Risk Management in EVA

Agenda

- Topic: Use of Risk Management in EVA
- Background
- Approach
- Usefulness/Conclusion

EVA Office at NASA - JSC

- EVA Office at JSC provides
  - Space Suits used for EVA's
    - Life support system
    - Soft-goods (bladder, MMOD and thermal protection)
    - Communication, and even propulsion
  - Tools & crew aids used for EVA's
    - Hand-tools
    - Transition and positioning aids
      - Handrails
      - Portable foot restraints
      - Tool caddies
  - Mission Support
    - Crew training (ground based eg NBL, VRL)
    - On-orbit execution (hardware supply, preparation, anomaly resolution

- EVA is an organization with a product focus, a strong customer orientation (ISSP, SSP, Cx), with significant integration activities

EVA Project Risk Management: Why and When

Why?

- Agency interest in adopting “best practices” resulted in ISSP accepting challenge to implement RM
- ISSP is primary customer, and mandated requirement to EVA (EVA as vendor/service supplier)

When?

- Informally, RM occurred since inception with use of “Threat Lists”
- The formal, structured system (database and graphics) began for EVA at “mid-life”

Comments

- Continuous improvement initiative
- EVA’s strong customer orientation

Note: can implement formal RM approach long after developing POS and the Project Definition Statement

EVA Office Risk Management: How

Systematic approach for ISSP & EVA

- Risk Matrix (5 X 5) – see illustration
  - Likelihood
  - Consequence
- Brainstormed initial listing with preliminary Risk Scores
- Established database to capture and track risk status and efforts to mitigate. Status reporting (monthly)
  - Summary Matrix of Risks
  - Narrative updates
- Risk Manager established for ISSP to manage Risk System
  - Needed method to elevate issues

Comments

- Simple estimations for values assigned to probabilities and impacts (Ordinal versus Cardinal)
- Used Risk Initiation Info Sheet, assigned ID number, rated each for probability & impacts, identified mitigation plans (Contingencies developed later)
- Risk Tracking System included feature to allow “promoting” and “demoting” risks by EVA Office. This facilitated accepting, transferring, mitigating, and closing risks.

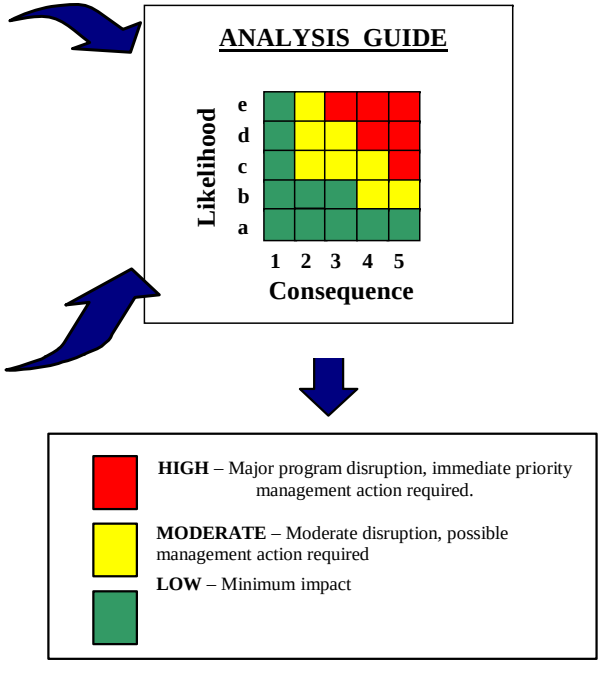
EVA Office Risk Guide Card - Example

Likelihood

What is the Likelihood the Risk Will Happen?		
Level	Chance of Occurrence	Your Typical Approach and Processes
a	Not Likely: Less than 10% chance	…Will effectively avoid this risk based on standard practices
b	Low Likelihood: 11% - 25% chance	…Have usually avoided this type of risk with minimal oversight in similar cases
c	Moderate: 26% - 50% chance	…May avoid this risk, but workarounds will be required
d	Highly Likely: 51% - 75% chance	…Cannot avoid this risk with standard practices, but a different approach may work
e	Near Certainty: Greater than 76% chance	…Cannot avoid this risk with standard practices, may not be able to mitigate

Consequence

Given the risk is realized, what would be the magnitude of the impact?			
Level	Technical Performance	Schedule Impact	Cost (millions)
1 Almost Negligible	Minimal or No technical Impact, same approach retained.	Minimal schedule slip but able to meet need dates w/o add'l resources. Critical path unaffected	Cost increase < 0.5
2 Marginal	Minor technical shortfall and/or small reduction in margin. Minor changes may be needed.	Minimal schedule slip requiring add'l resources to meet need dates. Critical path unaffected.	Cost increase 0.5 – 1.0
3 Moderate	Moderate technical shortfall and/or significant reduction in margin. Workarounds available.	Significant schedule slip.	Cost increase 1.0 - 5
4 Critical	No remaining margin. Severe technical shortfall.	Major schedule slip. Will miss Milestone date.	Cost increase 5 – 10
5 Catastrophic	Unacceptable, will result in technical performance failure w/ no known workarounds. Ship will be undeliverable.	Major (critical) schedule slip.	Cost increase >10



Source: EVA RM Plan (draft)
circa 2004

EVA Office Risk Initiation Information Sheet

Risk Title:

Date Identified: Identified By:

Risk Statement: (If A occurs because of B, then C will be the result (negative consequence))

Risk Context/Description:

Likelihood:	Not Likely	Low Likelihood	Moderate	Highly Likely	Near Certainty

Consequence:	Almost Negligible	Marginal	Moderate	Critical	Catastrophic

Urgency:	Near-Term	Mid-Term	Far-Term

~~Driver Impact:~~	~~Technical/Mission~~	~~Cost~~	~~Schedule~~	~~Safety~~	~~Supportability~~

~~Program/Local DLO Affected:~~	~~SSP~~	~~ISSP~~	~~CEV Program~~	~~XA Local~~	~~Other~~

Submitted By: Approved by EVA Area Risk Manager

_____ _____

Figure 4. The Risk Sheet is the Keystone of the EVA Risk Management System

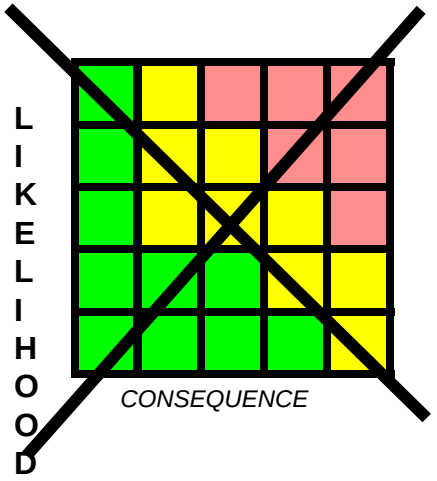
Source: EVA RM Plan (draft) circa 2004

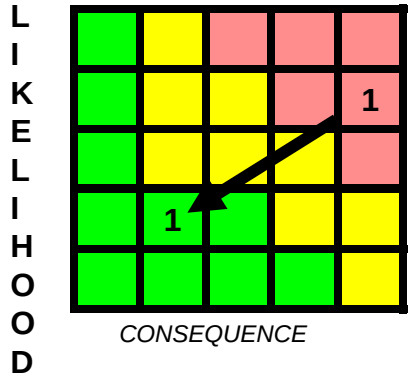
Criteria for Closing a Risk

1. Risk has been fully mitigated or is no longer present
   - All mitigation tasks have been met or accomplished

2. Risk is mitigated down to the "Green" 2x2 or lower area and it is determined sufficient mitigation has been accomplished and no further mitigation is necessary, desired or planned
   - Will not need to revisit issue in the future (subjective)

Process for Closing a Risk
- Notification (not approval) at PRAB for Non-TPR Risks
- Approval at PRAB for TPR Risks
- Document closure rationale with sufficient data (technical, cost, schedule) to support the recommendation
  - Already part of IRMA software





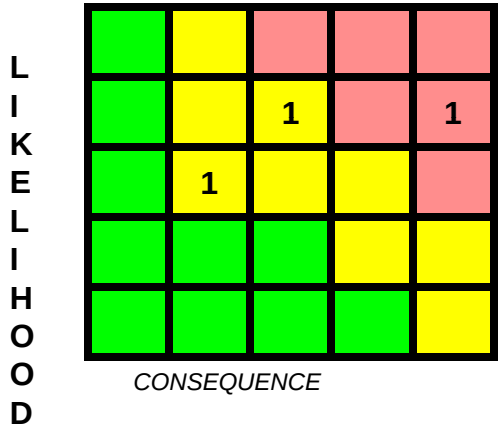
Source: ISSP

Criteria for Accepting a Risk

1. It is not feasible or desirable to fully mitigate a Risk or to mitigate the Risk any further
   - May not be possible, technically practical, or not cost effective
     - i.e. Reliance on Russians to provide attitude control & propellant resupply (Develop Propulsion Module)
   - May exceed time (schedule), money, or personnel to fully mitigate
2. Risk is in the “Red”, “Yellow”, or above a “Green” 2x2 area
   - Or could be any type of Risk or Watch Item where we desire visibility of “acceptance of risk” (subjective)

Process for Accepting a Risk

- Approval at PRAB by Program Manager
- Document closure [sic] rationale with sufficient data (technical, cost, schedule) to support the recommendation
- Re-assess all accepted risk periodically
  - Minimum twice per year



Source: ISSP

ISS IRMA Reference Card – Data Entry Requirements

Mandatory Field	Concern	Cost Issue	Watch Item	Risk
Title	√	√	√	√
Description			√	√
ECD			√	√
Most Likely Mit. Cost			√	√
High & Low Mit. Cost				√
Mit. Budget Amount		√	√	√
Cost Category		√	√	√
Cost Breakdown				√
Likelihood Score	√	√	√	√
Consequence Score	√	√	√	√
Impact/Consequence			√	√
Closure/Acceptance Criteria		√	√	√
Flights/Stages Affected	√	√	√	√
Orgs Affected			√	√
Status				√
Mitigation Plan Overview				√
Mitigation Tasks				√

Key
√ = New
√ = Proposed

Source: ISSP

XA/ EVA Office Risk Activity Summary

Type of Risk	Closed	Opened	Open Now
Risk	0	0	0
Watch Item	1	2	X
Cost Issue	2	1	Y
Concern	0	1	Z
Total	**3**	**4**	**(0+X+Y+Z)**

Watch Item (TPR) Transferred this period:

50XX "Lack of (insert phrase here)"

- **Transferred from EVA to Vehicle Office**
- **Authority and resources necessary to handle risk are Vehicle Office**

Source: J. Hall

EVA Significant Change Summary

- Transfers
  - To: OB 50XX Watch Item Lack of(insert phrase here)
- Openings
  - 51XX Watch Item Operations (insert phrase here)
  - 51XX Watch Item Possible Need for Additional Hardware
  - 51XX Cost Issue EVA Operations
  - 51XX Concern EVA hardware compatibility with next generation computers
- Closures

Num.	Risk Type	Risk Title	Closure Rationale
50xx	Watch Item	Completion of Budget Transfer	Received transfer of Budget from HQ
48xx	Cost Issue	EVA Materials	To be covered within budget.
50xx	Cost Issue	Lack of (insert phrase here)	Funding approved via CCB

- Conversions
  - 47xx Cost Issue to Watch Item New Design (insert phrase here)
- Pending
  - 46xx Watch Item EVA (insert phrase here) – cost impacts of are under review

Source: J. Hall

Integrated Risk Management Application (XA) Matrix, March 31, 2004

Corrective/Preventative Actions

Watch Items

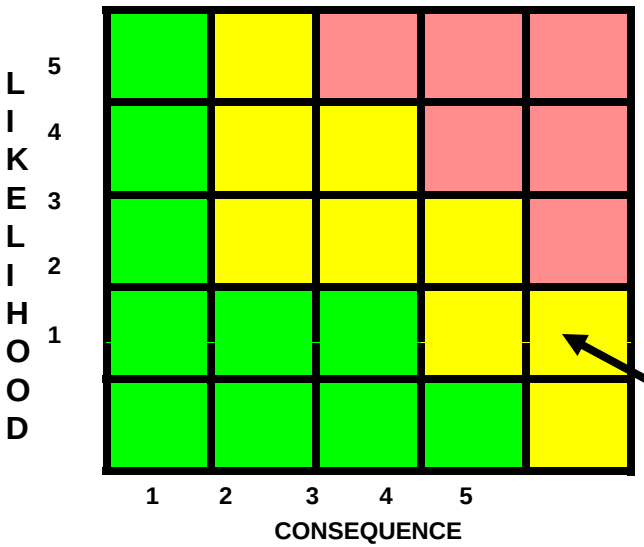
- 50xx - EVA hardware inventory
- 49xx - Reduced capability
- 49xx - EMU Battery logistics
- 48xx – Ops constraints
- 47xx - New Design Hardware Development
- 45xx - Tool Torque
- 45xx - EVA Limit Loads
- 46xx - EVA hardware inventory

Cost Issues

- 50xx - EMU inventory
- 51xx - EVA Operations
- 48xx - Hardware Replacement
- 48xx - New Requirement design

Continual Improvement

Program Risk Matrix for the EVA Projects Office



Low	Medium	High
C – Cost	S-Schedule	T-Technical
▲ – Top Program Risk (TPR)		
△ –Proposed Top Program Risk (TPR)		
■ - Top Organization Risk (TOR)		
□ - Proposed Top Organization Risk (TOR)		

Risks (L x C)

No Risks Elevated

Risks Being Watched/Monitored

▲ **Watch**: 50xx - Lack (insert phrase here)
Transferred to Vehicle Office in last period

Watch: 44xx – Maintenance (insert phrase here)
Watch: 45xx - Tool Loads

During March 2004 EVA had no Top Program Risks, so the Matrix is empty.

Source: J. Hall

Integrated Risk Management Application (IRMA) Home List of OPEN XA Risks

Status as of March 17, 2004

MO	Type	IRMA Num.	Owner	Title	FY04	FY05	FY06	FY07	FY08	FY09	Flights Affected	Orgs Affected	Risk Level	L x C
XA	Cost Issue	40XX	jdoe	ABCD facility	0	0.7	0.668	0.689	0.711	0.734		XA		0 x 0
XA	Cost Issue	40XX	jdoe	ABCDE hardware	0	0.6	0.64	0.68	0.73	0		XA		3 x 3
XA	Cost Issue	40XX	jdoe	BCDE hardware	0	0.2	0.4	2.3	4	1.6		XA		3 x 3
XA	Cost Issue	40XX	jdoe	BCDEF facility	0	0.3	2.5	2.5	0	0		XA		0 x 0
XA	Watch Item	40XX	jdoe	CDEF hardware	0	0	0	0	0	0		XA	TOR	3 x 3
XA	Watch Item	40XX	jdoe	CDEFG facility	0	1	1	1	1	0		XA		2 x 3
XA	Watch Item	40XX	jdoe	DEFG facility	0	0	0	0	0	0		XA	TOR	2 x 3
XA	Watch Item	40XX	jdoe	DEFGH hardware	0	0	0	0	0	0		XA	TOR	4 x 3
XA	Concern	40XX	jdoe	ABCD facility	0	0	0	0	0	0		XA		3 x 4
XA	Watch Item	40XX	jdoe	ABCDE hardware	0	4.2	0	0	0	0		XA, SA		2 x 3
XA	Concern	40XX	jdoe	BCDE hardware	0	0	0	0	0	0		XA		3 x 3
XA	Concern	40XX	jdoe	BCDEF facility	0	0	0	0	0	0		XA		3 x 4
XA	Cost Issue	40XX	jdoe	CDEF hardware	0	5	7	7	7	7		XA		1 x 1
XA	Cost Issue	40XX	jdoe	CDEFG facility	0	0	0.232	0.239	0.246	0.253		XA		0 x 0
XA	Cost Issue	40XX	jdoe	DEFG facility	0	1	1	1	1	1		XA		1 x 1
XA	Watch Item	40XX	jdoe	DEFGH hardware	0	1.5	2	1	0	0		XA	TOR	4 x 3
XA	Cost Issue	40XX	jdoe	ABCD facility	0	1.5	1.5	1.5	0	0		XA		1 x 2
XA	Cost Issue	40XX	jdoe	ABCDE hardware	0	8.6	6.4	1.6	0.37	0		XA	TOR	2 x 3
XA	Cost Issue	40XX	jdoe	BCDE hardware	0.95	1.2	0.7	0	0	0		XA	TOR	1 x 3
XA	Cost Issue	40XX	jdoe	BCDEF facility	0	0.372	0.384	0.268	0.278	0.288		XA		1 x 3
XA	Cost Issue	40XX	jdoe	CDEF hardware	0	0.525	0	0	0	0		XA		1 x 3
XA	Cost Issue	40XX	jdoe	CDEFG facility	0	0.65	0.794	0.942	1.095	1.252		XA		1 x 2
XA	Cost Issue	40XX	jdoe	DEFG facility	0	1.1	1.2	1.3	0.6	0		XA		1 x 2
XA	Watch Item	40XX	jdoe	DEFGH hardware	0	0	0	0	0	0		XA	TOR	4 x 3
XA	Cost Issue	40XX	jdoe	ABCD facility	0	0	0	0	0	6.6		XA		3 x 4
XA	Watch Item	40XX	jdoe	ABCDE hardware	0	0	0	0	0	0	ULF1, 8S, 14P, 15P, 9S, 16P	XA, OE	TOR	4 x 3
XA	Watch Item	40XX	jdoe	BCDE hardware	0	0	0	0	0	0	ULF1, 8S, 14P, 15P, 9S, 16P	XA, OE	TOR	2 x 2
XA	Concern	40XX	jdoe	BCDEF facility	0	0	0	0	0	0		XA		1 x 1
XA	Cost Issue	40XX	jdoe	CDEF hardware	0.1	0.001	0	0	0	0			TOR	1 x 5
XA	Watch Item	40XX	jdoe	CDEFG facility	0	0.6	0	0	0	0		XA	TOR	4 x 3
XA	Cost Issue	40XX	jdoe	DEFG facility	0	0.6	0.64	0.68	0.73	0		XA		3 x 3
XA	Cost Issue	40XX	jdoe	DEFGH hardware	0.7	0.6	0	0	0	0		XA	TOR	3 x 3
XA	Watch Item	40XX	jdoe	ABCD facility	0.0001	0	0	0	0	0		XA	TOR	2 x 4
XA	Watch Item	40XX	jdoe	ABCDE hardware	-0.6	0	0	0	0	0	LF1, ULF1.1, 12A, 12A.1, 13A, 13A.1, 15A	XA, OC, OE, CA, DA, EA, SA, MA, OB	TPR	5 x 3
XA	Watch Item	40XX	jdoe	BCDE hardware	4	2.4	0	0	0	0			TOR	3 x 3
XA	Concern	40XX	jdoe	BCDEF facility	0	0	0	0	0	0				1 x 1

Source: J. Hall

ISS Watch Item: 50XX Summary Report

Open Date: 1/27/2004 Status as of 3/25/2004 **ECD:** 3/6/2005

TRANSFERRED to ISS Vehicle Office

Title: Lack of (insert phrase here)

Description: Currently, there is no certified capability other than …….

Risk Owner: Doe, John

Likelihood: 5 **Consequence:** 2(C), 2(T)

Impact/Consequence: Without ……..

Organization: XX **MO Affected:** CA, DA, EA, MA, OB,SA, **XA**

Flights Affected: 12A, 12A.1, 13A, 13A.1, 15A, LF-1, ULF-1.1,

Total Most Like. Mit. Cost ($M): 0.15 **Total Budget ($M):** 0.75 **Cost of Inaction ($M):** 10

Current Status:

See Risk Owner

Source: J. Hall

EVA Project RM Usefulness

- Identifying risks improves awareness of vulnerabilities and forces consideration of mitigation and contingencies
  - Use of different types
    - Allows flexibility to elevate as appropriate
    - Reduces the number of sudden surprises by identifying “emerging risks”
- Tracking risks on monthly basis keeps project engineers and management focused on choices (accept/reject, mitigate, transfer)
- Although initially unpopular with engineering workforce (additional burden with “unknown benefit”), 2 years later it is part of the culture and an expected metric
- Risk System now “feeds” the annual budget development cycle for ISSP