Risk Management & Problem Solving

SEAPOWER THROUGH ENGINEERING

3.3.6

TOPIC LEARNING OBJECTIVES

Upon successful completion of this topic, the student will be able to:

1. Identify the definition and components of acquisition risk.

2. Identify typical sources of acquisition risk.

3. Relate the Acquisition Program Baseline (APB) to planning, control, and risk management in attaining cost, schedule and performance goals.

4. Identify the five steps (identifying, analyzing, planning, handling, and monitoring) of the risk management process model.

5. Recognize methods for risk handling (Control, Avoid, Accept, Transfer).

6. Recognize that the trade-off study process is used to evaluate alternatives.

7. Given data, apply Multi-Attribute Utility Theory (MAUT) and other qualitative/quantitative tools to support a decision.

8. Explain the use of the 5 Whys root cause determination method in identifying potential root causes.

9. Identify a generic problem-solving model appropriate for a specific acquisition situation.

10. Given sample risk management software tools, compare their features to determine their advantages and disadvantages.

STUDENT PREPARATION

Student Support Material

1. The 5 Whys – Lean Problem Solving - https://www.youtube.com/watch?v=SrlYkx41wEE (3:20)

2. Weighted Scoring Model: https://www.youtube.com/watch?v=FefJ1paq750 (5:56)

3. Multiple Criteria Decision Analysis: https://www.youtube.com/watch?v=7OoKJHvsUbo

Primary References

1. DoD 5000 series

2. DoD Risk, Issue and Opportunity Management Guide for Defense Acquisition Programs

Additional References

1. None

Overview

- **Risk Management**
  - **Introduction**
  - Risk Management Model
  - Opportunity Management
  - Issue Management

- Problem Solving
  - Introduction
  - Cause & Effect Diagrams
  - The 5 Whys
  - Multi-Voting
  - Multi-Attribute Utility Theory (MAUT)

What is Acquisition Risk?

- Risk Management is the identification, evaluation, and prioritization of risks (i.e., effect of uncertainty on objectives) followed by the application of resources to minimize, monitor, and control the probability or impact of unfortunate events
  - Risk Management is used in all industries (e.g., finance, health care, defense, etc.) as a management decision tool
  - Numerous companies provide tailored risk management services and tools, including software, to industry and Government to assist decision makers
- Risk Management is an integral part of program management and systems engineering
- Risks are future events or conditions that may have a negative effect on achieving program objectives for cost, schedule, and performance. Risks are defined by:
  1. The *probability* (greater than 0 but less than 1) of an undesired event or condition; and
  2. The *consequences* (also called impact, or severity) of the undesired event, were it to occur
  3. The *root cause* of the event or condition
- Acquisition risk is a measure of the inability to achieve program objectives within defined constraints
- Successful acquisition management is more likely when cost, schedule, and performance risk factors are assessed, addressed, and actively managed

General Sources of Acquisition Risk

- **External risk**
  - Threat and Requirement
    - Warfighter
  - Funding
    - Bill payer
  - Contractor
    - Expertise, workload stability
  - Politics

- **Internal risk**
  - Technology
  - Design and Engineering
  - Manufacturing
  - Support/Logistics
  - Cost and Schedule
  - Management

2

APB and Risk Management

- **Acquisition Program Baseline (APB)**
  - An agreement between the Program Manager (PM) and the Milestone Decision Authority (MDA) that documents the program cost, schedule, and performance baselines
  - Shall include sufficient parameters to describe cost, schedule, performance thresholds and objectives

- **Risk management allows for identification of sources of risk**
  - Potential risk events that flow from future root causes
  - These risk events threaten cost, schedule, and performance objectives
  - APB is used to plan, control, and manage risk to attain cost, schedule, and performance goals
  - ***In relation to risk management, the APB provides a baseline from which to manage risk***

Effective Risk Management requires a stable and recognized baseline from which to assess, mitigate, and manage risk

3

APB and Risk Management, cont.

- Risk management needs to be both ***top-down*** (embraced by the PM and others) and ***bottom-up*** (from working-level engineers) to be successful
- Typical ground rules for risk management relevant to programs include:
  - Time frame: Current probability and impact estimates are based upon the status of the item or event as assessed, not upon projected or planned activities
  - Time of risk event: To properly analyze a risk, the time at which the risk hypothetically will occur should be considered and documented, as occurrence or realization timing is most likely a primary factor in the impact
  - Work Breakdown Structure (WBS) level: Hardware and software risk events should be identified to the lowest level possible to facilitate identification of causal factors and handling strategies
- Risks associated with an event should be characterized in terms of ***probability and consequence***

Consider these ground rules as you develop your ICS presentations

3

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Risk Planning

- Answers the question
    - ***What is the program approach for addressing potential unfavorable consequences***?
- Required to summarize the risk management approach in the Systems Engineering Plan (SEP) and Acquisition Strategy (AcqStrat)
- Some programs document plans in a combined Risk, Issue and Opportunity (RIO) Management Plan, or a Risk and Opportunity Management Board (ROMB)
- When planning for risk management:
    - Assign roles, responsibilities, and authorities
    - Select and document an overall approach to identify, analyze, handle and monitor risks across the program
    - Establish traceability of risk to technical requirements and overall program objectives
    - Align Government and Contractor roles, responsibilities, tools, and information exchange
    - Determine risk management resources
    - Determine risk management battle rhythm

4

Risk Management Model

- The risk management model is identified in the DoD Risk, Issue and Opportunity (RIO) Management Guide for Defense Acquisition Programs
- Process has five activities performed on a continuous basis: Risk Planning, Risk Identification, Risk Analysis, Risk Mitigation/Correction, Risk Monitoring

Process Planning
What are the program's risk and issue management processes?

Identification
What has, can, or will go wrong?

Communication and Feedback

Monitoring
How has the risk or issue changed?

Analysis
What is the likelihood of the risk and the consequence of the risk or issue?

Mitigation / Correction
What, if anything, will be done about the risk or issue?

4

Risk Identification

- By looking across the program, answers the question
  - ***What can go wrong?***
  - Examines each element of the program to identify risks and their associated root causes, begins documentation, and sets the stage for successful RM
    - Current and proposed staffing
    - Resources and dependencies
    - Test results, especially test failures
    - Potential shortfalls against expectations
    - Negative data trends
- Begins as early as possible and continues throughout the program including, but not limited to, regular reviews and analysis of:
  - Technical Performance Measure (TPM)
  - Life-cycle cost information
  - Work Breakdown Structures (WBS)
  - Integrated Master Schedules (IMS)
  - Earned Value Management (EVM)
  - Technical baseline maturity

4

Where is the Risk?

Risk Factor Examples

Factor	Risks
Cost	Risks that could impact program costs include: • Increases in material prices • Higher-than-anticipated labor rates • Other factors that can change current program cost estimates
Schedule	Risks that could impact program schedule include: • Late deliveries • Political pressure • Changing capability needs (user needs the system sooner or user adds new capability needs)
Performance	Risks that could impact technical performance include: • Use of new or exotic materials or processes • Use of unproven technology • Use of new applications to meet demanding user needs

- Risk can be associated with all aspects of a program (e.g., threat, technology maturity, supplier capability, design maturation, performance, etc.); risk addresses potential variation in the planned approach and the expected outcome

Risk Analysis

- Answers the question
  - ***How big is the risk?***
    - Considering the probability of the root cause occurrence
    - Identifying the possible consequences in terms of performance, schedule, and cost
    - Identifying the risk level using the Risk Reporting Matrix

- Isolate the root cause of risk
  - Repeatedly ask "Why will this happen?"
    - Until you reach the root cause of failure

- Determine the impact of risk
  - Qualitative based upon judgment
  - Quantitative measures of probability and impact
  - Determine metrics to classify high, medium, and low risks

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Risk Reporting Matrix
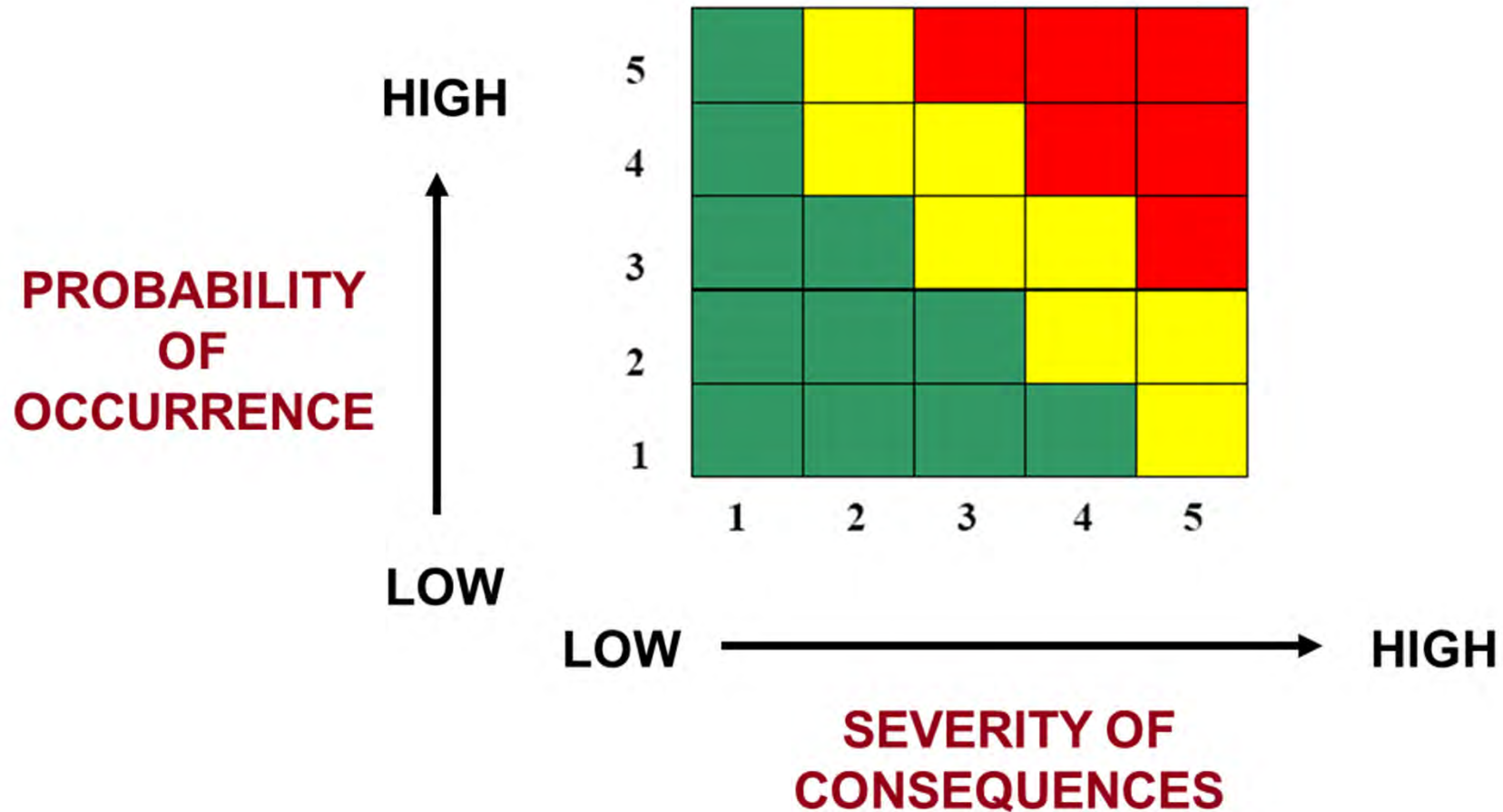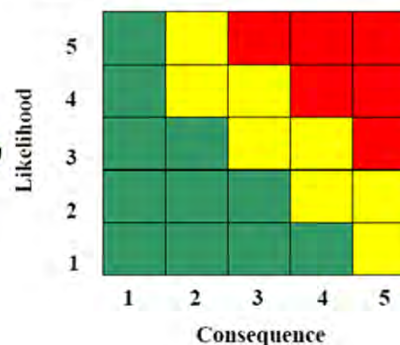
Program Risk Reporting Matrix Example

Questions about Risk Management?

Call a Member of the Process Integration Team for Risk.

LIKELIHOOD:

Level	What Is The Likelihood The Risk Will Happen?	
1	<5%	Remote
2	<15%	Unlikely
3	<85%	Likely
4	<95%	Highly Likely
5	>=95%	Near Certainty

ASSESSMENT GUIDE

Likelihood (vertical axis) 1–5; Consequence (horizontal axis) 1–5

RISK ASSESSMENT

HIGH - Unacceptable. Major disruption likely. Different approach required. Priority management attention required.

MODERATE - Some disruption. Different approach may be required. Additional management attention may be needed.

LOW - Minimum impact. Minimum oversight needed to ensure risk remains low.

CONSEQUENCE:
Given The Risk is Realized, What is the Magnitude of the Impact?

Level	Technical	Schedule	Cost
1	Minimal or No Impact	Minimal or No Impact	Minimal or No Impact
2	Acceptable with Some Reduction in Margin	Additional Resources Required Able to Meet Need Dates	< 5%
3	Acceptable with Significant Reduction in Margin	Minor Slip in Key Milestone; Not Able to Meet Need Dates	5 - 7%
4	Acceptable, No Remaining Margin	Major Slip in Key Milestone or Critical Path Impacted	> 7 - 10%
5	Unacceptable	Can't Achieve Key Team or Major Program Milestone	> 10%

ICS!

Risk Mitigation Techniques

- Prototyping at the system, subsystem, or component level
- Modeling and simulation
- Technology demonstrations and decision points to discipline the insertion of planned technologies into programs or the selection of alternative technologies provide additional discussions of technical management activities
- Intelligence analyses, data dependencies, and threat projections
- Multiple design approaches
- Alternative designs, including designs that meet requirements but with reduced performance
- Phasing program activities or related technology development efforts to address high-risk areas early
- Manufacturability
- Industrial base availability and capabilities
- Analysis or detailed identification of sub-tiers in the prime contractor supply chain
- Independent risk assessments by outside subject matter experts
- Providing schedule and funding margins for identified risks

10

Risk Management Software Tools

- Software tools can provide program and project managers with formats and analysis tools to support their Risk Management programs

- Software tools may incorporate Risk Management standards that have been developed by various institutions, such as:
  - Project Management Institute
  - National Institute of Standards and Technology
  - International Standards Organization (ISO)

- Functionality provided by these tools may include:
  - Generation of risk register and cubes
  - Modeling and forecasting of outcomes
  - Monte Carlo simulation to provide probability of outcomes
  - MS Office compatible
  - Web-based access

Review Question

- Risk is comprised of which of the following 3 variables?

  1. Number of things that could go wrong, the probability of each, and budget available

  2. A future root cause, a likelihood or probability of that root cause occurring, and the consequence of that future occurrence

  3. Time, money, and personnel invested in the program

  4. Planning, organizing, and directing

Risk Handling

- Answers the question
  - ***What is the preplanned response to address the risk*?**
- Risk handling includes the specifics of **_what_** should be done, **_when_** it should be done, **_who_** is responsible, and the funding and/or resources required to "burn-down" the risk
  - Determines what planning, budget, requirements, and contractual changes are needed
  - Provides a coordination vehicle with management and other stakeholders
  - Directs the teams to execute the defined and approved risk mitigation plans
  - Outlines the risk reporting requirements for ongoing monitoring
  - Documents the change history

4

Handling Options

- **_Control_**: Reduce probability/impact of occurrence to an acceptable level
  - Pre-planned Product Improvement (P3I), reuse software, parallel design, dual path, test

- **_Avoid:_** Reducing or eliminating the risk event by taking another path
  - Redesign, eliminate requirement/reduce scope, extend schedule, use COTS/more expensive materials/processes that have been proven

- **_Accept:_** Continuing on the current program plan
  - Identify resources and/or schedule in response to consequences

- **_Transfer:_** Transferring the risk by reassigning the risk responsibility to another entity.
  - Warranties/Fixed Price contracts
  - Reallocate to a more capable area/department
  - Involve Tech Warrant Holder/WSERB/NOSSA
    - WSERB – Weapons Safety & Explosives Review Board
    - NOSSA – Naval Ordnance Safety and Security Activity

4 5

Review Question

- Select the Risk Mitigation option being described: Lowering the chance that the event will occur by conducting multiple tests

  1. Accepting the risk

  2. Avoiding the risk

  3. Transferring the risk

  4. Controlling the risk

Review Question

- The use of proven technologies in commercial and non-developmental items eliminates technical risk

    - True

    - False

Risk Monitoring

- Answers the question
  - ***How are the risk handling options going?***
- Includes:
  - Communicating risks to all affected stakeholders
  - Monitoring risk handling plans
  - Reviewing regular status updates and ***burn-down plans*** (utilize periodic IPT meetings & Integrated Baseline Reviews (IBRs))
  - Displaying risk management dynamics by tracking risk status within the Risk Reporting Matrix
  - Alerting management as to when risk mitigation plans should be implemented or adjusted
  - Sunk cost or savings opportunities
- Track & evaluate performance of risk areas against established metrics throughout the acquisition process
  - Assessed also via Milestone Decision Process

4

Risk Management Plan Terminology

- Concern: A new item that has been identified by any stakeholder, prior to submission to the Risk Management Working Group (RMWG) for consideration

- Candidate: A potential risk from one of two sources: a) a concern that the RMWG has accepted for further consideration and development, or b) a segment-level risk that the segment developer has elevated to the program level. During the analysis phase, candidates are analyzed and presented to the Enterprise Risk Management Board (ERMB) for disposition. Generally made up of command risk representatives

- Active: A risk managed according to a formal handling plan that augments the previous program baseline. Active risks are either in a planning sub-phase during handling plan development, or in a tracking sub-phase during handling plan execution and monitoring

Risk Management Plan Terminology

- **Watch:** A low level risk or concern that is monitored and re-evaluated periodically, but without a formal handling plan. If its risk level rises enough, it will be elevated to active status, and a formal handling plan will be developed to manage and track it

- **Retired:** A risk that is no longer tracked because a) the risk has been successfully reduced to an acceptable level; or b) the root cause is no longer present or relevant, so handling is no longer required

- **Rejected:** A risk candidate that has been eliminated from further consideration by either the RMWG or the ERMB, because the level of concern is too low to warrant handling and/or monitoring

- **Issue:** A previously active risk or other problem that has been "realized," meaning that its likelihood of occurrence is certain, and that its negative consequence has already occurred or is certain to do so in the future

Example: Risk Register

PMW 150 Risk Register as of 14 Nov 2014 (sorted)

Slide	Risk ID	Name	Status	Risk Area	Project	Orig. Exp	Pres Exp	Impact Date	Created Date
2	5508	Link 16 Incr 2: MIDS J BC2 Software Update	Accepted/Mitigate	S	Link 16 Network	12	16	02-09-15	05-30-14
3	5696	Chief of Naval Air Training (CNATRA) Data Center Migration	Accepted/Mitigate	T	NTCSS	16	16	07-15-15	08-14-14
4	5136	Link 16: MIDS LVT BU2 Core Suitability with MOS for CM/FR	Accepted/Mitigate	S	Link 16 Network	8	12	02-02-15	01-03-14
5	5225	Operational Test & Evaluation (OT&E) for Interim Solutions	Accepted/Mitigate	S	NTCSS	16	12	01-02-15	02-06-14
6	5222	In-Service Baseline Dependency with Aviation NTCSS OA Interim Solution Development	Accepted/Mitigate	T	NTCSS	12	8	01-15-15	02-06-14
7	5395	Link 16 Incr 2: JTIDS CM/FR HPA A4 Card Availability During Production	Accepted/Mitigate	T	Link 16 Network	8	8	01-02-18	04-06-14
8	5414	Link 16 Incr 2: RT DDPI Cards with FR Firmware availability to support Operational Test	Accepted/Mitigate	S	Link 16 Network	8	8	03-31-15	04-18-14
9	5663	Link 16 Network: MOS HPA Switch	Accepted/Mitigate	C	Link 16 Network	8	8	07-31-15	07-28-14
10	5788	CALI Contract: LCS RDDs	Accepted/Mitigate	S	C2P/CDLMS	6	6	07-30-15	09-30-14
Candidate Risks									
12	5862	Link 16: JTIDS LLD BIT Test Performance	Candidate	S	Link 16 Network	12	12	02-16-15	10-31-14
13	5405	MFOM Contract Re-compete Award	Candidate	S	MFOM	10	10	12-01-14	04-11-14
Issues									
15	4642	MFOM COOP Site at Charleston	Issue	T	MFOM	12	12	07-31-14	04-29-13
16	5789	LCS C2P V(7) Legacy Configuration	Issue	S	C2P/CDLMS	10	5	09-30-14	09-30-14
17	5581	LMMT MDA Testing	Issue	S	LMMT	6	4	02-26-16	07-07-14
Recommended for Closure									
19	5027	C2P Inc 3 Work Stoppage	Recommended for Closure	S	C2P/CDLMS	3	12	10-31-14	10-21-13
20	4913	MFOM Processing Power, CPU, Storage Deficiency	Recommended for Closure	T	MFOM	9	6	03-11-14	08-14-13
21	5487	LMMT Test and Evaluation Master Plan	Recommended for Closure	C	LMMT	8	4	09-30-15	05-19-14
22	5399	JADOCS Secret Releasable	Recommended for Closure	T	NAOC2	15	3	04-20-15	04-08-14
Watchlist									
24	5235	JADOCS Interface Limitations w/ LMMT/C2P	Accepted	T	NAOC2	15	9	10-01-15	02-10-14
25	4885	Link 16 Incr 2: NSA Black Key Implementation	Accepted	S	Link 16 Network	4	4	04-30-15	08-01-13
26	5586	LMMT OT Platform	Accepted	S	LMMT	8	4	07-08-15	07-07-14

Program: Link 16 Network   Status: Accepted/Mitigate   Exp: 8.0   Source: Cost   Impact Date: Jul 31, 2015
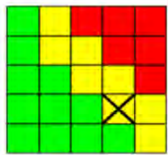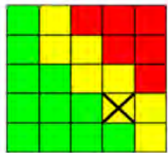
Description of Risk: If the MOS HPA switch is not successfully developed and integrated into the MOS system to bypass high power operations in Frequency Remapped mode by 31 March 2015, then there will be added development required to either the High Powered Amplifier or the MIDS LVT terminal with additional cost. Background: MOS HPA switch is being developed for the FR mode because the existing HPA A4 card and MIDS LVT terminals do not support required EMC features calculations required for certification. Impact Date: Assumes at 24 month period to develop and test a new HPA A4 card to support a March 2017 IV&V of the MOS CM/FR changes.

Last RRB Comment:

10 Nov 14 - RRB reviewed. Testing completed. Mitigation on track.

15 Oct 14 - RRC Reviewed. Mitigation on track. Step 2 should be done by Friday, 17 October 2014.

7 Oct 14 - RRB reviewed. Testing is being completed and report developed.

17 Sep 14 - RRC reviewed. Mitigation Step 1 to develop and build HPA switch for testing in complete. Rest of mitigation is on track. Recommended action: Continue managing.

| Step	Mitigation	Owner	Planned	Completed	Result Exp
1	Develop and build 2 HPA switch for testing.	PMW-150	Aug 29, 2014	Aug 29, 2014	8.0
2	Conduct Functional Test of switches.	PMW-150	Nov 7, 2014	Nov 7, 2014	8.0
3	Complete EMI/Environmental/Shock Analysis	PMW-150	Jan 30, 2015		4.0
4	Complete Business Case Analysis	PMW-150	Feb 27, 2015		4.0
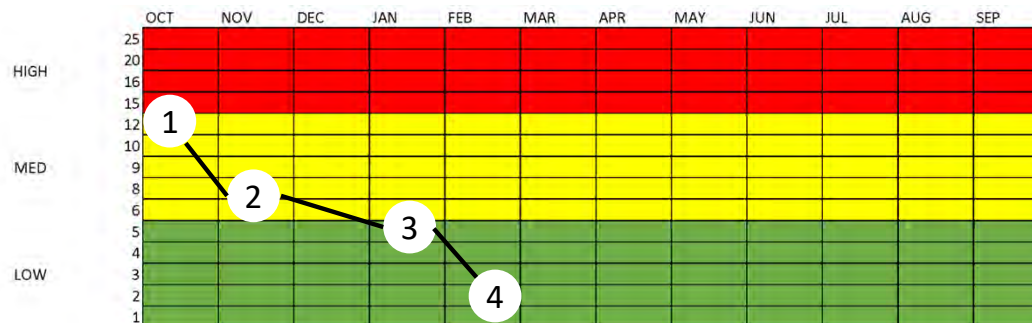
Overview

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  - Introduction
  - Risk Management Model
  - **Opportunity Management**
  - Issue Management

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Opportunity Management

- Occurs in parallel with Risk Management (RM)
  - Identify and pursue opportunities to exceed technical performance requirements, accelerate schedules, or reduce costs relative to the baseline plan
    - Opportunity – a future uncertainty that will enhance the ability to achieve or exceed objectives
    - Beware: Pursuit of opportunities almost inevitably introduces additional risks
      - If the opportunity is pursued, any risks identified will follow the RM process
  - The opportunity management organization is usually composed of the same team members as the RM organization
  - Follows essentially the same process as RM
    - Consequences are more positive in nature
    - Handling options are: Ignore, Transfer, or Pursue

Sample Opportunity Matrix
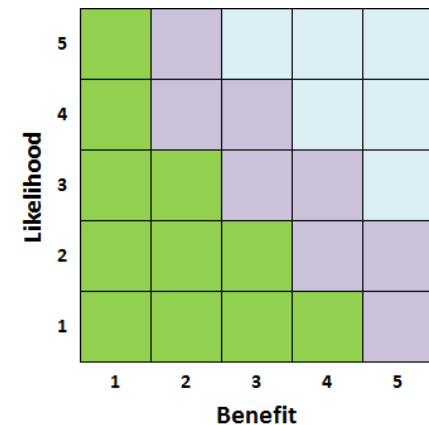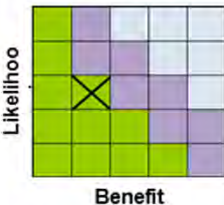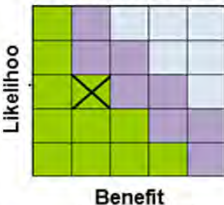
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colspan=11	PMW 150 Opportunity Register as of 15 October 2014 (sorted)									
3	5000	Sync Inc 2&3 Efforts	Accepted	Cost	C2P	6.0	6.0			30-Oct-14
4	5013	Leverage Lab and At Sea Test Assets	Accepted	Cost	C2P	6.0	6.0			15-Jul-15
5	5014	Decreased new SLOC development	Accepted	Cost	C2P	6.0	6.0			15-Jul-15
6	5015	Decrease C2P POR-Funded TDL Cert Events	Accepted	Cost	C2P	3.0	3.0			15-Jul-15
7	5012	Accelerate JTIDS Product Improvement Gov't Testing	Accepted	Cost	Link 16	9.0	9.0			15-Jul-15
8	5010	Acceleration of Full OA	Accepted	Schedule	NTCSS	9.0	9.0			31-Jul-15
9	5002	Testing Tool Usage	Accepted	Schedule	NTCSS	9.0	9.0			TBD
10	5004	External Test Reduction	Candidate	Schedule	G-TSCMIS	9.0	9.0			TBD
11	5016	Press new SUP C2 programs to be ACAT II	Preliminary					15-Oct-14		
12	5017	Achieve LMMT shore fielding decision without DT/OT	Preliminary	Cost	LMMT	9.0	9.0	13-Nov-14		30-Apr-15
13	5018	Consolidate LMMT Releases 2 and 3 into a single capability release	Preliminary	Cost	LMMT	9.0	9.0	13-Nov-14		30-Apr-15
SHOULD COST OPPORTUNITIES									
15	5005	C2P Should Cost	Accepted	Cost	C2P	9.0	9.0			31-Jul-14
16	5006	Link 16 Should Cost	Accepted	Cost	Link 16	9.0	9.0			31-Jul-14
17	5007	GCCS-M Should Cost	Accepted	Cost	GCCS-M	9.0	9.0			31-Jul-14
18	5008	G-TSCMIS Should Cost	Accepted	Cost	G-TSCMIS	9.0	9.0			31-Jul-14
19	5009	NTCSS VE Should Cost	Accepted	Cost	NTCSS	9.0	9.0			31-Jul-14

Example: Detailed Opportunity Description

Program: C2P Status: Accepted   Exp: 6.0   Source: Cost   Impact Date: 15 July 2015

Original Cube

Likelihoo / Benefit

Present Cube

Likelihoo / Benefit

Description of Opportunity:

Save $1.626M over the FYDP by leveraging lab and at sea test assets to cost share by scheduling C2P DT/OT coincident with Combat System test events. Note: Projected savings will be updated 9/14 when the C2P PLCCE is released.

Impact Date: *First TEMP draft need date.*

Last ORC Comment:

15 Oct 14 - This opportunity is related to Opportunity #5000.

17 Sep 14 - Reviewed, no update. Still tracking to planned efforts.

20 Aug 14 - Reviewed and accepted by DPM. Continue with plan.

19 Aug 14 - New Opportunity added.

Step	Effort	Owner	Planned	Completed	Result Exp
1	Program office coordinate with PEO IWS to coordinate C2P testing during IWS at sea events	Dearborn	12/31/14		8.0
2	Reflect test events in IWS test plans and C2P TEMP	Dearborn	9/30/15		8.0
3	Coordinate with C2P OTD to work C2P test requirements into shared at sea test windows	Dearborn	9/30/15		8.0

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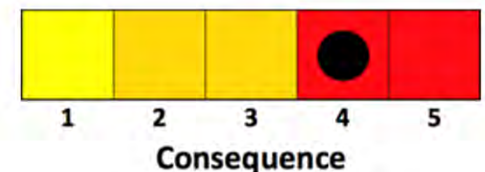
Issue Management

- Occurs in parallel with Risk Management (RM)
  - Programs must know how to deal with consequences (resulting from an active risk or not)
    - Issue – a risk that has been realized or other problem that has occurred
    - The formal issue process provides management visibility, structure, and discipline to issue resolution
  - Issue Management usually requires coordination with external stakeholders
  - The process should resemble RM as much as practical
    - Likelihood assessment not required, but a consequence rating should be assessed
    - Handling options are: Accept, Transfer, or Resolve/Control
    - A resolution strategy includes the following:
      - Specific technical/programmatic needs to resolve the issue
      - Cost of resolution vs. consequence of accepting
      - Expected reduction in consequence for each step to completion
      - Specific criteria for issue closure

Red (4 or 5): significant to unacceptable impact on program; priority management attention is required.

Orange (2 or 3): minor impact on performance, schedule, or performance; impact may be minor to moderate; additional management attention may be needed.

Yellow (1): minimal or no impact on program objectives; normal IPT/Segment effort and internal Program Office coordination should be sufficient.

Issue Consequence Rating Scale

Consequence

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Trade Study Fundamentals

- Process to evaluate viable alternatives and determine the preferred choice
  - Supports technical decisions concerning system concepts, requirements, product design and processes
  - Methodology provides rational, objective, and repeatable justification and documented results
  - Always includes appropriate analyses on cost vs. performance

Generic Problem Solving Model

1. Define the Problem
   - Get the facts, not opinions
   - Use flowcharts to map the expected steps and cause-effect diagrams to identify root causes

2. Generate Alternative Solutions
   - IPT brainstorming is essential to determine all possible alternatives

3. Evaluate and select an alternative

4. Implement a solution and follow-up on it

9

Cause and Effect Diagram
(A Qualitative Tool)

- **Fishbone diagram***
  - Focuses on determining the root cause of a problem
- **Consists of**
  - Problem Statement
  - 6 major causes
    - Materials
    - Machines
    - Methods
    - Measurement
    - Manpower
    - Milieu (Environment)
  - Related causal factors
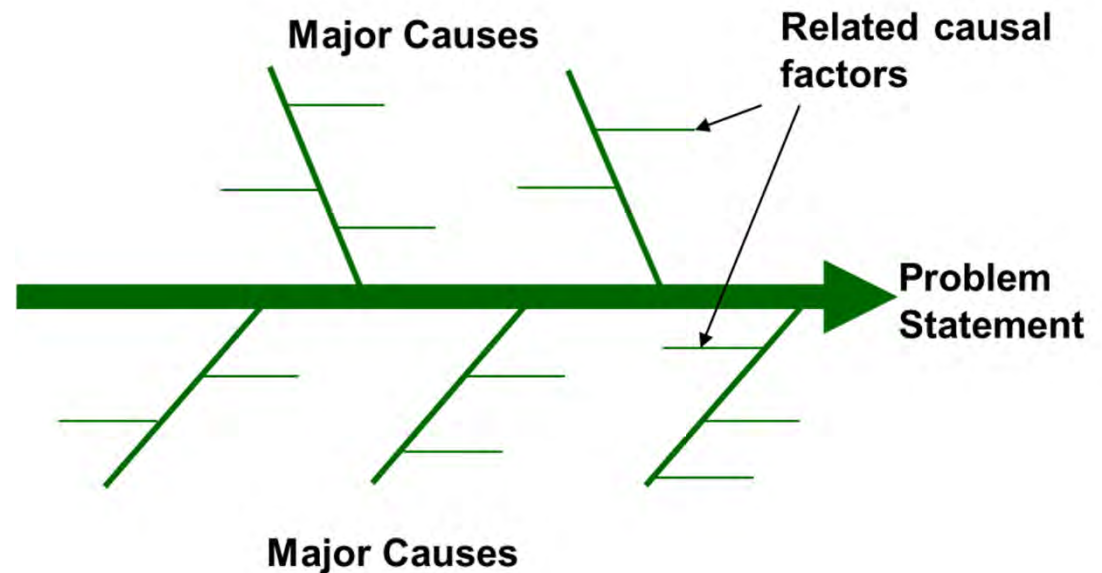
* Also known as the Ishikawa Diagram

Fishbone Example

Material　　　**Machines**　　　**Measurement**

Methods　　　**Manpower**　　　**Milieu**

"Computer will not boot up"
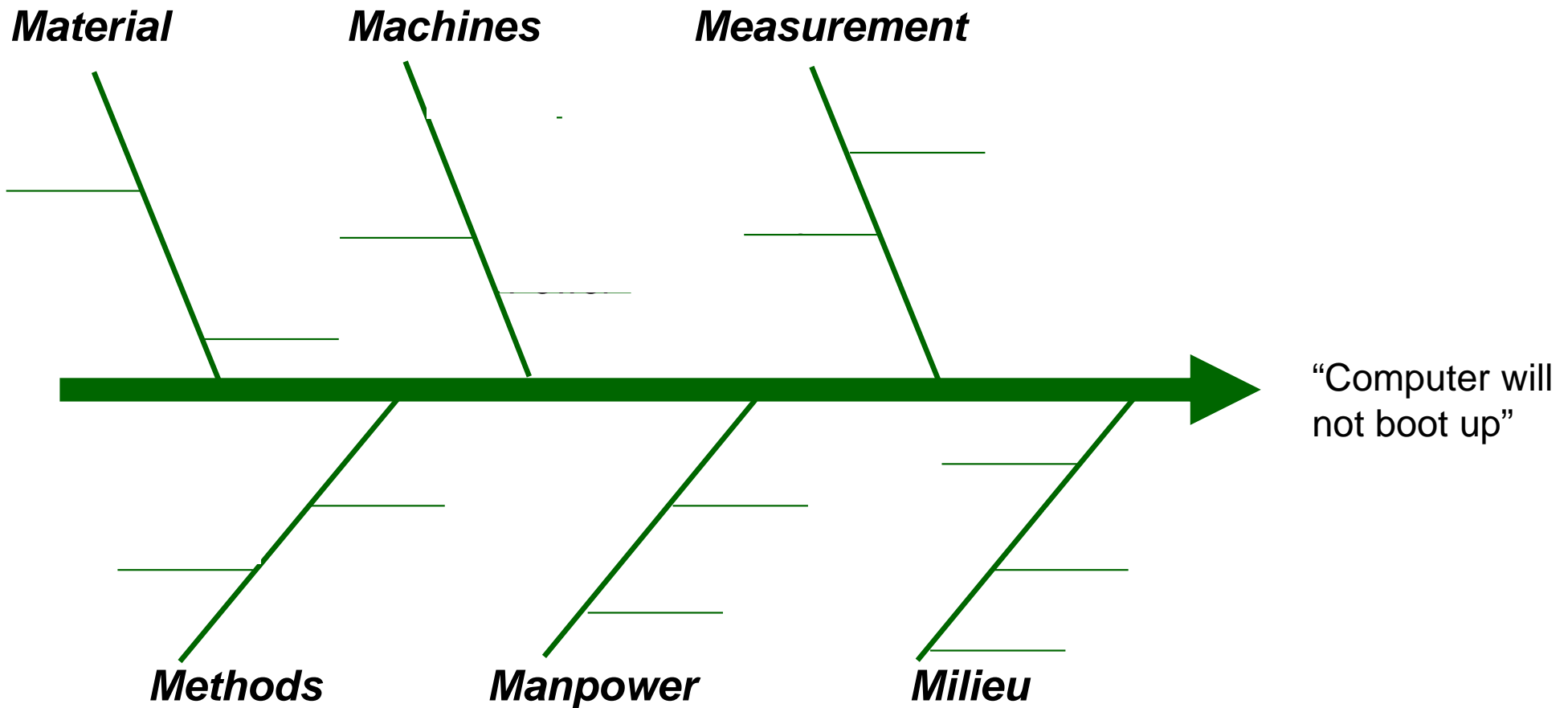
Brainstorm for all related causal factors for each major cause and rule them out, one by one

The "5 Whys"

- Question-asking method to explore cause/effect relationship and underlying issues
  - Non-scientific approach – draws from opinions and observation of team
  - Confirm results with more robust analysis

- Originally developed by Sakichi Toyoda
  - Used within Toyota during evolution of manufacturing methodologies

- "5" is a guideline, not a hard and fast rule

- Three key elements to effective use:
  - Accurate, complete problem statement
  - Complete, unbiased, honest answers to each "why"
    - Most people tend to look away from themselves or their team
  - Determination to find root cause and not just symptoms
    - Correcting symptoms wastes resources – correcting root cause resolves the problem permanently

Multi-Voting

- Narrows large list of possibilities to smaller list of top priorities

- Preferable to straight voting – allows item that is favored by all, but not top choice of any, to rise to top

- When to multi-vote:
  - After long list of possibilities has been generated;
  - List must be narrowed down, and;
  - Decision must be made by group judgment

- How to multi-vote (one variation):
  - Working individually, members select a pre-determined number of items (typically 3-5) thought to be most important
  - Tally votes – votes can be prioritized and weighted, if desired
  - Repeat process if necessary to further reduce list of options
  - Further investigate and/or refine top vote-getters

Multi-Attribute Utility Theory

1. Identify the alternatives

2. Choose the desired attributes or criteria and create a numerical grading scale

3. Apply weights to the attributes

4. Score each alternative in each attribute

5. Multiply scores by the weights and sum

6. Compare the results

7

Multi-Attribute Utility Theory
Which Combat System to use for new Small Surface Combatant (SSC)?

Attribute					Total
Weights					

1. Identify the alternatives

7

Multi-Attribute Utility Theory
Which Combat System to use for new Small Surface Combatant (SSC)?

Attribute / Combat System	Cost	Tech Maturity	Meet Req	Open Design	Total
Aegis no BMD					
Aegis with BMD					
Ship Self Defense System (SSDS)					
New Technology					

2. Choose the desired attributes or criteria

7

Multi-Attribute Utility Theory
Which Combat System to use for new Small Surface Combatant (SSC)?

Attribute / Combat System	Cost	Tech Maturity	Meet Req	Open Design	Total
	(1-10 Least)	(1-10 High)	(1-10 Meets)	(1-10 Open)	
Aegis no BMD					
Aegis with BMD					
Ship Self Defense System (SSDS)					
New Technology					

...and create a numerical grading scale

7

Multi-Attribute Utility Theory
Which Combat System to use for new Small Surface Combatant (SSC)?

Attribute / Combat System	Cost	Tech Maturity	Meet Req	Open Design	Total
	(1-10 Least)	(1-10 High)	(1-10 Meets)	(1-10 Open)	
Weights	4	3	2	1	
Aegis no BMD					
Aegis with BMD					
Ship Self Defense System (SSDS)					
New Technology					

3. Apply weights to the attributes

Multi-Attribute Utility Theory
Which Combat System to use for new Small Surface Combatant (SSC)?

Attribute Combat System	Cost	Tech Maturity	Meet Req	Open Design	Total
	(1-10 Least)	(1-10 High)	(1-10 Meets)	(1-10 Open)	
Weights	4	3	2	1	
Aegis no BMD	8	10	6	6	
Aegis with BMD	4	6	8	6	
Ship Self Defense System (SSDS)	8	8	4	8	
New Technology	2	2	10	10	

4. Score each alternative in each attribute

3.3.6 Risk Management & Problem Solving

Multi-Attribute Utility Theory
Which Combat System to use for new Small Surface Combatant (SSC)?

Attribute / Combat System	Cost		Tech Maturity		Meet Req		Open Design		Total
	(1-10 Least)		(1-10 High)		(1-10 Meets)		(1-10 Open)		
Weights	4		3		2		1		
Aegis no BMD	8	**32**	10	**30**	6	**12**	6	**6**	**80**
Aegis with BMD	4	**16**	6	**18**	8	**16**	6	**6**	**56**
Ship Self Defense System (SSDS)	8	**32**	8	**24**	4	**8**	8	**8**	**72**
New Technology	2	**8**	2	**6**	10	**20**	10	**10**	**44**

5. Multiply scores by the weights and sum

7

Multi-Attribute Utility Theory
Which Combat System to use for new Small Surface Combatant (SSC)?

Attribute \ Combat System	Cost (1-10 Least)		Tech Maturity (1-10 High)		Meet Req (1-10 Meets)		Open Design (1-10 Open)		Total
Weights	4		3		2		1		
Aegis no BMD	8	32	10	30	6	12	6	6	80
Aegis with BMD	4	16	6	18	8	16	6	6	56
Ship Self Defense System (SSDS)	8	32	8	24	4	8	8	8	72
New Technology	2	8	2	6	10	20	10	10	44

6. Compare the results

Summary

1. Components of Acquisition Risk?

2. Sources of Acquisition Risk?

3. Relate APB to Risk Management

4. 5 steps of Risk Management Model?

5. How do you handle risk?

6. The trade-off study process is used to evaluate alternatives

7. Multi-Attribute Utility Theory (MAUT) is used to support decisions