Risk Management from GSFC Perspective

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Panel Session – NASA’s Approach to Integrated Risk Management
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What’s Risk Management

• An organized, systematic decision making process that efficiently identifies, analyzes, plans, tracks, controls, communicates and documents risk.

• Risk management is performed continuously.

• Helps to prevent “unacceptable risk” due to...
  • Lack of planning for what could go wrong
  • Departure from established systems engineering and management processes
  • Not following design and verification rules
  • Lack of engineering curiosity when a result is unexpected
  • Not asking independent experts for confirmation and advice
  • Lack of communication up and down the chain
Why Risk Management

- NASA Policy Directive (NPD) 1000.5 (2009) states: "It is NASA policy to incorporate in the overall Agency risk management strategy a risk-informed acquisition process that includes the identification, analysis, and management of programmatic, infrastructure, technical, environmental, safety, cost, schedule, management, industry, and external policy risks that might jeopardize the success with which the Agency executes its acquisition strategies."

- NPR 8000.4A (2009), Agency Risk Management Procedural Requirements, evolves NASA's risk management approach to entail two complementary processes:
  - **Risk-informed Decision Making (RIDM)**
    - To risk-inform direction-setting decisions (e.g., space architecture decisions)
    - To risk-inform the development of credible performance requirements as part of the overall systems engineering process
  - **Continuous Risk Management (CRM)**
    - To manage risk associated with the implementation of baseline performance requirements

\[
\text{RM} \equiv \text{RIDM} + \text{CRM}
\]
Motivating Factors for doing RM

- To manage risk in a holistic and coherent manner across the Agency
  - Agency strategic goals explicitly drive RM activities at all levels
  - All risk types and their interactions are considered collectively during decision-making
  - Implementation of RM in the context of complex institutional relationships (programs, projects, centers, contractors, ...)
- To better match the stakeholder expectations and the “true” resources required to address the risks to achieve those expectations
- To better establish close ties between the selected alternatives and the requirements derived from it.
Risk-related NASA Documents

• 2002 – Issuance of PRA Procedures Guide
• 2006 – Issuance of NPR 7123.1 “Systems Engineering Processes…”
• 2006 – Revision of NPR 8715.3A “NASA General Safety Program Requirements,” Rewrite of System Safety Requirements (Chapter 2)
• 2007 – Revision of NPR 7120.5D “Space Flight Project Management Processes…”
• 2008 – Reissue of NPR 8705.2B “Human-Rating Requirements for Space Systems”
• 2009 – Issuance of NPD-1000.5 “Policy for NASA Acquisition”
• 2009 – Revision of NPR 8000.4A “Agency Risk Management Requirements”

Emerging themes:
Integrated perspective of risk analysis
Scenario-based modeling of risk
Better treatment of uncertainties
Risk Management Drivers at GSFC

- Agency Level Requirements per NPR 8000.4A
- Center Level Requirements per GPR 7120.4
- Directorate Level Requirements such as
  - Flight Program/Project level Risk Management Plan
  - Institutional Project Risk Management Plan
  - Procedures and Guidelines by Office of the Management Operations Directorate (200-PG-8000.0.1)
  - Threat, Lien and Encumbrance Policy to determine the potential cost impact associated with risks (Programs and Projects)
Risk Escalation Process at GSFC

Risk owners shall perform due diligence to understand the risk and escalation process. Reasons for escalation may include:

- Additional resources are needed to mitigate the risk.
- Direction is needed from the next level of management.
- External integration is required (e.g. suppliers, other programs/projects/centers).
- The risk has cross-cutting significance.

The following levels are defined to support the Center’s escalation process:

**Top Center Risk (TCR)** – Requires Center management resources or direction

**Top Directorate Risk (TDR)** – Requires Directorate Management direction.

**Top Organizational Risk (TOR)** – Requires Division Management direction and/or resources.
Lessons Learned

The Challenger Launch Decision
"There is great risk in placing human beings atop a machine that stores and then burns millions of pounds of dangerous propellants. Equally risky is having humans then ride the machine back to Earth while it dissipates the orbital speed by converting the energy into heat, much like a meteor entering Earth's atmosphere. No alternatives to this pathway to space are available or even on the horizon, so we must set our sights on managing risky process using the most advanced and versatile techniques at our disposal." It starts with the decisions we make and the uncertainty in those decisions.
Common Themes of Mishap Reports

Inadequate:

- **Risk Management/Assessment**
- Testing, Simulation, Verification & Validation
- Independent Review
- Communications
- Health Monitoring During Critical Operation
- Safety/Quality Culture
- Resources/Staffing
Where Are The Risks?

Most risks are below the surface.

Knowns
We understand our risks & options.

Unknowns
✓ Someone understands our risks
✓ Beyond our current knowledge but knowable if we work at it
✓ Not knowable with today’s knowledge, therefore we make blind decisions

Once Risks have been identified, much is still below the surface. You need to know your degree of exposure!
Reasons for Success (4R Model)

- Responsible Leadership
- Rigorous Engineering
- Risk Management
- Requirements Management

Open Discussion & Debate
Risk management & Mission Success

Risk Management helps us better identify the risks, manage the uncertainty and understand our decisions.

Implementing a Risk Management Process increases the likelihood of Mission Success.
What is Risk (per NPR 8000.4)

The expression of the potential for performance shortfalls, which may be realized in the future, with respect to achieving explicitly established and stated performance requirements.

The performance shortfalls may be related to any one or more of the following mission execution domains:

- Safety
- Technical performance
- Cost
- Schedule
Acceptable Risk

Acceptable risk is a result of a knowledge-based review and decision process.

Management and stakeholders must participate in the risk acceptance process.

Effective communication is essential to the mutual understanding of risk.

Assessment and communication of acceptable risk must be a continuing process.

“Risk that is understood and agreed to by project team, partners, Center management, suppliers, HQ mission directorates, stakeholders”
Unacceptable Risk

- Lack of planning for what could go wrong
- Departure from established systems engineering and management processes
- Not following design and verification rules
- Lack of engineering curiosity when a result is unexpected
- Not asking independent experts for confirmation and advice
- Lack of communication up and down the chain
Writing A Good Risk Statement

Condition + Consequence = Risk Statement

✓ Condition - a single, factual, phrase briefly describing the current key circumstances, situations, etc., is based in reality and have no uncertainty attached.

✓ Consequence - a single phrase or sentence that describes the key, negative outcome of the current condition.

✓ Risk Statement - a descriptive statement of a clear condition, that is concise, followed by a single consequence and will be understood by a majority of program/project stakeholders.
Building Consistency into a Risk Statement

✓ Consider these questions when writing a risk statement:
  Is it clear and concise?
  Will most project members understand it?
  Is there a clear condition?
  Is the consequence clear?
  Is there only ONE condition followed by ONE consequence?

✓ Consistency builds Credibility
What Makes Up a Risk Statement?

- Must be a Fact or perceived to be Fact
- Must be Reality Based

- GIVEN
- CONDITION
- there is a POSSIBILITY that,
- CONSEQUENCE

- Must have a Negative impact to the Condition
- Must focus on the long term impact of the risk to the Program/Project

A good risk statement must be ACTIONABLE and have ONE condition and ONE consequence per statement.
### GSFC Risk Matrix Standard Scale

#### Likelihood

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Safety</th>
<th>Technical</th>
<th>Cost/Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Very High</td>
<td>( P_{SE} &gt; 10^{-1} )</td>
<td>( P_T &gt; 50% )</td>
<td>( P_{CS} &gt; 75% )</td>
</tr>
<tr>
<td>4 High</td>
<td>( 10^{-2} &lt; P_{SE} \leq 10^{-1} )</td>
<td>( 25% &lt; P_T \leq 50% )</td>
<td>( 50% &lt; P_{CS} \leq 75% )</td>
</tr>
<tr>
<td>3 Moderate</td>
<td>( 10^{-3} &lt; P_{SE} \leq 10^{-2} )</td>
<td>( 15% &lt; P_T \leq 25% )</td>
<td>( 25% &lt; P_{CS} \leq 50% )</td>
</tr>
<tr>
<td>2 Low</td>
<td>( 10^{-4} &lt; P_{SE} \leq 10^{-3} )</td>
<td>( 2% &lt; P_T \leq 15% )</td>
<td>( 10% &lt; P_{CS} \leq 25% )</td>
</tr>
<tr>
<td>1 Very Low</td>
<td>( P_{SE} \leq 10^{-6} )</td>
<td>( 0.1% &lt; P_T \leq 2% )</td>
<td>( P_{CS} \leq 10% )</td>
</tr>
</tbody>
</table>

#### Consequence Categories

<table>
<thead>
<tr>
<th>Risk</th>
<th>1 Very Low</th>
<th>2 Low</th>
<th>3 Moderate</th>
<th>4 High</th>
<th>5 Very High</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Safety</strong></td>
<td>Negligible or No impact.</td>
<td>Could cause the need for only minor first aid treatment.</td>
<td>May cause minor injury or occupational illness or minor property damage.</td>
<td>May cause severe injury or occupational illness or major property damage.</td>
<td>May cause death or permanently disabling injury or destruction of property.</td>
</tr>
<tr>
<td><strong>Technical</strong></td>
<td>No impact to full mission success criteria</td>
<td>Minor impact to full mission success criteria</td>
<td>Moderate impact to full mission success criteria. Minimum mission success criteria is achievable with margin</td>
<td>Major impact to full mission success criteria. Minimum mission success criteria is achievable</td>
<td>Minimum mission success criteria is not achievable</td>
</tr>
<tr>
<td><strong>Schedule</strong></td>
<td>Negligible or no schedule impact</td>
<td>Minor impact to schedule milestones; accommodates within reserves; no impact to critical path</td>
<td>Impact to schedule milestones; accommodates within reserves; moderate impact to critical path</td>
<td>Major impact to schedule milestones; major impact to critical path</td>
<td>Cannot meet schedule and program milestones</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td>&lt;2% increase over allocated and negligible impact on reserve</td>
<td>Between 2% and 5% increase over allocated and can handle with reserve</td>
<td>Between 5% and 7% increase over allocated and can not handle with reserve</td>
<td>Between 7% and 10% increase over allocated, and/or exceeds proper reserves</td>
<td>&gt;10% increase over allocated, and/or can't handle with reserves</td>
</tr>
</tbody>
</table>

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**Note:** The likelihood ratings are based on the estimated probability of safety event occurrence and meeting performance requirements. The cost/schedule ratings consider the estimated likelihood of not meeting cost or schedule commitment.
Sample Risk Matrix

Example – Program Top Risk Report

Risks are identified and trended from the previous review to the current review.
When Do You Start Risk Management?

As Soon As Possible! - NPR 7120.5
Risk Management and the Life Cycle

Risk management is done throughout project life cycle
Performing risk management during the early phases has a high payoff

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Design the "Right System"

Design and Build the System "Right"

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Formulation | Implementation
---|---
SRR | PDR | CDR | Launch
Pre A | A | B | C | D | E/F

- Cost to Change / Fix
- System Life Cycle Phases
- Crisis Management Period
- Band-Aid Time
- No. of Alternatives / Fixes Available

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Risk Management & Your Role

- Managing Risks is a part of your job
  - It is a management expectation.

- Identify and manage Risks NOT Problems
  - However mitigating/eliminating risks may create new risks.
  - A single problem may have multiple risks.
Familiar Conversations...

✓ I've carefully thought out all the angles.
✓ I have done it a thousand times.
✓ It comes naturally to me.
✓ I know what I'm doing, it's what I've been trained to do

Nothing could possibly go wrong, right?
Think Again!
Summary

- Everyone is involved in managing risks.
- Implement RM early in the program life cycle.
- Risks have been and always will be with us.
- Documentation and communication are essential parts of managing risk.
- NASA's Risk Management (CRM + RIDM) process starts with identifying risks, understanding risks, mitigation strategies, decisions and managing the uncertainties around those decisions.
- RM is a structured process that ensures consistency and increases credibility to include planning, tracking & controlling risks.
- Most risks are below the surface, yet there are always indicators.
- A good risk statement should be clear, concise and actionable.