Introduction to Software Engineering

(CS350)

Lecture 05

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Risk Management

What is A Risk?

- "The chance or possibility of suffering loss, injury, damage, or harm" – Webster's dictionary, 1981
- "The measure of the probability and severity of adverse effects" – William Lawrance, "Of Acceptable Risk", 1976
- "problems that could cause some loss or threaten the success of projects, but which has not happened yet"
  - http://www.processimpact.com/articles/risk_mgmt.html
- No universally accepted definition
- All definitions share the following characteristics:
  - ***Uncertainty*** – an event may or may not happen
  - ***Loss*** – an event has unwanted consequences or losses

If you don actively attack the risks?

The risks will actively attack you !

-Tom Gilb -

Reactive Risk Management

- Project team reacts to risks when they occur
- Mitigation: plan for additional resources in anticipation of fire fighting
- Fix on failure: resource are found and applied when the risk strikes
- Crisis management: failure does not respond to applied resources and project is in jeopardy

Proactive Risk Management

- Formal risk analysis is performed
- Organization corrects the root causes of risk
  - TQM concepts and statistical SQA
  - examining risk sources that lie beyond the bounds of the software
  - developing the skill to manage change

Seven Principles

- **Maintain a global perspective**—view software risks within the context of system and the business problem
- **Take a forward-looking view**—think about the risks that may arise in the future; establish contingency plans
- **Encourage open communication**—if someone states a potential risk, don’t discount it.
- **Integrate**—a consideration of risk must be integrated into the software process
- **Emphasize a continuous process**—the team must be vigilant throughout the software process, modifying identified risks as more information is known and adding new ones as better insight is achieved.
- **Develop a shared product vision**—if all stakeholders share the same vision of the software, it likely that better risk identification and assessment will occur.
- **Encourage teamwork**—the talents, skills and knowledge of all stakeholder should be pooled

Risk and Project Management

Risk Management is aimed addressing the risks within the project management environment .. Not just the technical risks

Is This A Risk?

- We just started integrating the software
  - and we found out that COTS* products A and B just can't talk to each other
- We've got too much tied into A and B to change
- Our best solution is to build wrappers around A and B to get them to talk via CORBA**
- This will take 3 months and $300K
- It will also delay integration and delivery by at least 3 months

*COTS: Commercial off-the-shelf

**CORBA: Common Object Request Broker Architecture

Is This A Risk?

- No, it is a problem
  - Being dealt with reactively
- Risks involve *uncertainties*
  - And can be dealt with pro-actively
  - Earlier, this problem was a risk

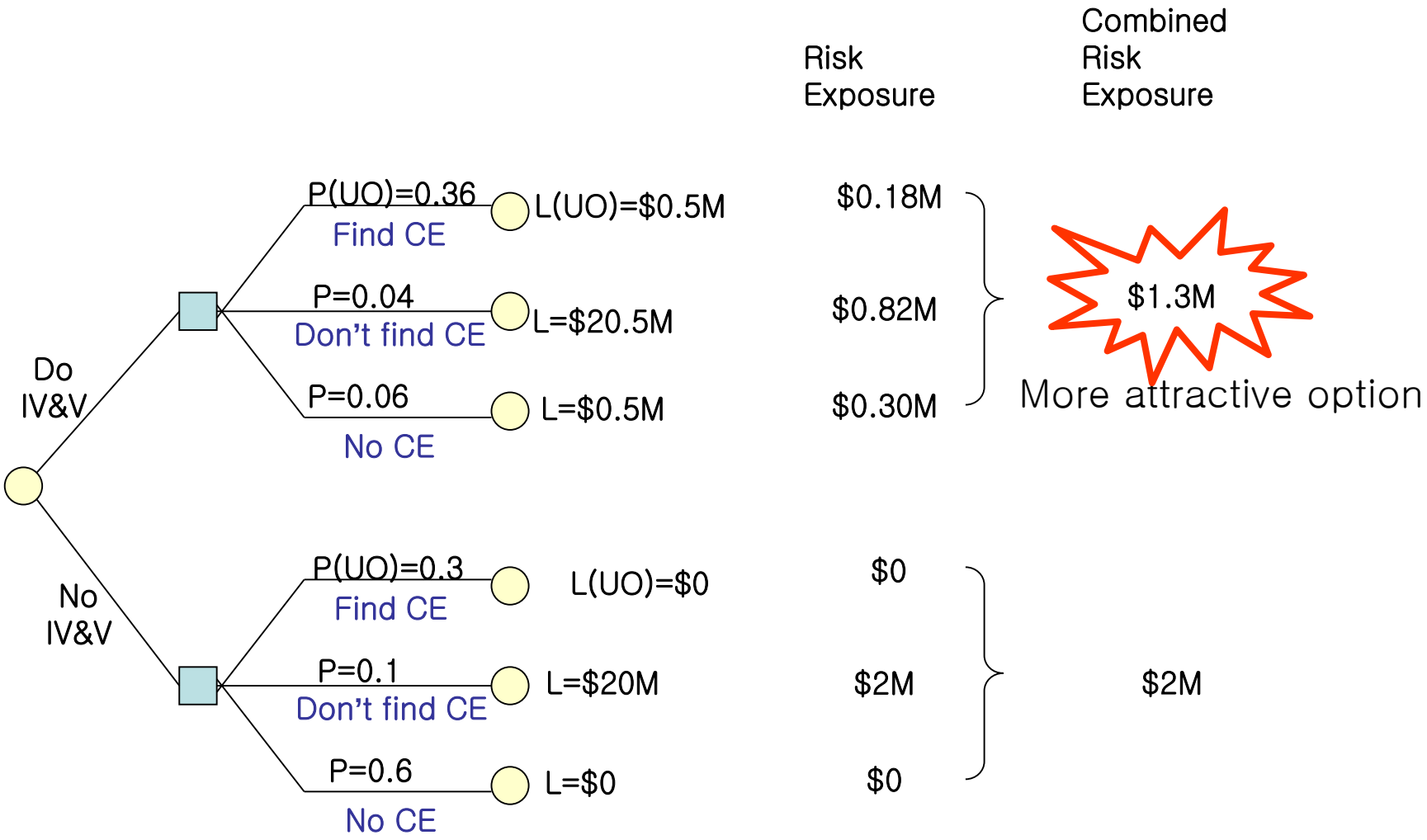
Earlier, This Problem Was A Risk

- A and B are our strongest COTS choices
  - But there is some chance that they can't talk to each other
  - Probability of loss P(L) [or P(UO)]
  - If we commit to using A and B
  - And we find out in integration that they can't talk to each other
  - We'll add more cost and delay delivery by at least 3 months
  - Size of loss S(L) [or L(UO)]

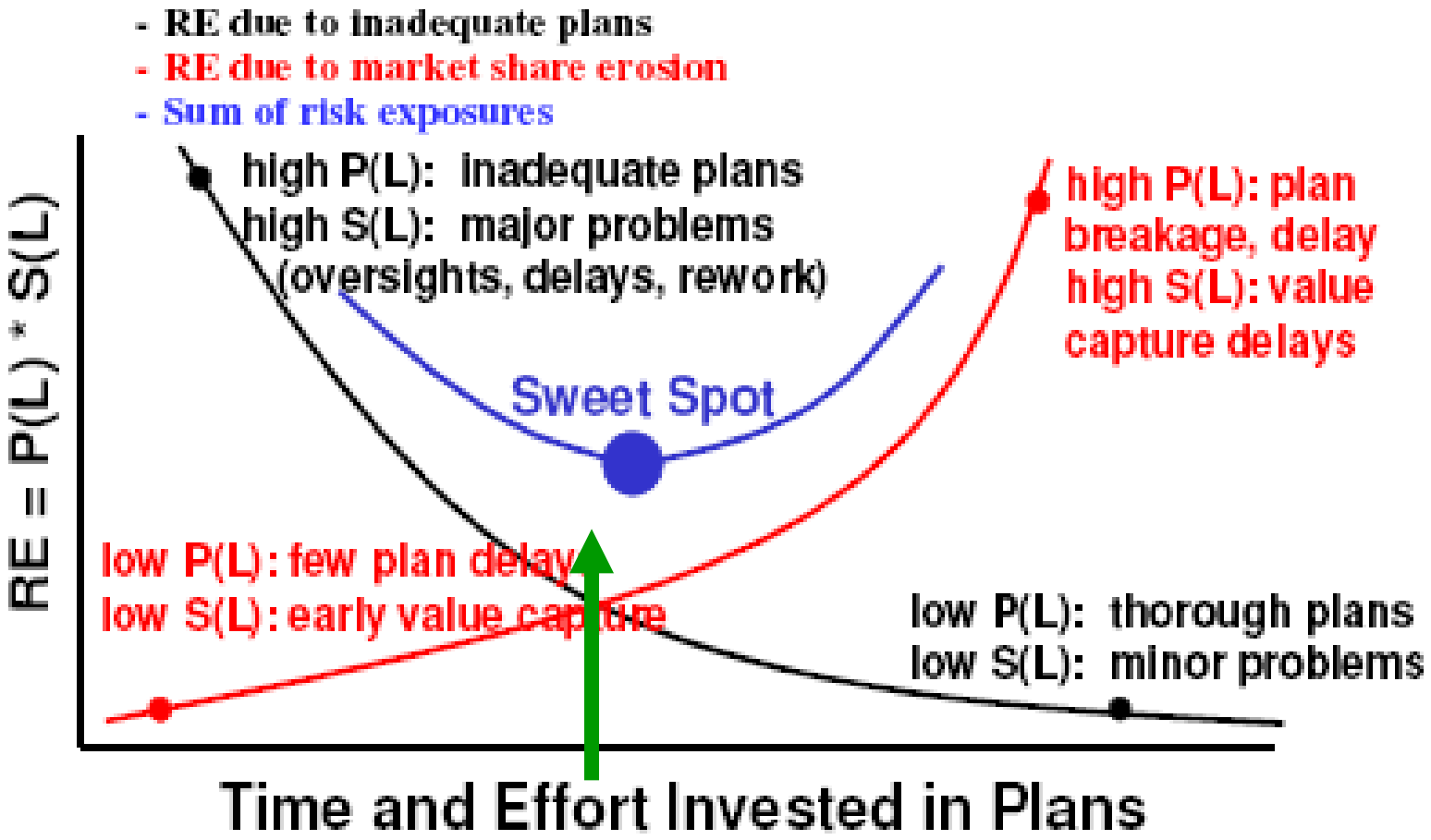
- Risk Exposure (RE)

RE = P(L) * S(L)

Risk-Analysis: Decision Tree



Using Risk to Determine "HOW MUCH ENOUGH"



RISK vs. PROBLEM

- Example:
  - A risk: threat of your top technical people being hired away by the competition
  - A problem: unable to hire right skilled staff
- Current, real problems
  - Requires prompt corrective actions
- Looming risk
  - Dealt with several different ways

How to Deal with Risks?

- Buying Information
- Risk Avoidance
- Risk Transfer
- Risk Reduction
- Risk Acceptance

Risk Management Strategies - I

Buying Information

- Let's spend $30K and 2 weeks prototyping the integration of A and B
- This will buy information on the magnitude of P(L) and S(L)
- If RE = P(L) * S(L) is small, we'll accept and monitor the risk
- If RE is large, we'll use one/some of the other strategies

Risk Avoidance

- COTS product C is almost as good as B, and it can talk to A
- Delivering on time is worth more to the customer than the small performance loss

Risk Management Strategies - II

Risk Transfers

- If the customer insists on using A and B, have them establish a risk reserve.
- To be used to the extent that A and B can't talk to each other

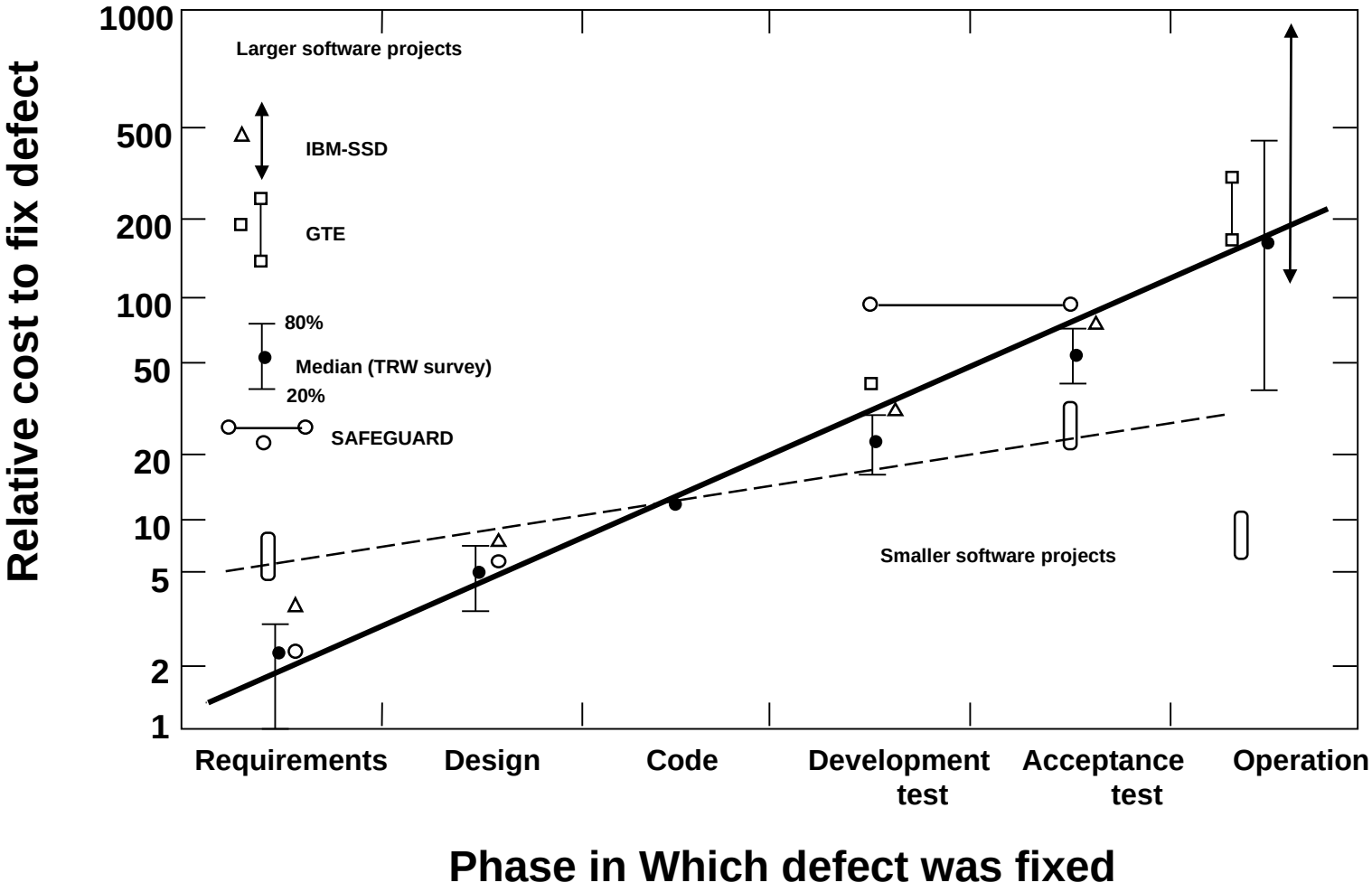
Risk Reduction

- If we build the wrappers and the CORBA corrections right now, we add cost but minimize the schedule delay

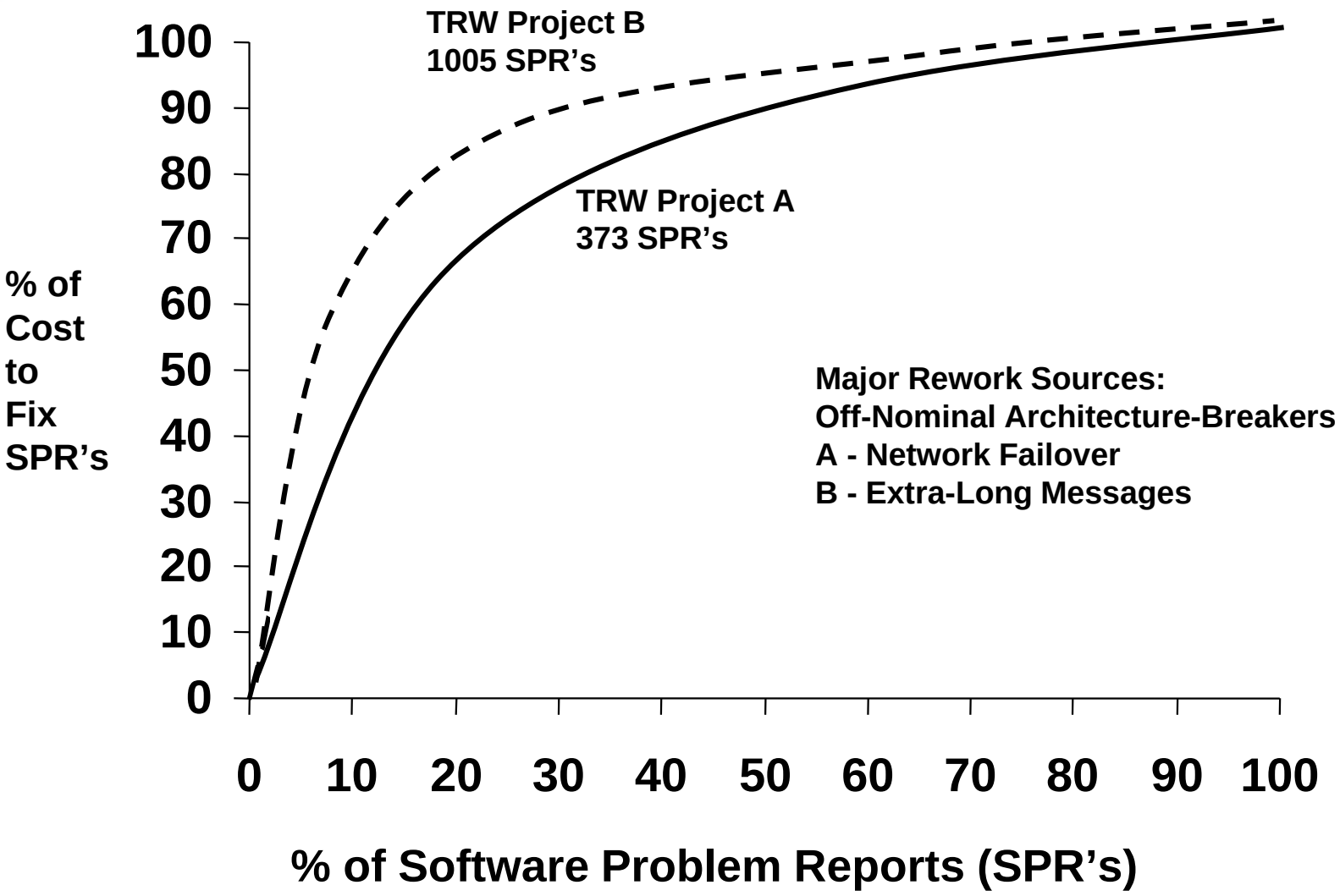
Risk Acceptance

- If we can solve the A and B interoperability problem, we'll have a big competitive edge on the future procurements
- Let's do this on our own money, and patent the solution

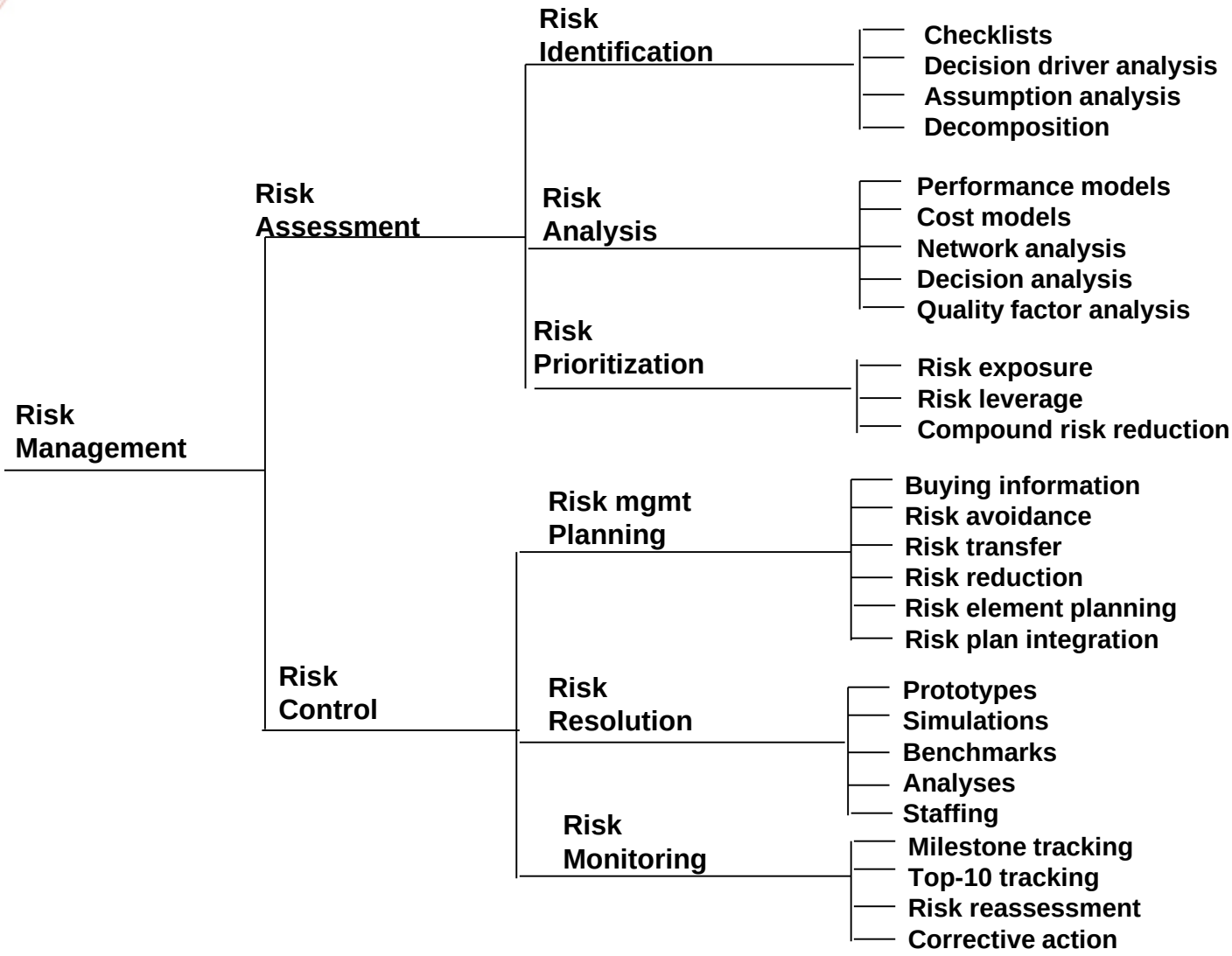
Risk of Delaying Risk Management:



Steeper Cost-to-fix for High-Risk



Software Risk Management



Risk Identification

Risk Identification

- Produce lists of the project specific risk items likely to compromise a project's success

- Typical risk Identification Techniques
  - Risk-item checklists
  - Decision driver analysis
  - Comparison with experience (Assumption Analysis)
  - Win-lose, lose-lose situations
  - Decomposition
    - Pareto 80 – 20 phenomena
    - Task dependencies
    - Murphy's law
    - Uncertainty areas
  - Analysis of Model Clashes

Example: Risk Item Checklist

- Will you project really get all the best people?
- Are there critical skills for which nobody is identified?
- Are there pressures to staff with available warm bodies?
- Are there pressures to overstaff in the early phases?
- Are the key project people compatible?
- Do they have realistic expectations about their project job?
- Do their strengths match their assignment?
- Are they committed full-time?
- Are their task prerequisites (training, clearances, etc.) Satisfied?

Example: Examination of Decision Drivers

- Political versus Technical
  - Choice of equipment
  - Choice of subcontractor
  - Schedule, Budget
  - Allocation of responsibilities
- Marketing versus Technical
  - Gold plating
  - Choice of equipment
  - Schedule, budget
- Solution-driven versus Problem-driven
  - In-house components, tools
  - Artificial intelligence
  - Schedule, Budget
- Short-term versus Long-term
  - Staffing availability versus qualification
  - Reused software productions engineering
  - Premature SRR, PDR
- Outdated Experience

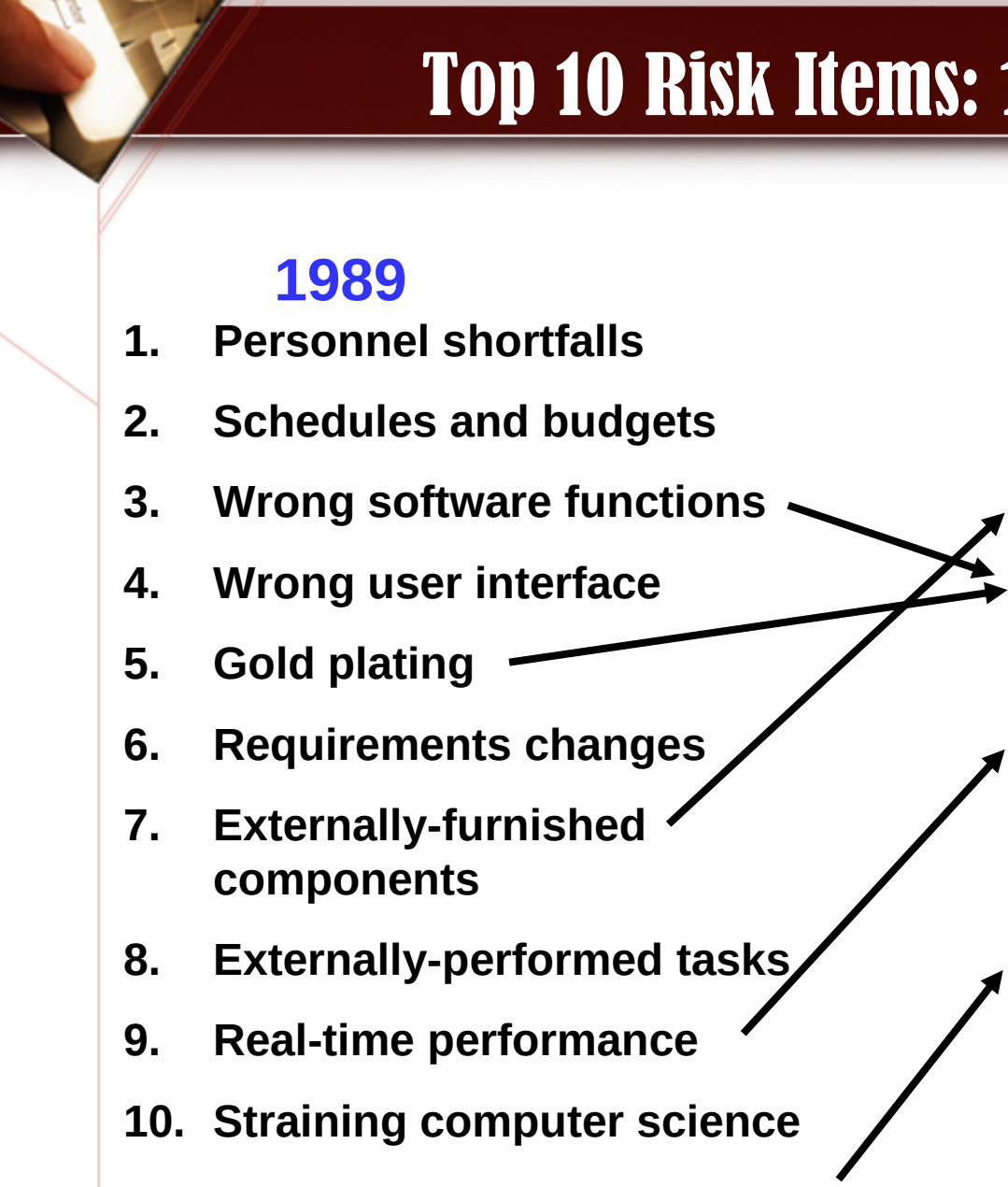
Top 10 S/W Risk Items

Risk item	Risk-management technique
Personnel shortfalls	Staffing with top talent, job matching, team building, key personnel agreements, cross training.
Unrealistic schedules and budgets	Detailed multisource cost and schedule estimation, design to cost, incremental development, software reuse, requirements scrubbing.
Developing the wrong functions and properties	Organization analysis, mission analysis, operations-concept formulation, user surveys and user participation, prototyping, early users' manuals, off-nominal performance analysis, quality-factor analysis.
Developing the wrong user interface	Prototyping, scenarios, task analysis, user participation.
Gold-plating	Requirements scrubbing, prototyping, cost-benefit analysis, designing to cost.
Continuing stream of requirements changes	High change threshold, information hiding, incremental development (deferring changes to later increments).
Shortfalls in externally furnished components	Benchmarking, inspections, reference checking, compatibility analysis.
Shortfalls in externally performed tasks	Reference checking, preaward audits, award-fee contracts, competitive design or prototyping, team-building.
Real-time performance shortfalls	Simulation, benchmarking, modeling, prototyping, instrumentation, tuning.
Straining computer-science capabilities	Technical analysis, cost-benefit analysis, prototyping, reference checking.

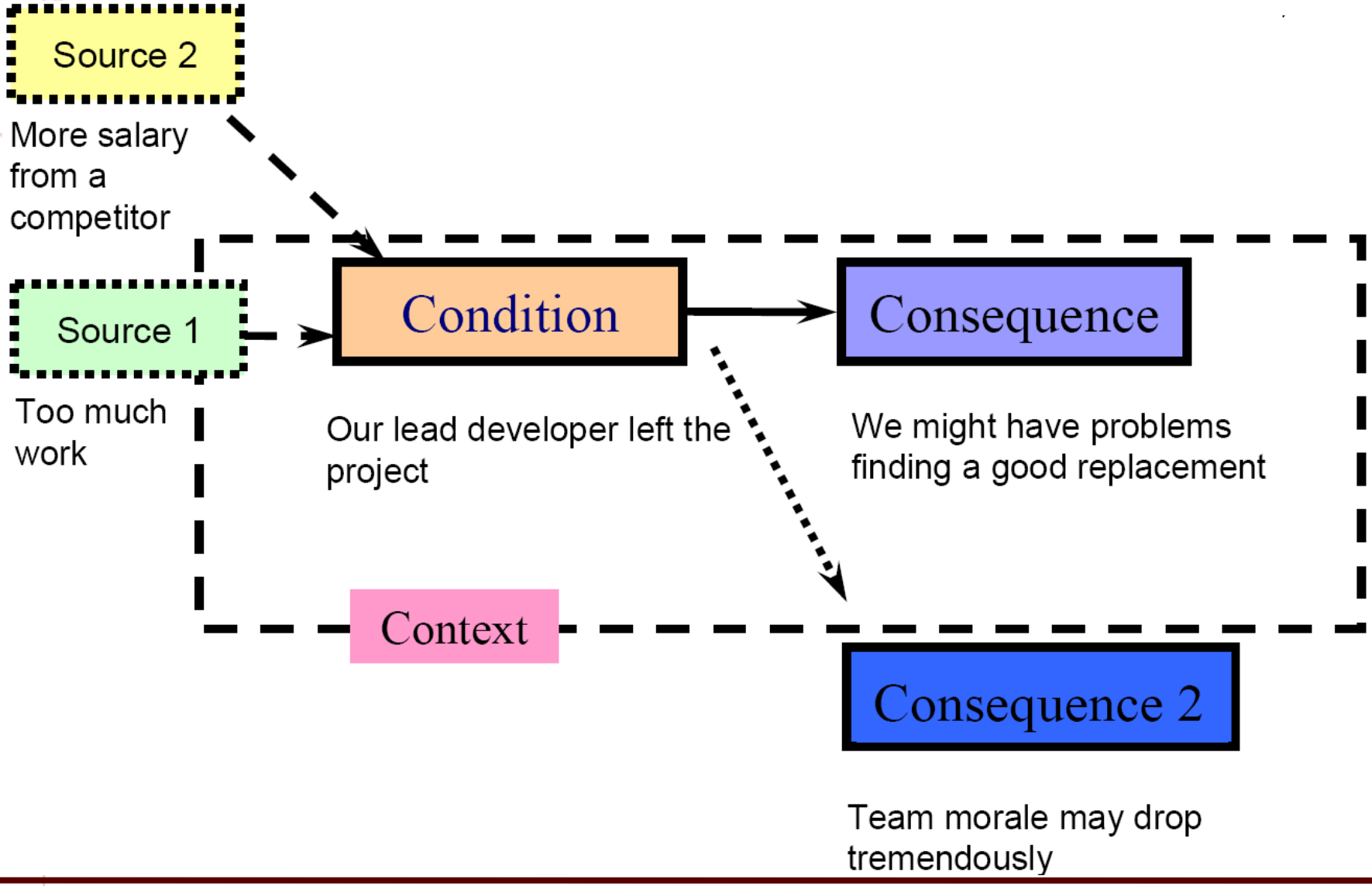
Barry Boehm, IEEE Software January, 1991

Top 10 Risk Items: 1989 vs. 1995

1989	1995
1. Personnel shortfalls	1. Personnel shortfalls
2. Schedules and budgets	2. Schedules, budgets, process
3. Wrong software functions	3. COTS, external components
4. Wrong user interface	4. Requirements mismatch
5. Gold plating	5. User interface mismatch
6. Requirements changes	6. Architecture, performance, quality
7. Externally-furnished components	7. Requirements changes
8. Externally-performed tasks	8. Legacy software
9. Real-time performance	9. Externally-performed tasks
10. Straining computer science	10. Straining computer science



Risk Context & Source(s)



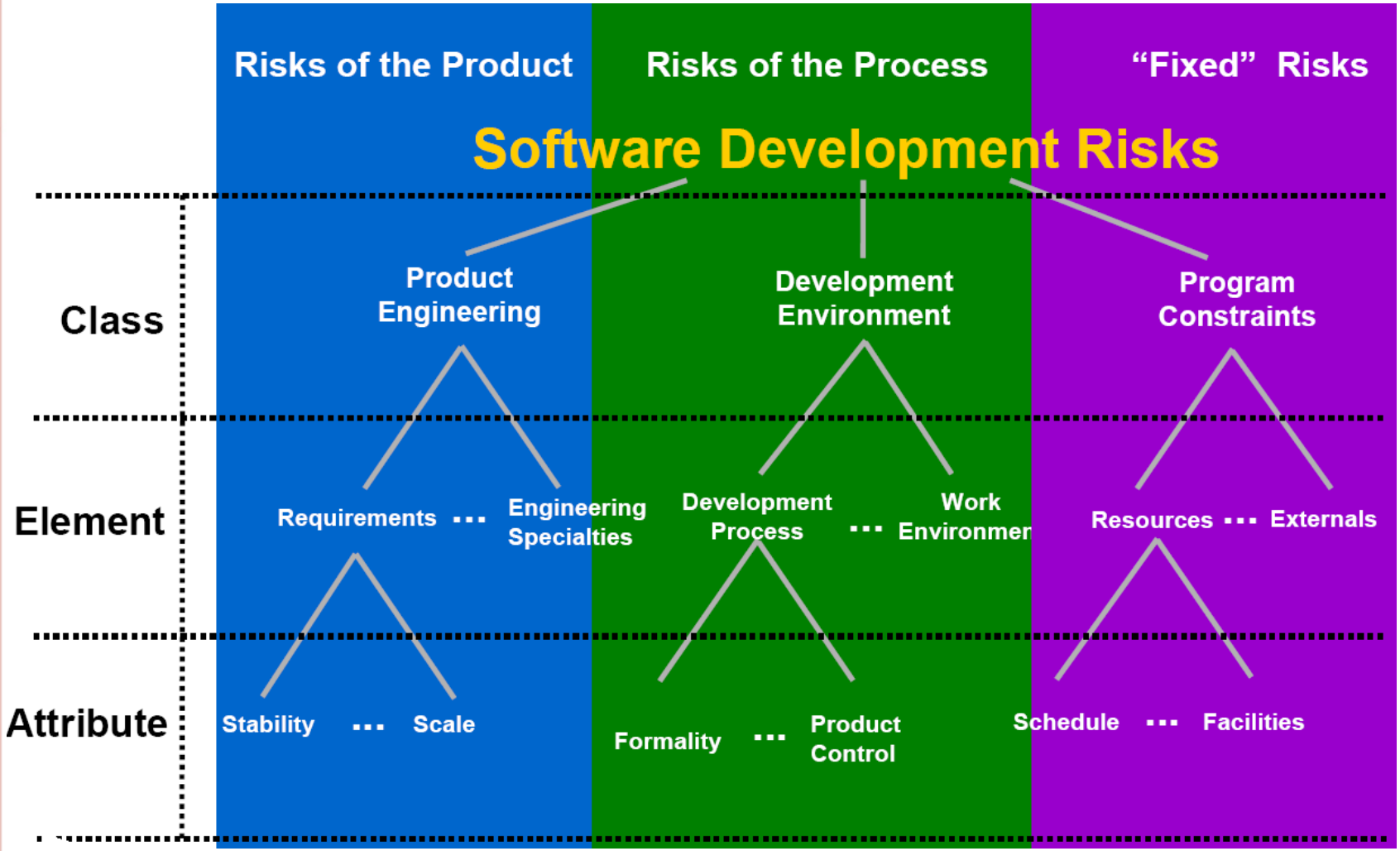
Taxonomy-Based Questionnaire (TBQ)

- Questionnaire organized according to the taxonomy of software development for the purpose of identifying risks by interviewing a group of one or more individuals in a structured brainstorming

- TBQ can be tailored or expanded to meet additional needs

CMU/SEI-93-TR-006 : "Taxonomy-Based Risk Identification"

S/W Development Risk Taxonomy



Example: TBQ Questions

Class: A. Product Engineering

Element: 2. Design

Attribute: d. Performance

[Are there stringent response time or throughput requirements?]

Starter: [22] Are there any problems with performance?

Cues:
- throughput
- scheduling asynchronous real-time events
- real-time response
- recovery timelines
- response time
- database response, contention, or access

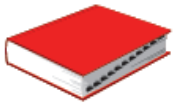
Starter: [23] Has a performance analysis been done?

Follow-up:
(Yes) [23.a] What is your confidence in the performance analysis?

(Yes) [23.b] Do you have a model to track performance through design and implementations?

Risk Analysis and Prioritization

Statements of Risk
Condition
Consequence
Context



List of Risks

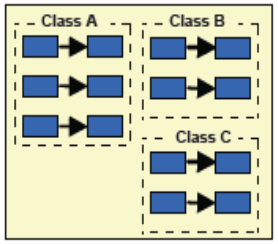
Analyze & Prioritize Risks

- Evaluate
- Classify
- Prioritize

Statements of Risk
Condition
Consequence
Impact
Probability
Time Frame
Classification
Rank

Risk Classification

Risk Classification

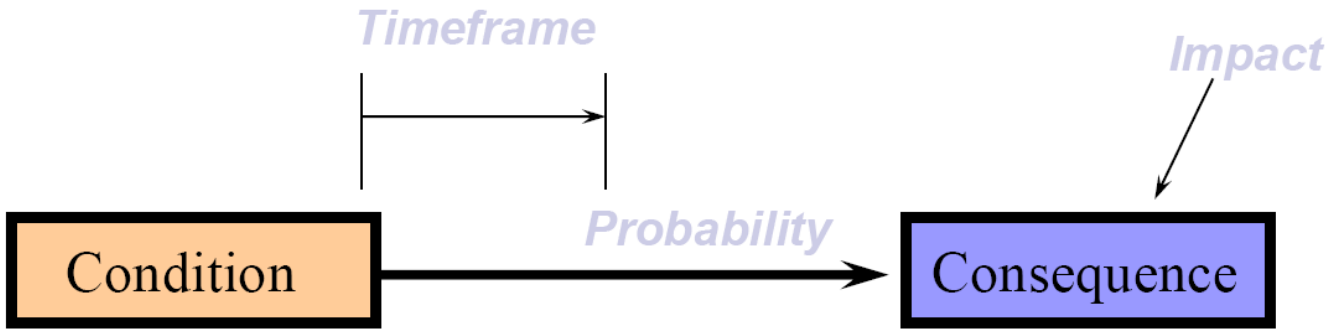


Top N Risk List

Risk Analysis

- Assess the loss of probability and loss magnitude for each identified risk item
- Assess compound risks in risk-item interactions
- Typical risk analysis techniques
  - Performance models
  - Cost models
  - Network analysis
  - Statistical decision analysis
  - Quality factor analysis (reliability, availability, security, etc.)

Risk Attributes



There is water on the hall floor; someone might slip in it and get hurt.

- Understand risk better by determining its probability, timeframe, and impact
  - Generate values for
    - Impact: The potential loss or the effect on the project if the risk occurs
    - Probability: The likelihood that the risk would occur
    - Timeframe: The period of time left until the risk should be addressed

Various Levels of Evaluation

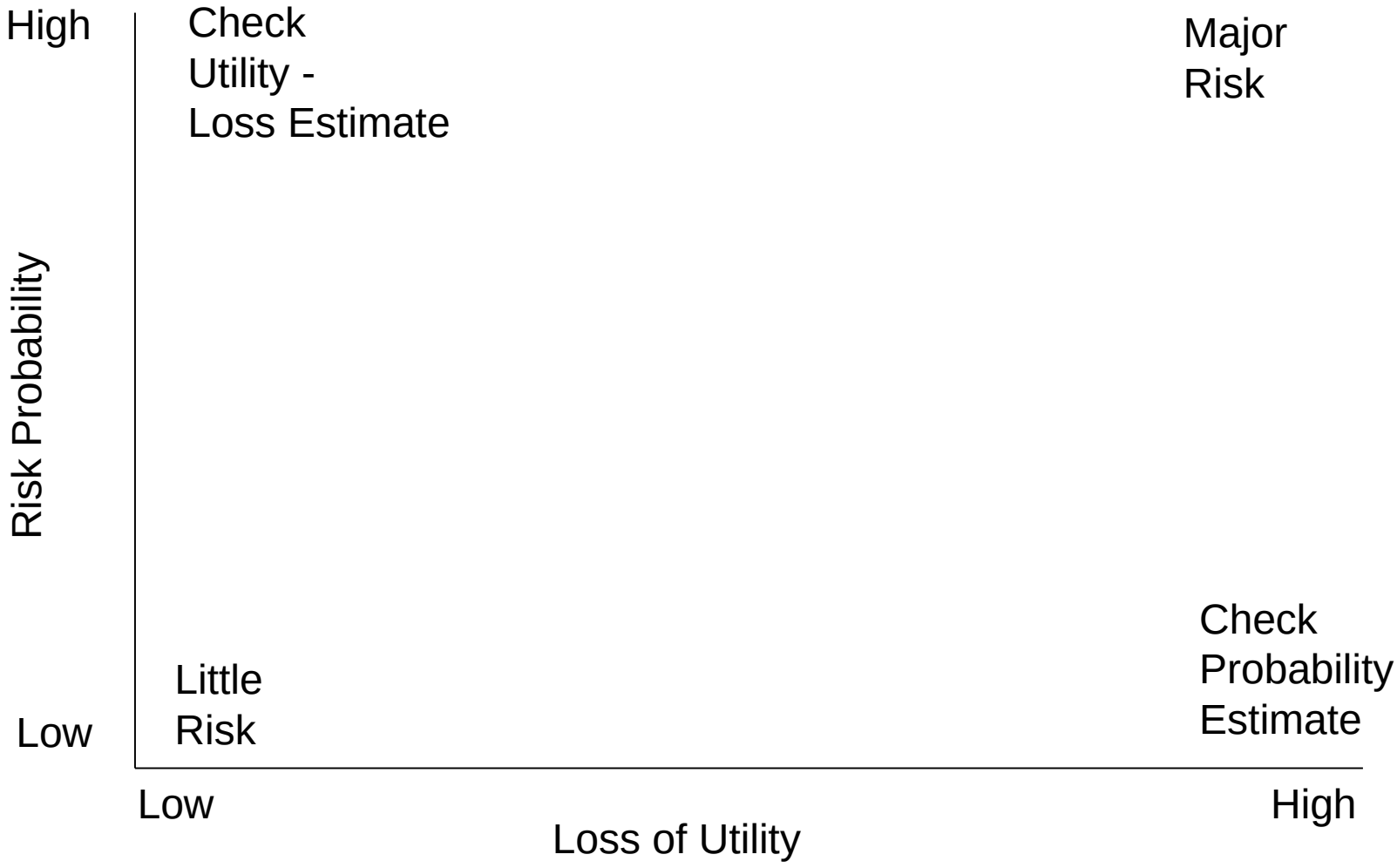
Level	Impact	Probability	Timeframe
Binary	Significant Insignificant	Likely Not likely	Significant Insignificant
3-Level	High Moderate Low	High Moderate Low	Near Mid Far
5-Level	Very High High Moderate Low Very Low	Very High High Moderate Low Very Low	Imminent Near Mid Far Very Far
N-Level	N- levels of impact	N- levels of probability	N- levels of timeframe

Possible Definitions

- Impact
  - Catastrophic
    - Schedule slip > 20%, Cost overrun > 25%
  - Critical
    - Schedule slip 10-20%, Cost overrun 10-25%
  - Marginal
    - Schedule slip 5-10%, Cost overrun 5-10%
- Probability
  - Very likely > 70%
  - Likely ~50%
  - Not likely < 30%
- Timeframe
  - Near term Within a month or so
  - Mid term Within three months or so
  - Long term Within six months or so

Risk Exposure

RE = P(L) * S(L)



Risk Exposure Matrix

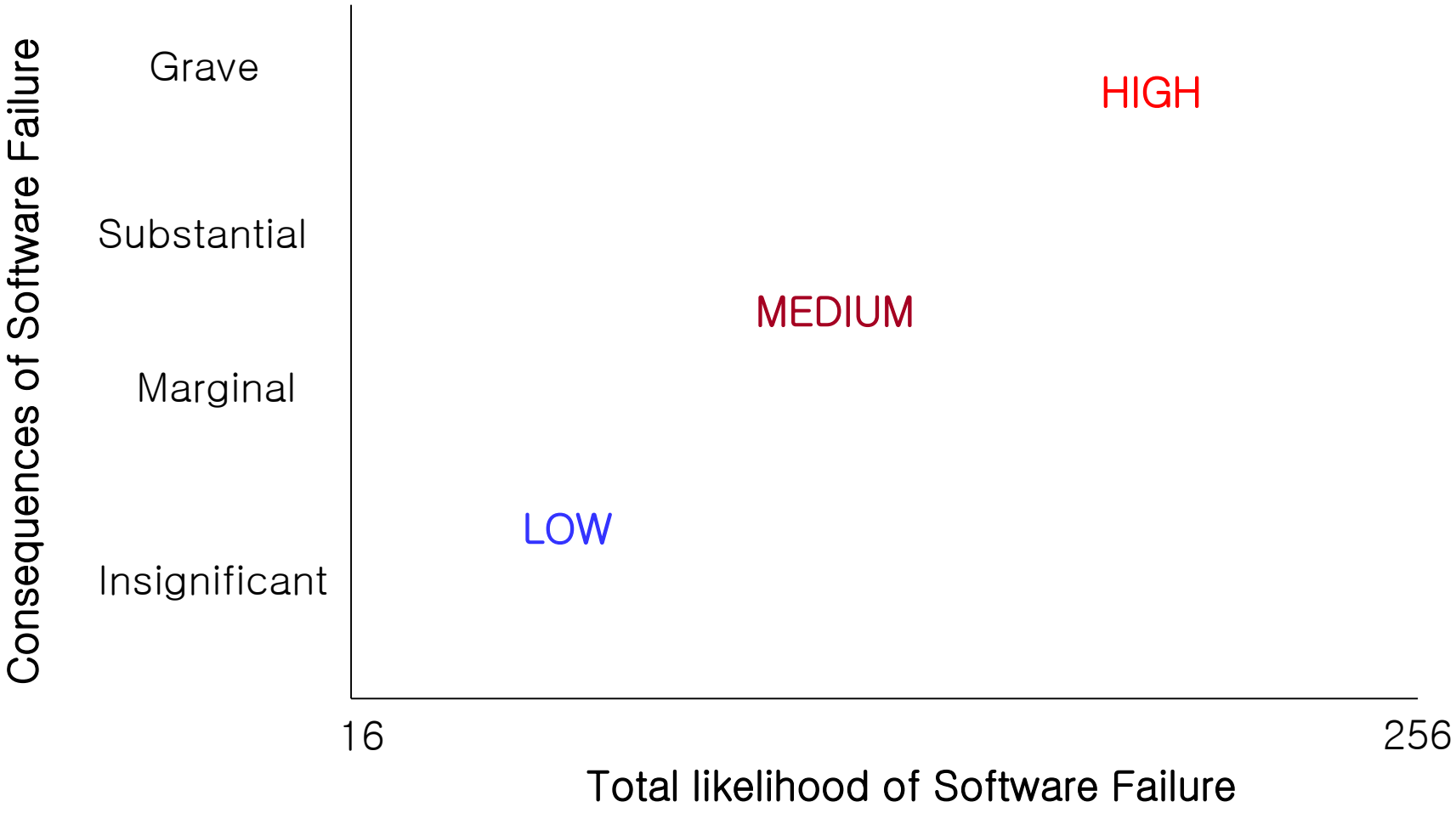
Probability

Impact

	Very High	High	Moderate	Low	Very Low
Catastrophic	High (9)	High (8)	High (7)	Med (6)	Med (5)
Critical	High (8)	High (7)	Med (6)	Med (5)	Med (4)
Moderate	High (7)	Med (6)	Med (5)	Med (4)	Low (3)
Marginal	Med (6)	Med	Med	Low (3)	Low (2)
Negligible	Med (5)	Med (4)	Low (3)	Low (2)	Low (1)

Air force Systems command/logistics command Pamphlet 800-45, 1988

Risk Prioritization: NASA NPD 2820



Risk Prioritization

- Produce a ranked ordering of the identified and analyzed risk items
  - Figure out which risks are most important
  - Establish which risks should be dealt with first
- Typical risk prioritization techniques
  - Risk exposure analysis
  - Risk reduction leverage analysis (Cost-Benefit analysis)
  - Pareto Top N risks
  - Delphi or Group consensus (Multivoting) techniques

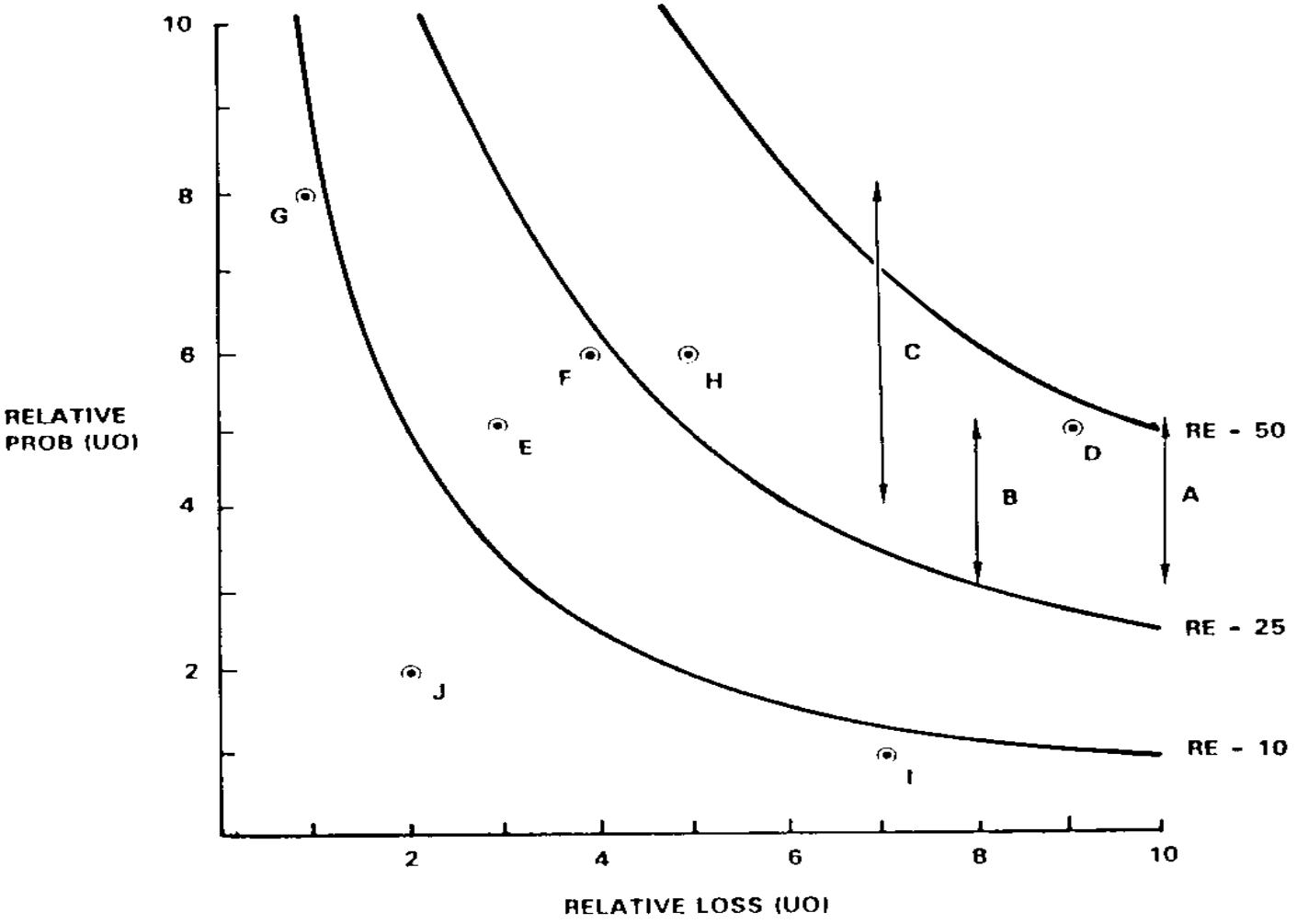
Risk Exposure Factors

(Satellite Experiment Software)

Unsatisfactory Outcome (UO)	Prob (UO)	Loss (UO)	Risk Exposure
A. S/ W error kills experiment	3 - 5	10	30 - 50
B. S/ W error loses key data	3 - 5	8	24 - 40
C. Fault tolerance features cause unacceptable performance	4 - 8	7	28 - 56
D. Monitoring software reports unsafe condition as safe	5	9	45
E. Monitoring software reports safe condition as unsafe	5	3	15
F. Hardware delay causes schedule overrun	6	4	24
G. Data reduction software errors cause extra work	8	1	8
H. Poor user interface causes inefficient operation	6	5	30
I. Processor memory insufficient	1	7	7
J. DBMS software loses derived data	2	2	4

Risk Exposure Factors and Contours

Satellite Experiment Software



Risk Reduction Leverage (RRL)

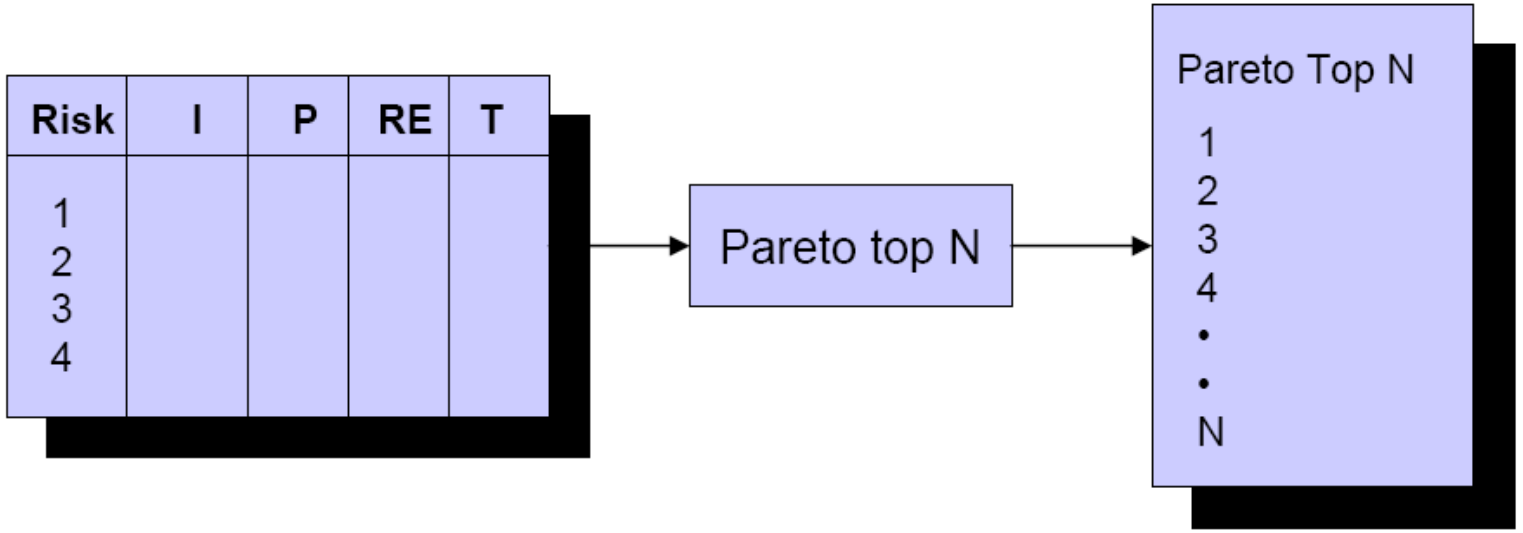
$$RRL = \frac{RE_{BEFORE} - RE_{AFTER}}{\text{RISK REDUCTION COST}}$$

· Spacecraft Example

	LONG DURATION TEST	FAILURE MODE TESTS
LOSS (UO) PROB (UO) $_B$ RE_B	\$20M 0.2 \$4M	\$20M 0.2 \$4M
PROB (UO) $_A$ RE_A	0.05 \$1M	0.07 \$1.4M
COST	\$2M	\$0.26M
RRL	$\frac{4-1}{2} = 1.5$	$\frac{4-1.4}{0.26} = 10$

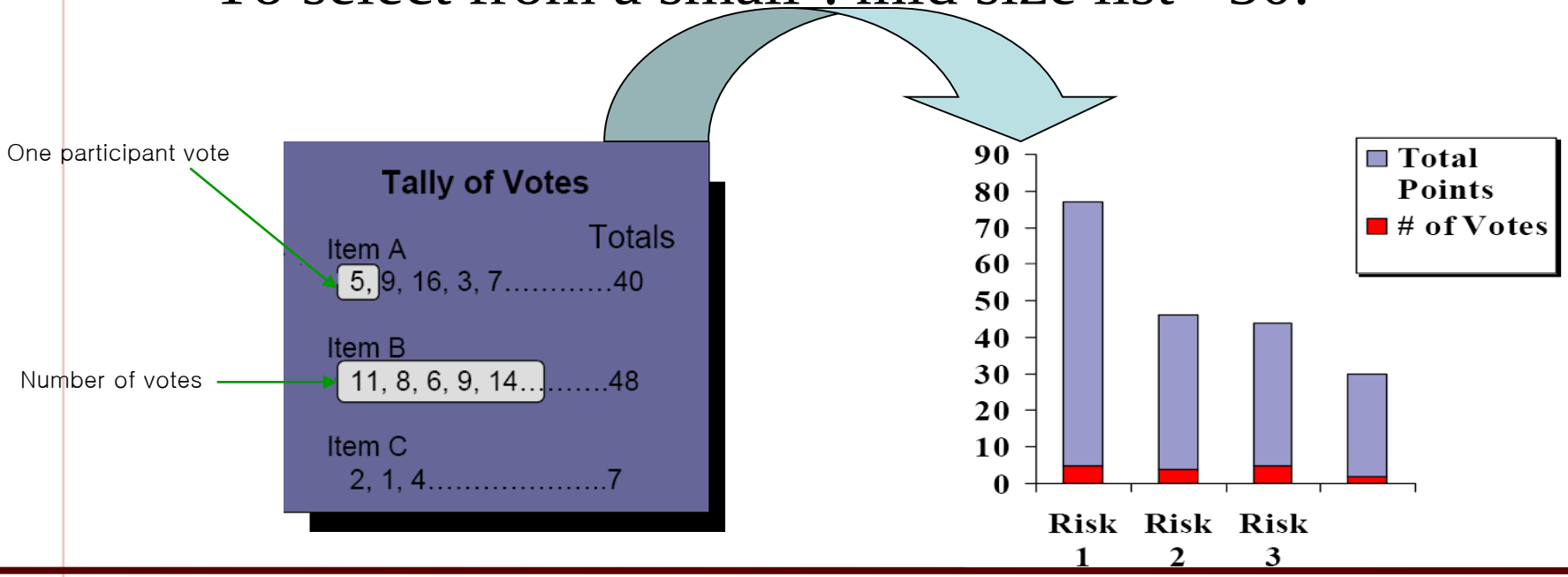
Risk Prioritization: Pareto Top N

- Calculate Risk Exposure
- Rank all the risks
- Decide on a cut-off mark
- Easy, Straightforward, Not resource intensive method



Risk Prioritization: Multivoting

- Quick, Straightforward, Easy-to-use method
- When to use:
  - When facing a group decision.
  - To select the most. important risks from a list.
  - To select from a small-. mid size list <50.



Risk Management Planning

- **Help you prepare to address each risk item**
  - Buying information, risk avoidance, risk transfer, risk reduction
  - Includes the coordination of the individual risk-item plans with each other and with overall project plan

- **Typical Risk Mgmt. techniques**
  - Checklist of risk-resolution techniques
  - Cost-benefit analysis
  - Standard risk management plan outlines, forms, and elements

- **For Each Risk Item, Answer the Following Questions:**

1. **Why?**
   Risk Item Importance, Relation to Project Objectives
2. **What, When?**
   Risk Resolution Deliverables, Milestones, Activity Nets
3. **Who, Where?**
   Responsibilities, Organization
4. **How?**
   Approach (Prototypes, Surveys, Models, …)
5. **How Much?**
   Resources (Budget, Schedule, Key Personnel)

Risk Resolution (Mitigation)

- Produces a situation in which the risk items are eliminated or otherwise resolved
  - e.g.: Risk avoidance via relaxation of requirement

- Typical Risk Resolution Techniques
  - Prototypes, Simulation, Benchmarks, Mission Analyses, Key-personnel agreements, design-to-cost approaches, and incremental development

Risk Monitoring

- Involves the followings:
  - Tracking the project's progress toward its resolving risk items
  - Taking corrective action where appropriate

- Typical Risk Monitoring Techniques
  - Milestone Tracking
    - Monitoring of risk Management Plan Milestones
  - Top-10 Risk Item Tracking
    - Identify Top-10 risk items
    - Highlight these in monthly project reviews
    - Focus on new entries, slow-progress items
      Focus review on manger-priority items
  - Risk Reassessment
  - Corrective Action

What Risk Management is not?

- Silver Bullet

- A way to solve project management problems with respect to:
  - Budget
  - Planning
  - Scheduling
  - Passive
  - A one time deal

Risk Management is:

- Ongoing (Continuous)
- A Team sports
- The key is to identify the right risks
- You get better at it over time but you have to start
- Start Now, start early in your project as your risks will not go away if you ignore them

Key Contributions of Risk Mgmt.

- Create focus on critical success factors in the process
- Provide techniques that let the project deal with the critical success factors
- Provides some of skills, an emphasis on getting good people, and a good conceptual framework for sharpening judgments

- But, Risk Mgmt. : Not a cookbook approach
  - Great Measure of human judgment is required to handle all the complex people oriented and technology-driven success factors in projects

http://www.softwaretechnews.com/technews2-2/cartoon.html

Q & A