Software Engineering Economics (CS656)

Risk Management – II

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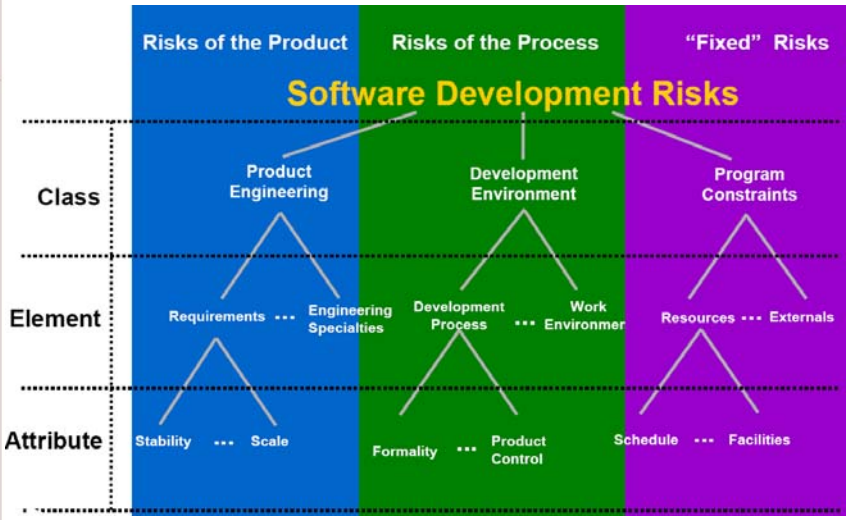
Taxonomy-Based Questionnaire (TBQ)

- 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?

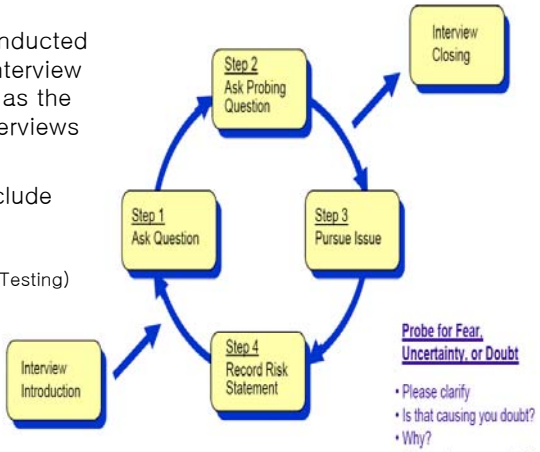
Cues
- throughput
- scheduling asynchronous real-time events
- real-time response
- recovery timelines
- response time
- database response, contention, or access

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?

TBQ Interview & Protocol

- The TBQ interview is conducted by a trained facilitator/interview team and uses the TBQ as the basis for conducting interviews
- Peer groups typically include
  - S/W engineers
  - Technical manages
  - Support groups (CM, QA, Testing)
  - Project manager



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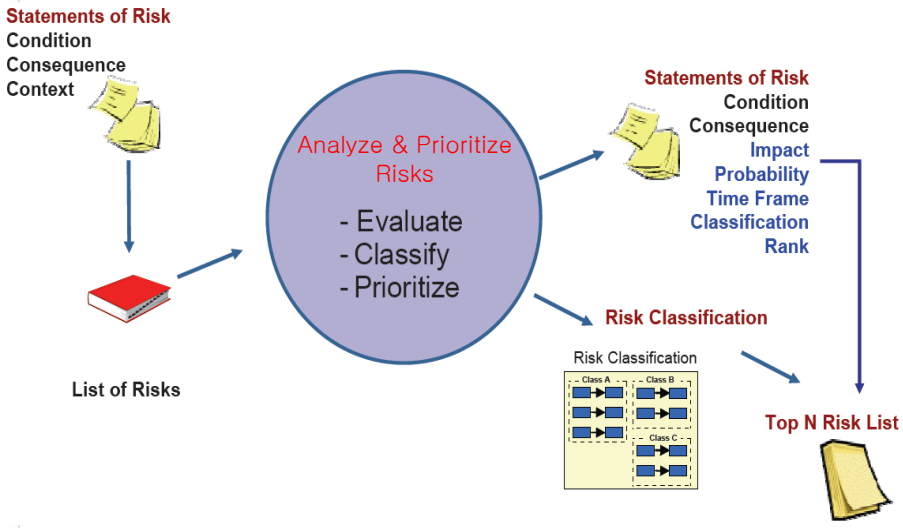
Risk Analysis and Prioritization



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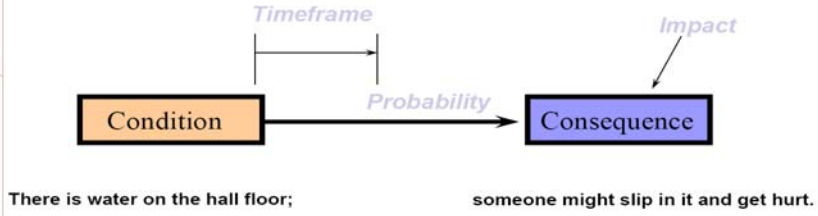
Risk Analysis

- 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



- 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

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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

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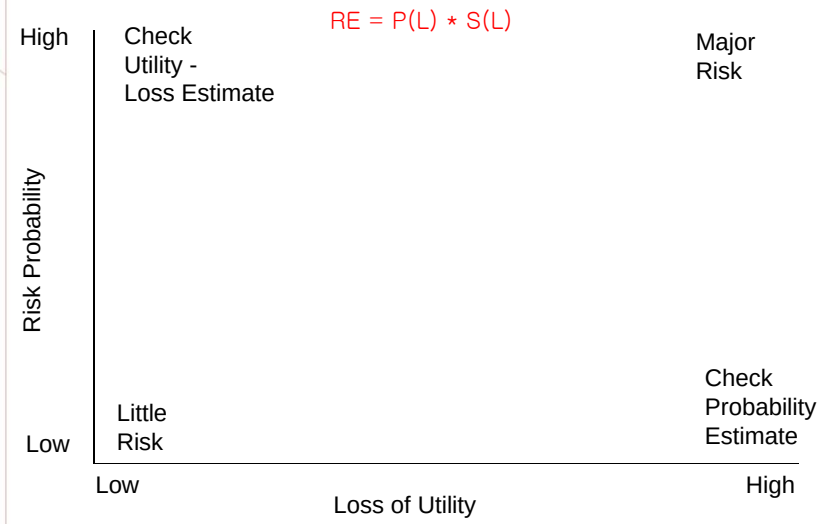
Risk Exposure



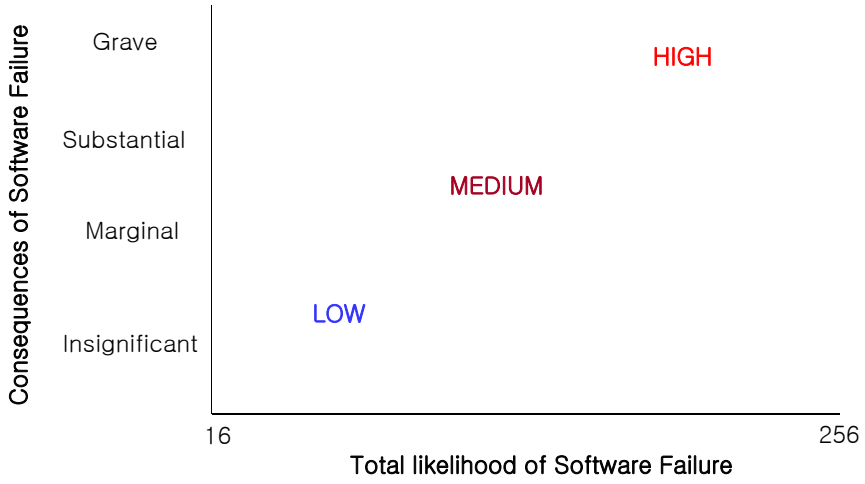
Risk Exposure Matrix

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



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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

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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

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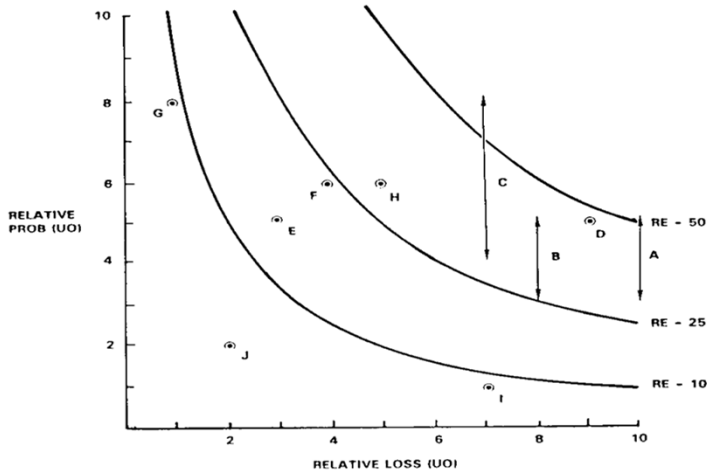
Risk Exposure Factors and Contours

Satellite Experiment Software



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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	$\frac{4-1}{2} = 1.5$	$\frac{4-1.4}{0.26} = 10$

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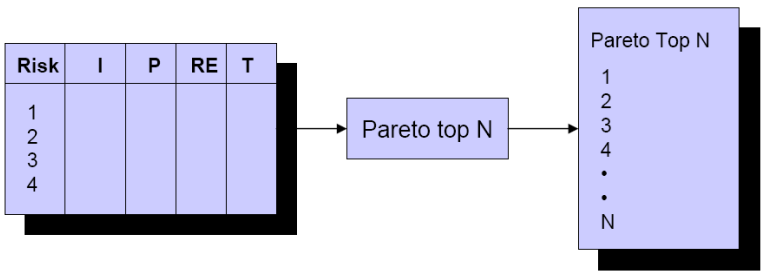
Risk Prioritization: Pareto Top N Risks

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



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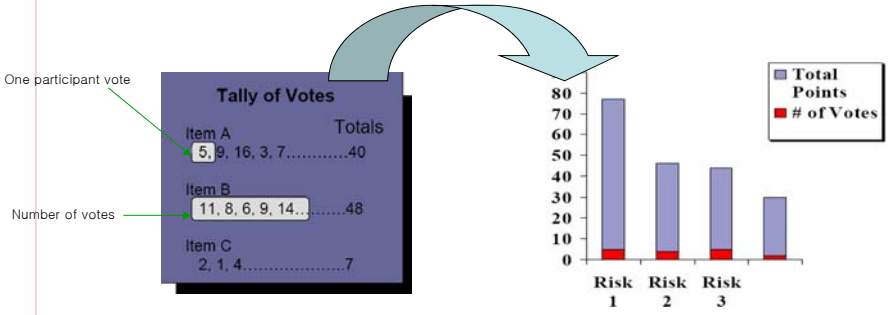
Risk Prioritization: Multivoting

- 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

Project Top 10 Risk Item List

- Satellite Experiment Software

Risk Item	Mo. Ranking This	Last	#Mo.	Risk Resolution Progress
Replacing Sensor-Control Software Developer	1	4	2	Top Replacement Candidate Unavailable
Target Hardware Delivery Delays	2	5	2	Procurement Procedural Delays
Sensor Data Formats Undefined	3	3	3	Action Items to Software, Sensor Teams; Due Next Month
Staffing of Design V&V Team	4	2	3	Key Reviewers Committed; Need Fault-Tolerance Reviewer
Software Fault-Tolerance May Compromise Performance	5	1	3	Fault Tolerance Prototype Successful
Accommodate Changes in Data Bus Design	6	-	1	Meeting Scheduled With Data Bus Designers
Testbed Interface Definitions	7	8	3	Some Delays in Action Items; Review Meeting Scheduled
User Interface Uncertainties	8	6	3	User Interface Prototype Successful
TBDs In Experiment Operational Concept	-	7	3	TBDs Resolved
Uncertainties In Reusable Monitoring Software	-	9	3	Required Design Changes Small, Successfully Made

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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

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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

Software FMEA

- FMEA (Failure Mode & Effect Analysis)
  - A powerful pro-active engineering quality method (one of Six Sigma tools)
  - identify and counter weak points in the early conception phase of products and processes
  - benefits obtained encompass by large the investments in time and resources to execute the analysis
- FMEA Types
  - System - focuses on global system functions
  - Design - focuses on components and subsystems
  - Process - focuses on manufacturing and assembly processes
  - Service - focuses on service functions
  - Software - focuses on software functions

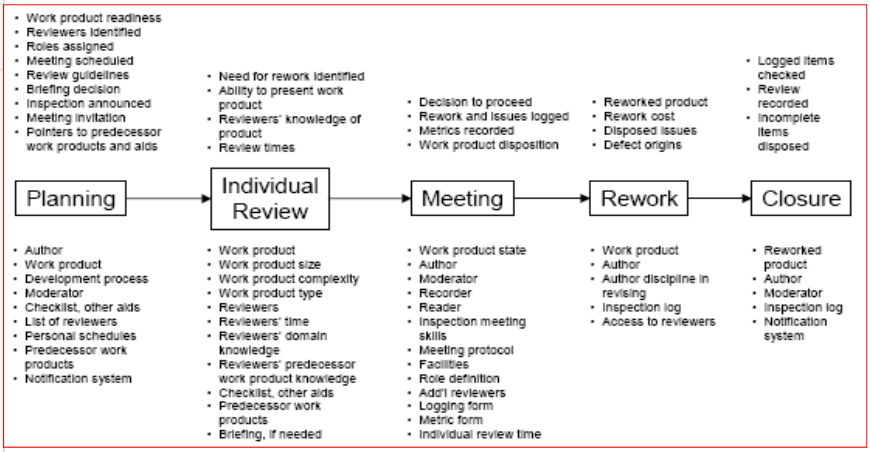
Benefits of FMEA

- Improve product/process reliability and quality
- Increase customer satisfaction
- Early identification and elimination of potential product/process failure modes
- Prioritize product/process deficiencies
- Capture engineering/organization knowledge
- Emphasizes problem prevention
- Documents risk and actions taken to reduce risk
- Provide focus for improved testing and development
- Minimizes late changes and associated cost
- Catalyst for teamwork and idea exchange between functions

When to Apply S/W FMEA?

- A new product or process is being initiated (at the beginning of the cycle).
- Changes are made to the operating conditions the product or process is expected to function in.
- A change is made to either the product or process design. The product and process are inter-related. When the product design is changed the process is impacted and vice-versa.
- New regulations are instituted.
- Customer feedback indicates problems in the product or process.

Example: Software Inspection Process



http://www.sei.cmu.edu/sema/pdf/sdc/houston.pdf

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Example: Software FMEA (Risk Assessment)

Process Step	Potential Failure Mode	Failure Mode Effects	SEV	Causes	OCC	Current Controls	DET	RPN
What is the process step being studied?	How might this step fail to produce the required outputs?	What are the effects on the customer of failing to meet the requirement?		What are the causes of the failure mode?		What existing control(s) either (1) detects the cause (allowing for corrective action), or (2) detects the failure mode before the effect occurs?		
Individual Review	Inadequate reviews, defects not found	Needed rework not identified	10	Work product too large	8	Requires guidance from industry or local experience. None.	10	800
Meeting	Meeting occurs without sufficient preparation	Needed rework not identified; meeting time wasted	10	Moderator decides incorrectly to hold meeting	8	None	10	800

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Example: Software FMEA (Risk Control)

Actions Recommended	PSEV	POCC	PDET	PRPN	Delta RPN
What actions can be taken to reduce the occurrence of the cause and failure mode, or to improve detection? (Enter only for high RPNs.)	Predicted severity of effect after action?	Predicted occurrence of cause *and* the failure mode after action?	Predicted effectiveness of new controls?	Predicted RPN	RPN - Predicted RPN
Establish review rate guidelines and train moderators to use them.	10	1	2	20	780
Establish guidelines for holding inspection meeting and train moderators to use them.	10	2	2	40	760

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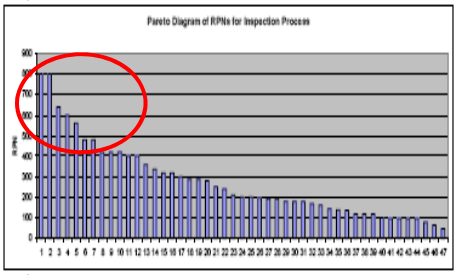
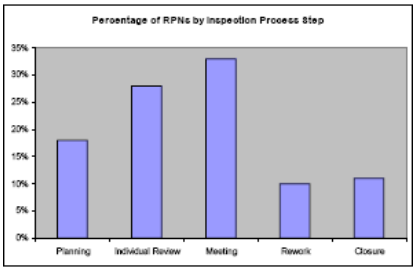
Example: Software FMEA (Risk Profile)

- 47 risks are identified
- Focus on High RPN risks (20%)
  - Based on constraints of resources
- Highest percentage of RPN: Meeting





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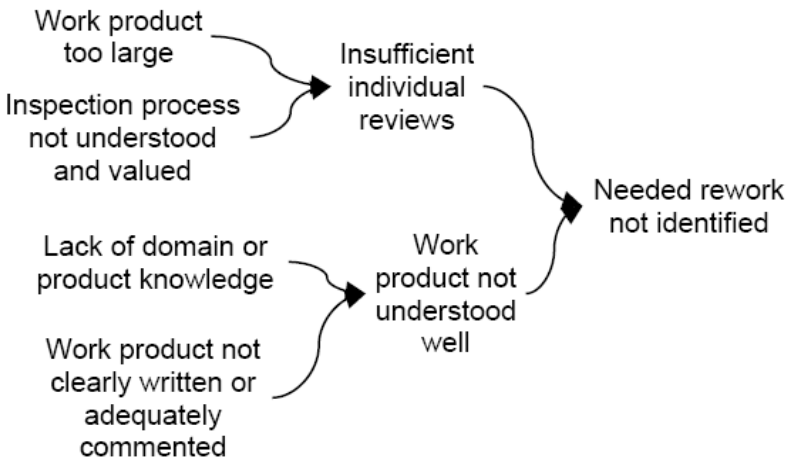
Causal Relation of Top 5 Risks (RPN > 500)



Risk Reduction by Moderator Training

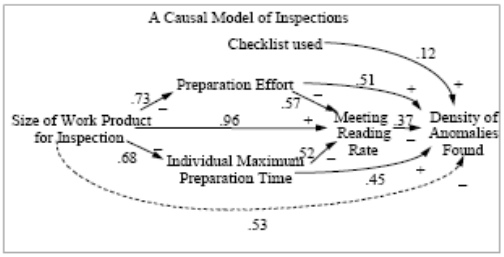
- Total Risk can be reduced by 50% via effective training of moderators

Moderator Role In Software Inspection Process

Planning	Work product sizing and readiness for inspection Designating reviewers and roles (process and content) Decision to hold a briefing Provide rate guidelines and checklist
Individual review	
Meeting	Identifying insufficient preparation Keeping meeting focused Controlling meeting pace Monitoring recording for accuracy Decision about re-review
Rework	
Closure	Ensure all items disposed, required rework performed and checked, root causes identified, metrics recorded

Other Risks & Recommendations

- Inadequate Review, little or no rework found due to review rate
  - Gather data on product size, review rate, and influence on inspection results
  - Develop guidelines based on data
  - Train reviewers in use of guidelines for product sizing and review rate



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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

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

Q & A