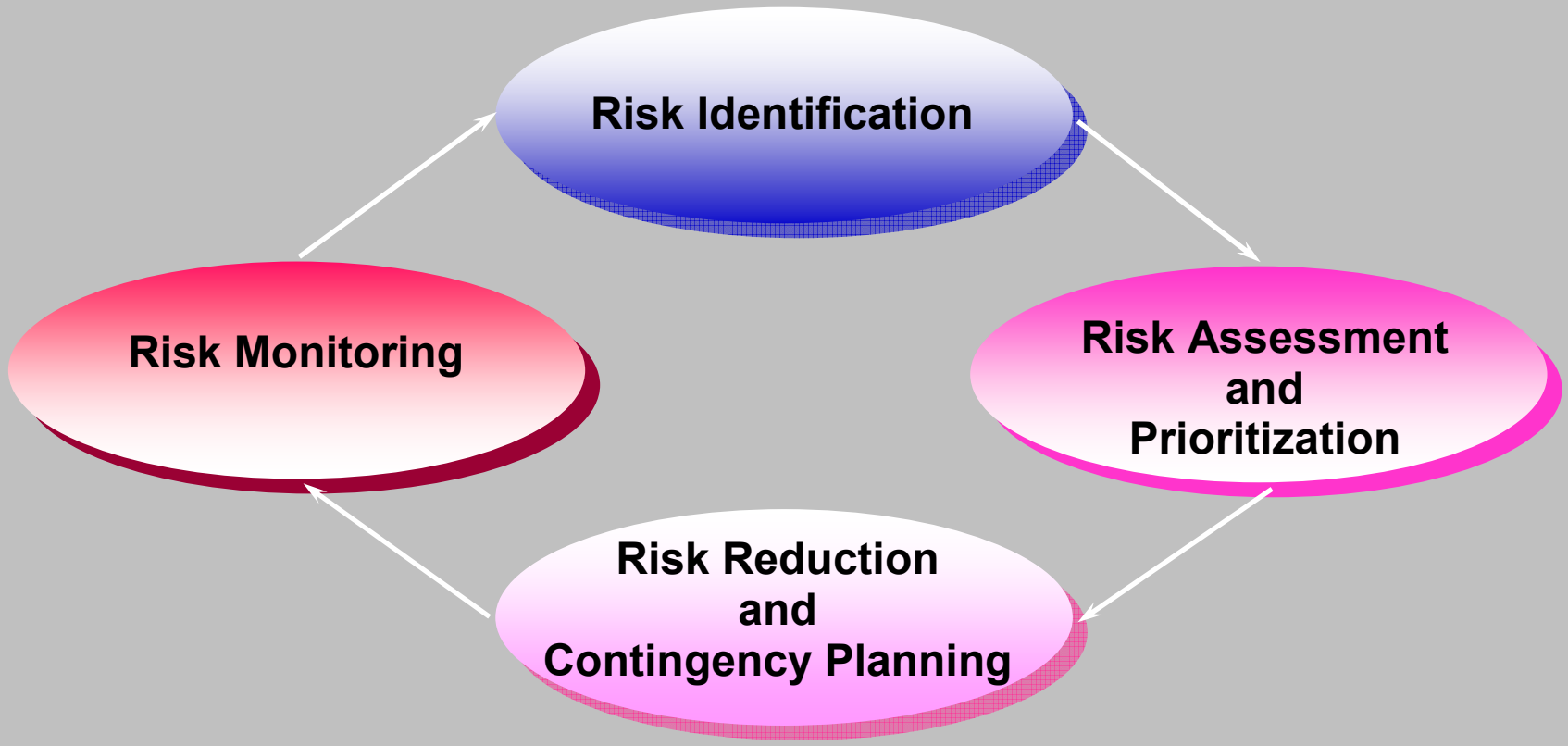
Risk Management Cycle



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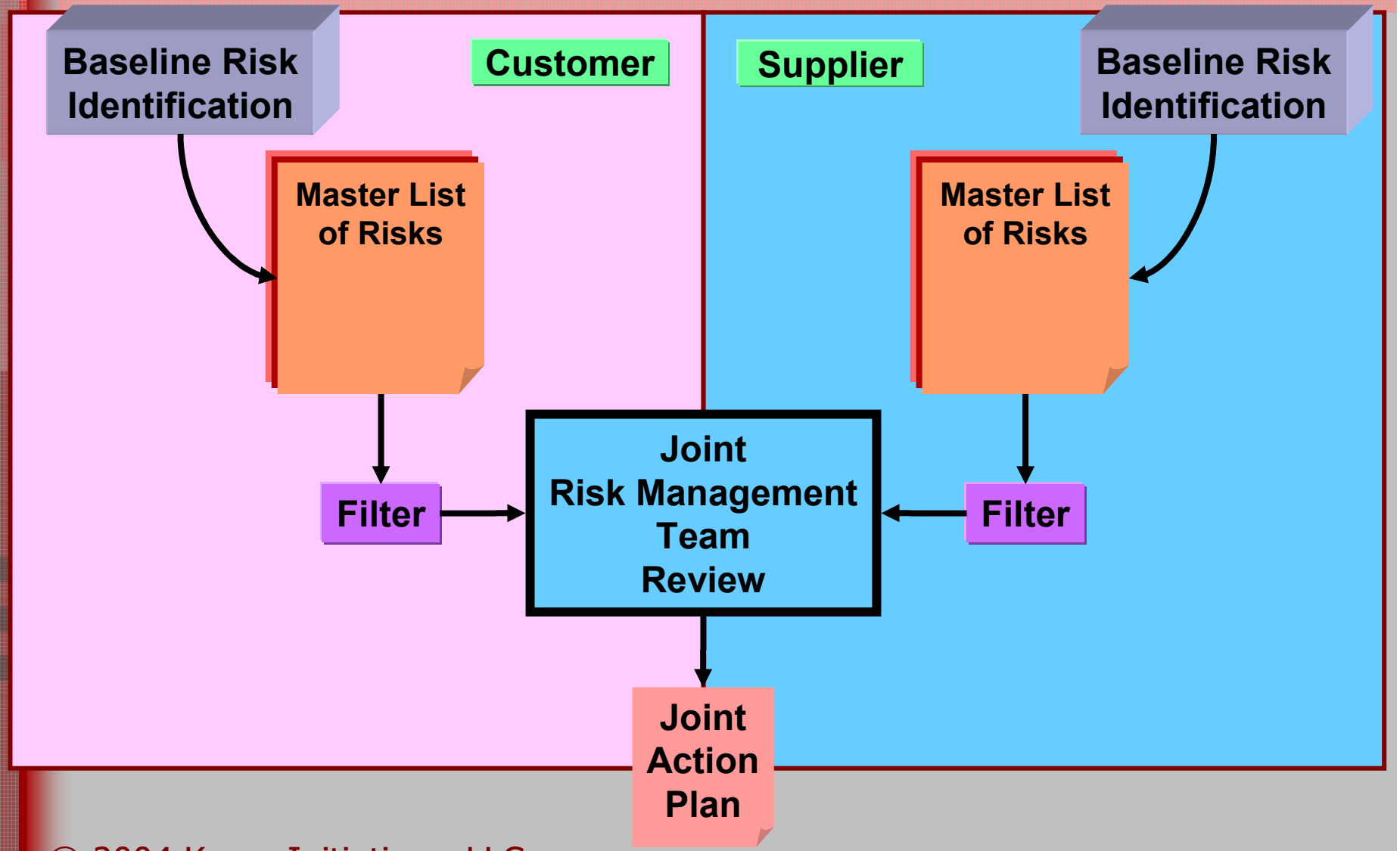
Baseline Risk Identification Outcome



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Risk Management Observations

- Project managers DO manage risks, BUT:
  - Tend to manage the risks they see, and don't often see all the risks or the critical risks
  - Tend to only manage risks for which they have domain expertise
  - Tend to really manage to cost & schedule – the symptoms
  - Are usually selected and rewarded for their crisis management skills
- Risk management is performed during "risk management season"
- Generally lacks structured approach, resulting in ad hoc risk management

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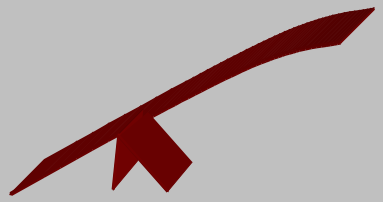

Risk Assessment

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Assess Risks

- Assess likelihood or probability of risks
- Assess consequences or impact of risks
- Determine the time frame in which the risk is likely to occur
  - Long
  - Medium
  - Short
  - Imminent

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Probability

- How likely is a future problem to occur?
- Often difficult to define precisely
- Probability can be defined as a percentage, a phrase or a relative number:

Probability	Uncertainty	Rank
> 80%	Almost certainly, highly likely	5
61%-80%	Probable, likely, probably, we believe	4
41%-60%	We doubt, improbable, better than even	3
21%-40%	Unlikely, probably not	2
< 21%	Highly unlikely, chances are slight	1

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Determining the Potential Impact

- In order to analyze a risk, one must determine the potential impact
- Ideally, one should determine the cost of the problem, should it occur
  - However, most people are afraid to place a figure on the **consequences** of a remote possibility
  - In the absence of figures, relative classification is useful

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Relative Classification of Impact

Level	Cost
Binary	High Low
3 Level	High Moderate Low
4 Level	Catastrophic Critical Marginal Negligible
5 Level	Catastrophic High Moderate Low Very Low

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Time Frames

- Risks that require rapid reactions need to be flagged as such
- This includes risks that may only be visible close to release time, or risks that require a mitigation plan to be implemented at the time of the assessment
- Usually three or four reaction levels are sufficient:
  - Long
  - Medium
  - Short
  - Immediate

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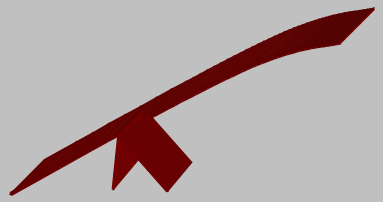

Risk Planning

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Risk Identification in the Iterative Project Planning Cycle

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Risk Identification

- Risk identification should concentrate on the identification of hazards, threats, vulnerabilities, etc., that could negatively affect work efforts or plans
- Risk identification should seek out probable or realistic risks in achieving objectives
  - It is not effective to attempt to address every possible event

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Risk Identification - 2

- Risk Identification steps include:Review and analysis of the requirements specification
  - Review and analysis of the interface requirements specification
  - Identify the risks associated with cost, schedule, and performance in all appropriate product life-cycle phases
  - Identify other risks such as risks associated with labor strikes, technology cycle time, and competition
  - Examine lessons learned
- Review any environmental elements that may impact the project such as weather or political changes

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Risk Identification - 3

- Review all elements of the work breakdown structure to ensure all aspects of the work effort have been considered
- Review all elements of the project plan to ensure that all aspects of the project have been considered
  - Use historical database
- Document the context of the risk including:
  - Relative time frame
  - Conditions surrounding the risk that have caused concern
  - Any doubt or uncertainty

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Risk Identification - 4

- Assess state of technology
  - Is required architecture available?
  - Is required support software available?
  - Are proposed methodologies and development systems tried and proven? Is help available?
  - Has development methodology been applied to similar systems?
  - Is staff properly trained for the project?

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Risk Identification - 5

- Assess level of complexity of system
  - Complex functionality and logic?
  - Extensive interfaces?
- Assess requirements stability
- Assess delays in using non-standard tools
- Assess delivery times for all critical hardware and software to be procured

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Risk Identification - 6

- Include a description of how to detect that the risk is becoming a problem
- Ensure each description is written clearly and is verifiable

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Identify Strategies

- Most risks require the identification of strategies
- Each strategy should include at least:
  - A description of the action to be taken
  - An estimate of required resources
  - An estimated schedule
  - An estimated benefit or change in the state of the risk (i.e., an analysis of the remaining risk)
  - A description of any known relationships to other risks or strategies (i.e., how this strategy may influence or be influenced by the implementation of another)

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Identify Strategies - 2

- Possible strategies for each risk include:
  - Acceptance
    - conscious decision to live with the risk, having determined that the mitigation effort would be more expensive than the problem
  - Avoidance
    - eliminate the risk altogether in order to avoid a lose-lose situation (e.g., decision not to bid on a request for proposal)
  - Protection
    - employ redundancy to mitigate the risk (e.g., two systems backing up each other)

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Identify Strategies - 3

- Reduction
  - decrease the risk through mitigation, prevention and anticipation
  - reduction can be applied to either the probability or the consequences
- Research
  - investigate and obtain more information
- Reserves
  - use contingency funds and build in schedule slack to cover uncertainties
- Transfer
  - shift the risk to another person or group better able to act upon it

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Evaluate Strategies

- The alternative strategies can be evaluated to determine which one has the best potential for managing each risk
  - Provides the greatest reduction in risk
  - Requires the fewest resources
  - Requires available resources
  - Has the least impact on the schedule
- The question that requires an answer is:
  - "What set of strategies best manages the project's risk?":

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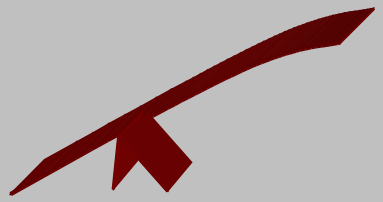

Risk Mitigation and Contingency Planning

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Mitigation Strategy

- Mitigation Tactics
  - Change control mechanisms to monitor risk areas
  - Consider alternative designs
  - Provide additional training
  - Provide cross training to ensure each function is backed up
  - Involve users more – focus groups
  - Increase reviews and inspections

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Mitigation Strategy - 2

- Develop and use traceability matrix
- Increase level of testing and audit testing results
- Provide additional time & cost
- Use prototyping
- Use simulation
- Search for higher-performance hardware
- Follow incremental development or evolutionary development approach

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Developing Risk Scenarios

- For every high severity risk a **scenario** should be developed
- One procedure for developing such a scenario involves:
  - Thinking about the risk as if it had occurred
  - Stating the scenario as if the problem had happened
  - Listing the events and conditions that would precede the risk occurrence

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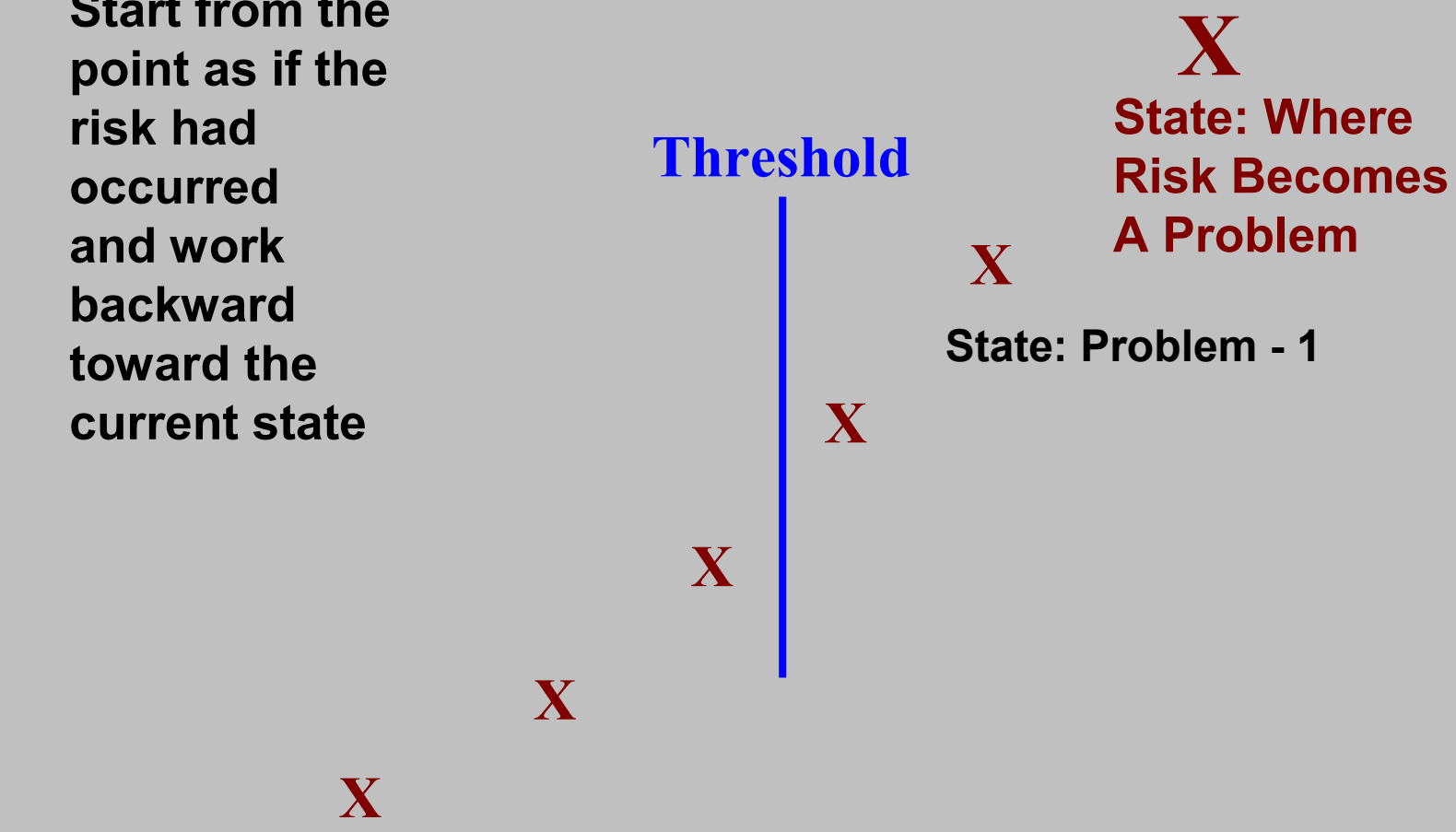
Risk Scenario Example

Start from the point as if the risk had occurred and work backward toward the current state



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Contingency Planning

- Activities to be executed if the risk is realized/occurs
  - Developed for those risks that exceed established thresholds for risk exposure (should be found in the project tailoring guidelines)
- Activities which require contingency planning:
  - Critical path activities
  - Activities dependent on partially committed resources
  - Activities dependent on the timely delivery of h/w, s/w or other equipment and supplies

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Contingency Planning - 2

- Contingency planning includes developing:
  - Alternative courses of action (Plan B)
  - Workarounds
  - Fall-back positions
  - Recommended courses of action

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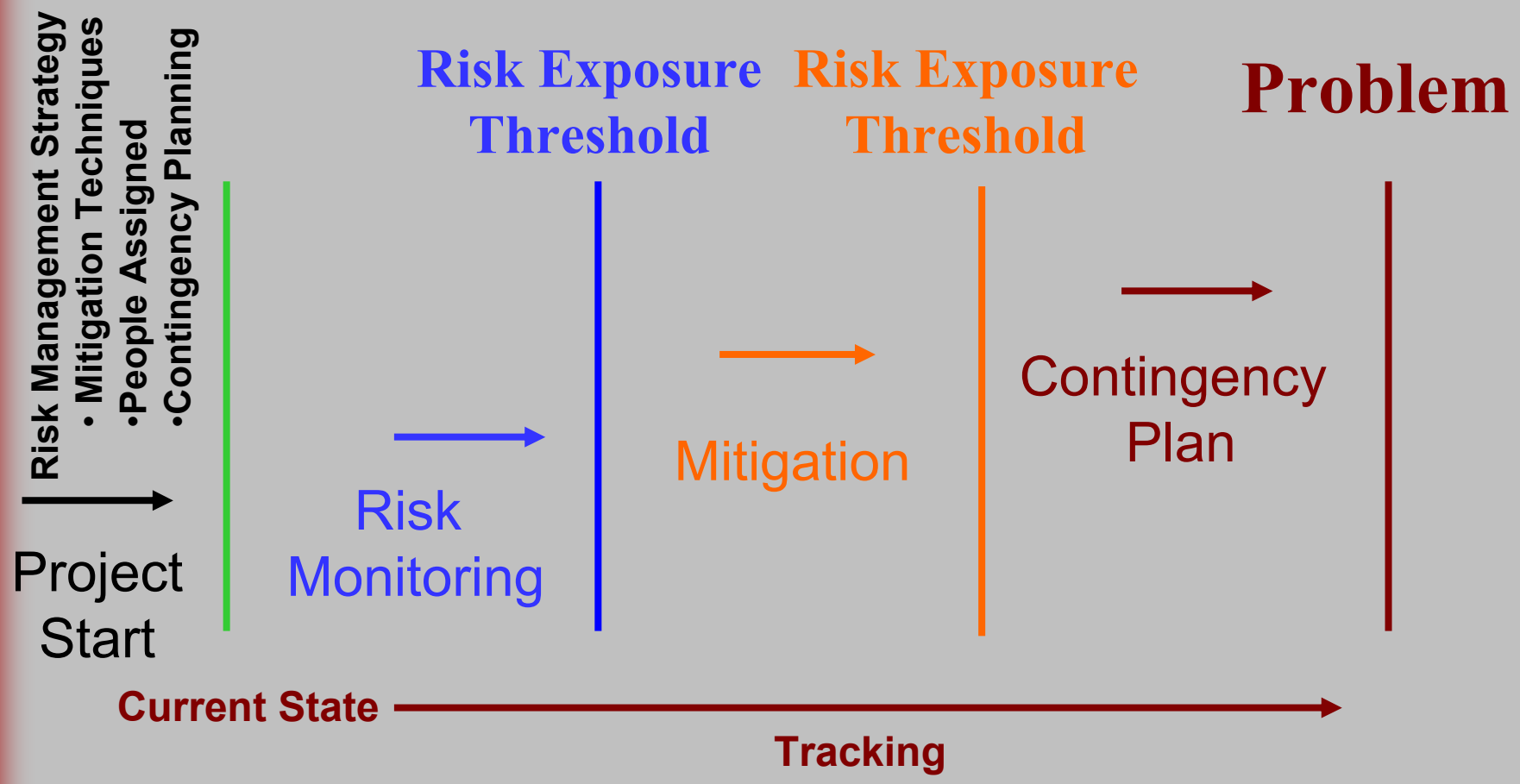
Establishing Risk Thresholds



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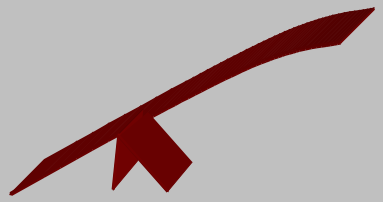

Risk Tracking

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Track Risks, Update as Appropriate

- Ensure information for each risk is current and accurate
  - If the risk is no longer valid, retire the risk
  - If the probability/impact or mitigation/contingency have changed or need to be updated, change them
- Repeat steps to review and update risks at least on the periodic basis as specified by project tailoring
  - Risks should be reviewed and updated prior to each status reporting period

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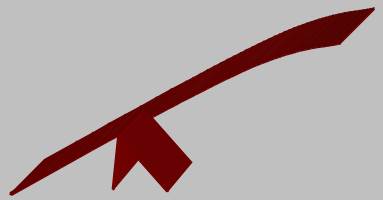

Summary

- Risk management is about making informed decisions under conditions of uncertainty
- Effective risk management depends on open communication
- Risk management facilitates the quick and effective selection of process improvement efforts
- Practiced effectively, risk management can help to avoid or lessen the impact of issues that threaten the success of the project

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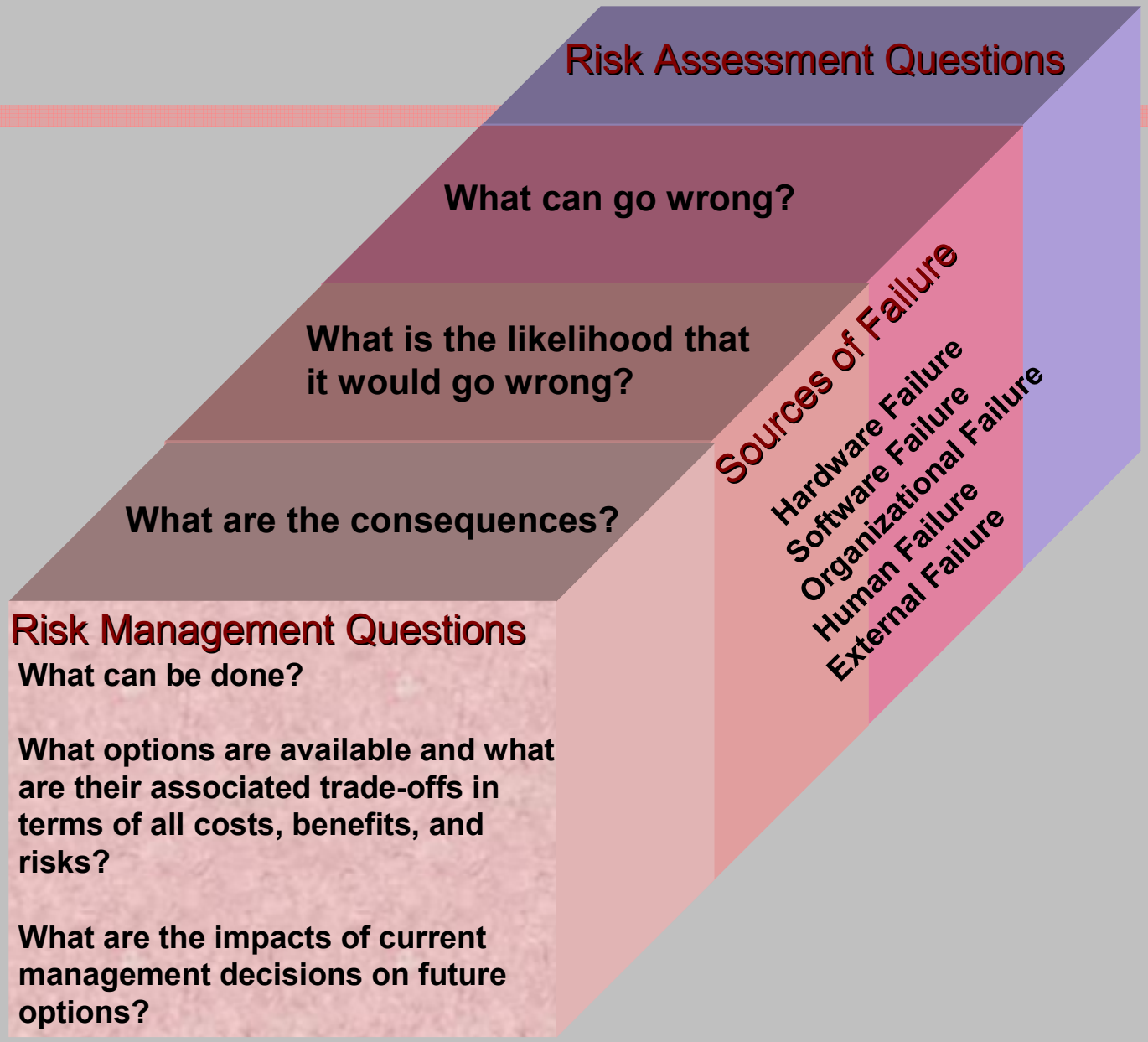
Total Risk Management



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