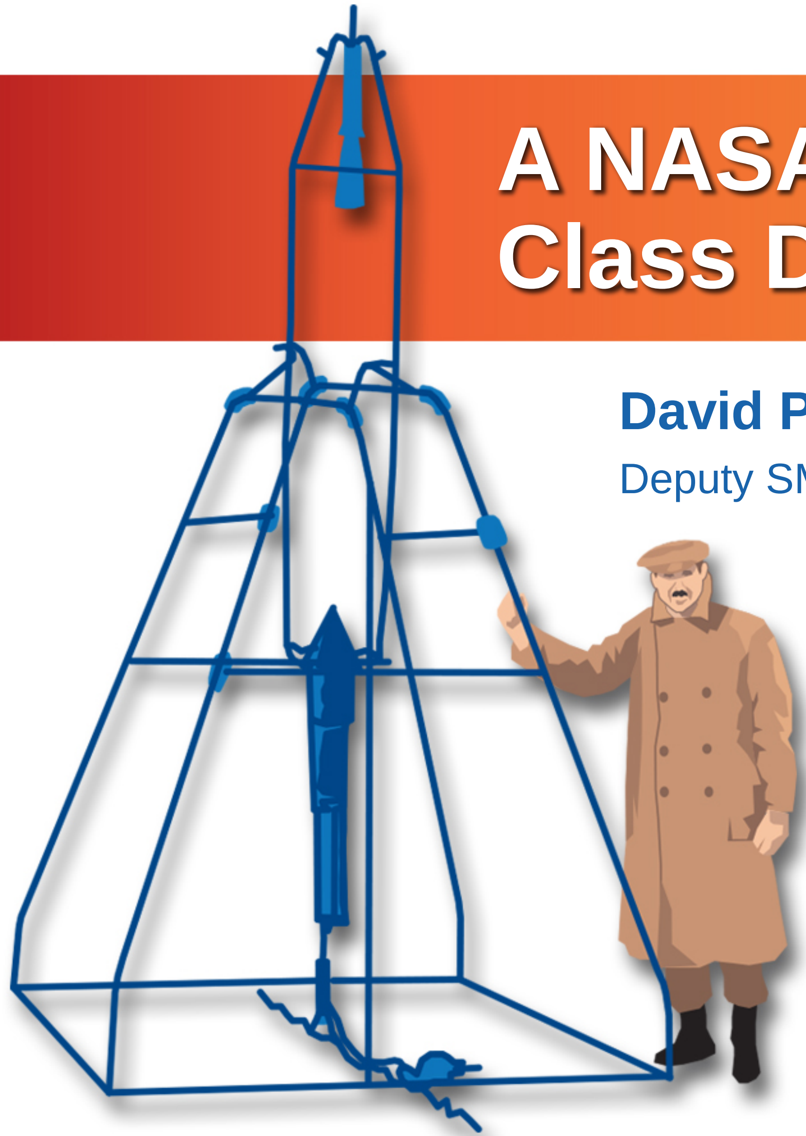
https://ntrs.nasa.gov/search.jsp?R=20190029641 2020-07-14T20:29:55+00:00Z

National Aeronautics and Space Administration

A NASA GSFC perspective on Class D



David Petrick

Deputy SMA Chief Engineer, NASA GSFC

SAFETY and MISSION ASSURANCE DIRECTORATE Code 300

SAFETY and MISSION ASSURANCE NASA Goddard

www.nasa.gov

Agenda

- What is Risk?
- Credible and Baseline risk
- Breakdowns of Risk in Space Systems
- Risk vs. Possibility
- Balanced Risk
- Perspectives of Risk (Stakeholder, Developer)
- Risk as a Development Tool
- Acceptance of Risk at Different Levels and Times
- Risk Classification
- What is Class D?

What is Risk Classification?

- Establishment of the level of risk tolerance from the stakeholder, with some independence from the cost
  - Cost is covered through NPR 7120.5 Categories
- If we were to try to quantify the risk classification, it would be based on a ratio of programmatic risk tolerance to technical risk tolerance.
  - For Class A, we take on enormous levels of programmatic risk in order to make technical risk as close to 0 as possible. The assumption is that there are many options for trades and the fact is that there must be tolerance for overruns.
  - For Class D, there will be minimal tolerance for overruns and a greater need to be competitive, so there is a much smaller programmatic risk “commodity” to bring to the table.
- The reality is that the differences between different classifications are more psychological (individual thoughts) and cultural (longstanding team beliefs and practices) than quantitative.
- There is one technical requirement from HQ associated with risk classification: single point failures on Class A missions require waiver.

Risk Classification—(NPR 7120.5 Projects)

- **Class A: Lowest risk posture by design**
  - Failure would have extreme consequences to public safety or high priority national science objectives.
  - In some cases, the extreme complexity and magnitude of development will result in a system launching with many low to medium risks based on problems and anomalies that could not be completely resolved under cost and schedule constraints.
  - Examples: HST and JWST
- **Class B: Low risk posture**
  - Represents a high priority National asset whose loss would constitute a high impact to public safety or national science objectives
  - Examples: GOES-R, TDRS-K/L/M, MAVEN, JPSS, and OSIRIS-REX
- **Class C: Moderate risk posture**
  - Represents an instrument or spacecraft whose loss would result in a loss or delay of some key national science objectives.
  - Examples: LRO, MMS, TESS, and ICON
- **Class D: Cost/schedule are equal or greater considerations compared to mission success risks**
  - Technical risk is medium by design (may be dominated by yellow risks).
  - Many credible mission failure mechanisms may exist. A failure to meet Level 1 requirements prior to minimum lifetime would be treated as a mishap.
  - Examples: LADEE, IRIS, NICER, and DSCOVR

Risk Classification—(Non-NPR 7120.5 Projects)

- **NPR 7120.8 "class"—Technical risk is high**
  - Some level of failure at the project level is expected; but at a higher level (e.g., program level), there would normally be an acceptable failure rate of individual projects, such as 15%.
  - Life expectancy is generally very short, although instances of opportunities in space with longer desired lifetimes are appearing.
  - Failure of an individual project prior to mission lifetime is considered as an accepted risk and would not constitute a mishap. (Example: ISS-CREAM)
- ***"Do No Harm" Projects***—If not governed by NPR 7120.5 or 7120.8, we classify these as "Do No Harm", unless another requirements document is specified
  - Allowable technical risk is very high.
  - There are no requirements to last any amount of time, only a requirement not to harm the host platform (ISS, host spacecraft, etc.).
  - No mishap would be declared if the payload doesn't function. Note: Some payloads that may be self-described as Class D actually belong in this category. (Example: CATS, RRM)

7120.8 and "Do No Harm" Projects are not Class D

Risk Classification Trends

- **Stepping from A, B, … "Do No Harm" results in:**
  - More control of development activities at lower levels; people actually doing the work
  - Less control by people who are removed from the development process
  - Less burden by requirements that may not affect the actual risks for the project
  - More engineering judgment required
  - Less formal documentation (does not relax need to capture risks nor does it indicate that processes should be blindly discarded)
  - Greater understanding required for reliability and risk areas to ensure that requirements are properly focused, risk is balanced to enable effective use of limited resources, and that good engineering decisions are made in response to events that occur in development
  - Emphasis on Testing/Test results to get desired operational confidence
  - Greater sensitivity to decisions made on the floor

What is Class D? Depends on your view

- Agency compliance view (SMA): NPR 8705.4
  - High level attributes
  - Major change coming soon
- SMD Implementation: Jan 2018 Town Hall and Lightfoot memo
- SMD SMA practices: SMD Class D MAR
- GSFC NPR 7120.5e tailoring: Class D Constitution
- GSFC SMA Practices:
  - GPR 8705.4
  - Class D MAR templates
- What should it mean philosophically?

(Outgoing) NPR 8705.4: Guidelines

Attributes	Actions
Class D	**SPFs allowed**
Low priority	Limited engineering models and flight spares
Low to medium	Qual testing for safety compliance and interface compatibility.
Medium to low	Level 3 parts or Center PMP
Short, < 2 years	Safety-driven reliability analyses
Low	Closed-loop GIDEP
Few to none	Formal software assurance insight, no IV&V
May be feasible and planned	Materials based on safety requirements, proper applications, and assessment of limited life items
Significant alternative or re-flight opportunities	
SPARTAN, GAS Can, technology demonstrators, simple ISS, express middeck and subrack payloads, SMEX	

Class D at GSFC

- **What is Class D by strict definition?** = Highest risk posture for missions governed by NPR 7120.5
- **What is Class D not?**—A catch-all for projects that are not NPR 7120.5 Classes A-C
- GSFC Class D Constitution was a document that addressed some of the programmatic processes such as management structure, waivers, etc.
- GPR 8705.4 and the SMA organizational structure address the technical SMA processes

Class D (*and below*)—Dos & Don'ts

- **Do:**
  - Streamline processes (less formal documentation, e.g., spreadsheet vs. formal software system for waivers, etc.)
  - Focus on tall poles and critical items from a focused reliability analysis
  - **Capture and communicate risks diligently**
  - Rely more on knowledge than requirements
  - Have significant margin on mass, volume, power (not always possible, but strongly desirable)
  - Have significant flexibility on performance requirements (not always possible, but strongly desirable)

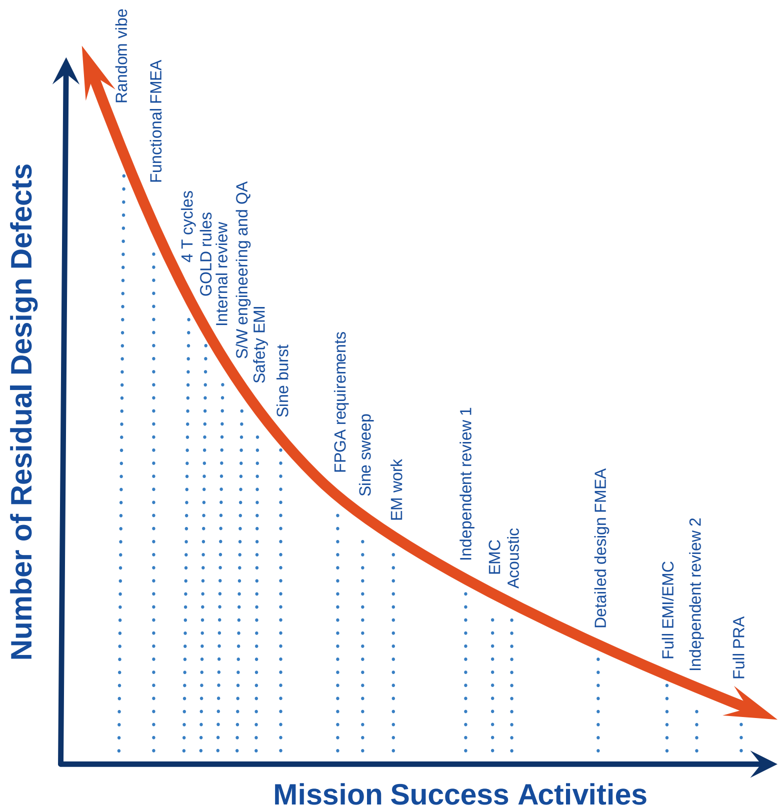
- **Don't:**
  - **Ignore risks!**
  - Reduce reliability efforts (but do be more focused and less formal)
  - Assume nonconforming means unacceptable or risky
  - Blindly eliminate processes

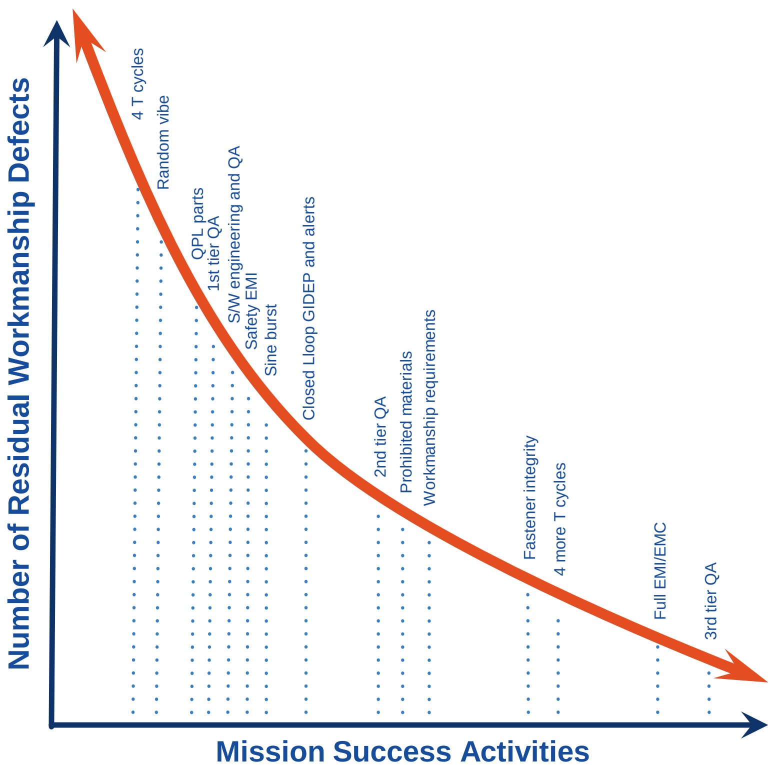
Prioritization is critical

- Highly constrained (as is typically the case for Class D) projects do not have the resources to perform all of the standard activities for mission success
- Overconstrained situations tend to prompt engineering and SMA personnel to prioritize efforts as a matter of course
- Unfortunately, many are drawn to activities that may not buy down risk as effectively as others, and further may drive up programmatic risk, so as to increase the overall level of risk (technical, programmatic, safety) for the project without effectively improving the likelihood for mission success.
- Hence, a useful activity is to prioritize mission success activities in terms of their criticality in ensuring safety and the effectiveness in buying down technical risk for the resources consumed or the programmatic risks taken to implement them.

Defects vs Mission Success

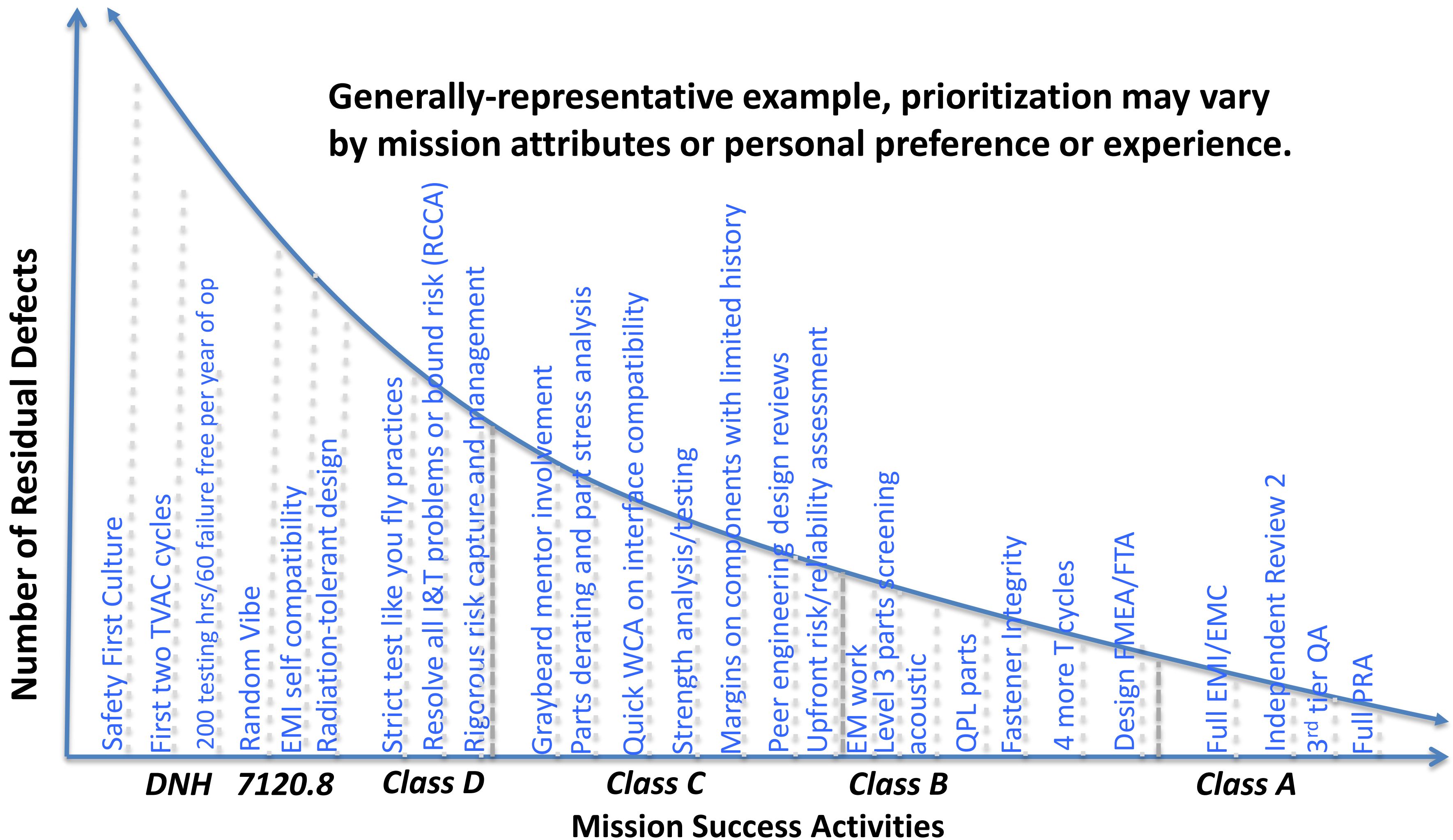
Risk can be characterized by number of defects that affect performance or reliability and the impact of each. Defects are generally of design or workmanship.





Note: A thorough environmental test program will ensure most risks are programmatic (cost/schedule) until very late, when time and money run out.

Defects vs Mission Success as a function of risk classification



GPR 8705.4

- GSFC implementation of NPR 8705.4
- Risk Classification Definitions
- Nonconformance handling
  - Do not reject without understanding the risk
  - Determine cause of NC before reproducing the item (even from different vendor)
- Guidelines for activities vs mission class
- One element used to develop project Mission Assurance Requirements vs mission class
- How does a project demonstrate that they are developing a Class “X” product?
- How do we convey to a vendor what we expect for Class “X”?

Mission Success Activities vs. Risk Posture (example elements)

Technical Categories	Class A	Class B	Class C	Class D	Ground System (GS)	7120.8 Class	Do No Harm (DNH)	Hosted Payload Class (host requirements)
Polymeric Applications	Polymerics-A from GSFC workmanship STD	Polymerics-B from GSFC workmanship STD	Polymerics-C from GSFC workmanship STD	Polymerics-D from GSFC workmanship STD	-STD-001E, lass 3, onformal oating and ncapsulation nly, tailor **own** for epairs	J-STD-001E, Class 3, conformal coating and encapsulation only, tailor **down** for repairs	J-STD-001E, Class 3, conformal coating and encapsulation only, tailor **down** for repair	n/a
Cable/Harness	Cable/Harness-A from GSFC workmanship STD	Cable/Harness-B from GSFC workmanship STD	Cable/Harness C from GSFC workmanship STD	Cable/Harness-D from GSFC workmanship STD	PC/WHMA-A-620B, lass 3	IPC/WHMA-A-620B, Class 1	IPC/WHMA-A-620B, Class 1	
Printed Circuit Boards (PCBs)	GSFC-led design review of all new PCB designs and designs that have not been proven reliable in comparable environment. PCB-A from GSFC PCB STD. Note that flexibility	For cost- plus, GSFC-led design review of all new PCB designs and designs that have not been proven reliable in comparable environment. For fixed price, GSFC participant in	GSFC participant in developer design reviews for all new PCB designs. PCB-C from GSFC PCB STD or PCB-I from GSFC PCB STD. Vendors with significant	GSFC participant in developer design reviews for all new PCB designs. PCB-D from GSFC PCB STD. Vendors with significant GSFC	ommercial ractice	Visual inspection of boards. Selection of requirements based on criticality and known board and environ-mental attributes (thermal cycles,	Visual inspection of boards.	Host practices

*Excerpt from GPR 8705.4

Other Activities With Cost & Risk Reduction Implications to dial up or down

- **Nonconformance handling**
  - Is the requirement that is not met important for the current project in its environment?
  - Is the nonconforming item critical?
  - What is the risk for this project of the nonconformance?
    - Cost/schedule
    - Technical

- **Work orders and procedures**

- **Anomaly resolution**
  - Documentation
  - Root cause analysis
  - Lessons learned for same project or others

Class D general philosophy

- Insight vs Oversight
  - GMIP by exception based on unknown/problematic vendors and/or critical products with limited history
- Commercial practices as a rule
- Risk-based review planning
- Risk-driven vs Requirements-driven
- Sound and robust risk management
- Reduced formality in documentation
- Emphasis system test over piece part screening
- No compromise on safety of personnel or public

Best Applicability of a Streamlined Class D Approach

- **Simple design** (few critical elements)
- **Short mission life**
- **Clear and static science objectives and goa**ls
  - Sufficient, but not overreaching
- **Robust design** (tolerant to variance in workmanship)
- **Stable and repeatable manufacturing processes** (with known process variances)
- **High Margins** (to allow more design flexibility)
  - Mass
  - Power
  - Volume
  - Specifications: Dimensions, Materials
- **Prior flight experience** (with critical components in the same environment)

Uncertain vs Statistical Risk

Risks acceptable for Class D

Uncertainty-based Risk:

- Alternate practices
- Reduced testing margins
- Use of COTS parts and components with limited history
- Blind single-string design

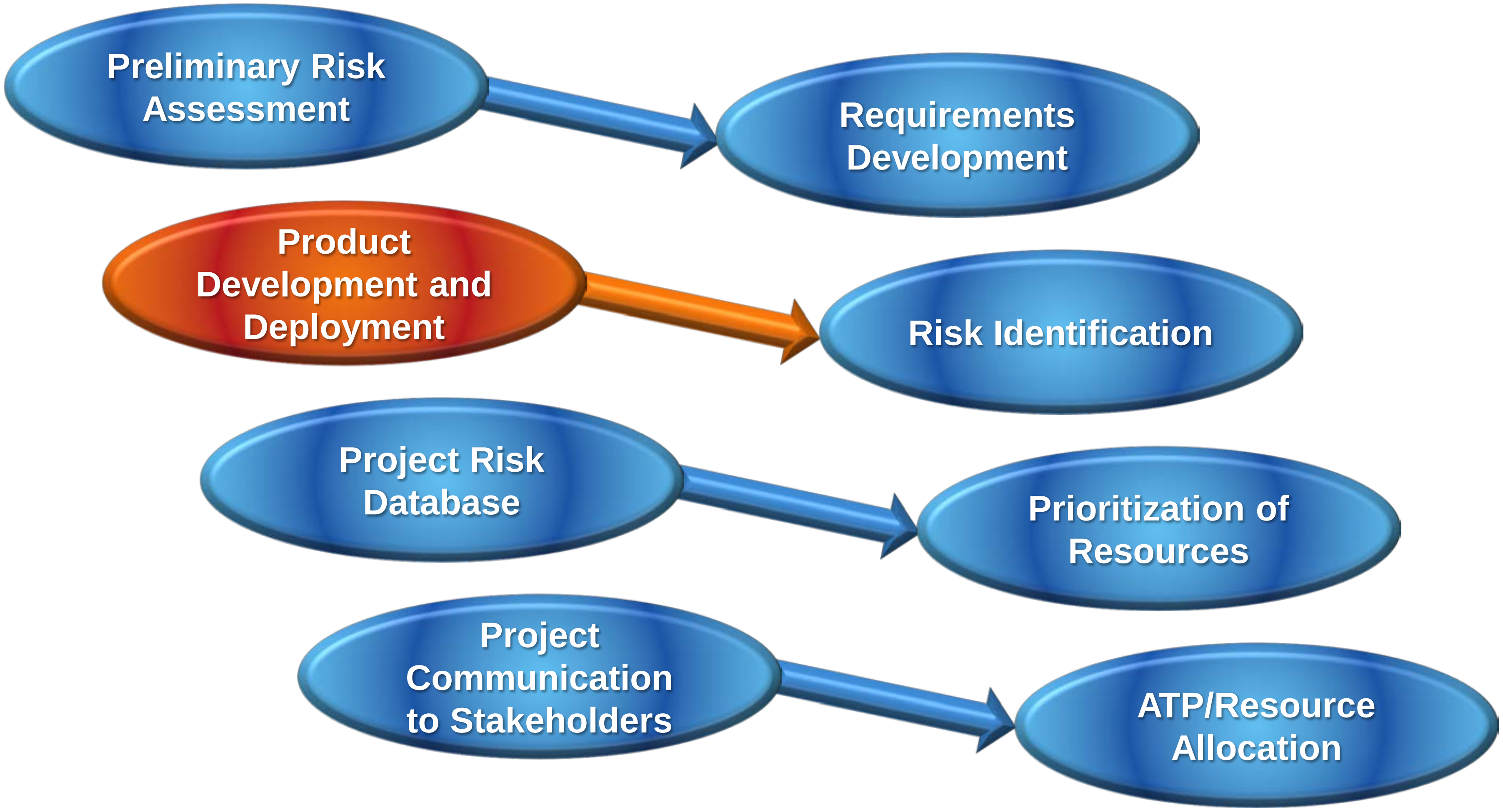
Statistically-based Risk:
- Heritage similarity
- Prior failure/anomaly history
- Reliable design

Summary

- Risk is an essential element of Space System Development
- Risk Classification is generally about priority and payoff on the stakeholder side and trades of resources and programmatic risks to buy down other programmatic risks and technical risks on the developer side
- Class D is more of a philosophy and general approach than a set of requirements.

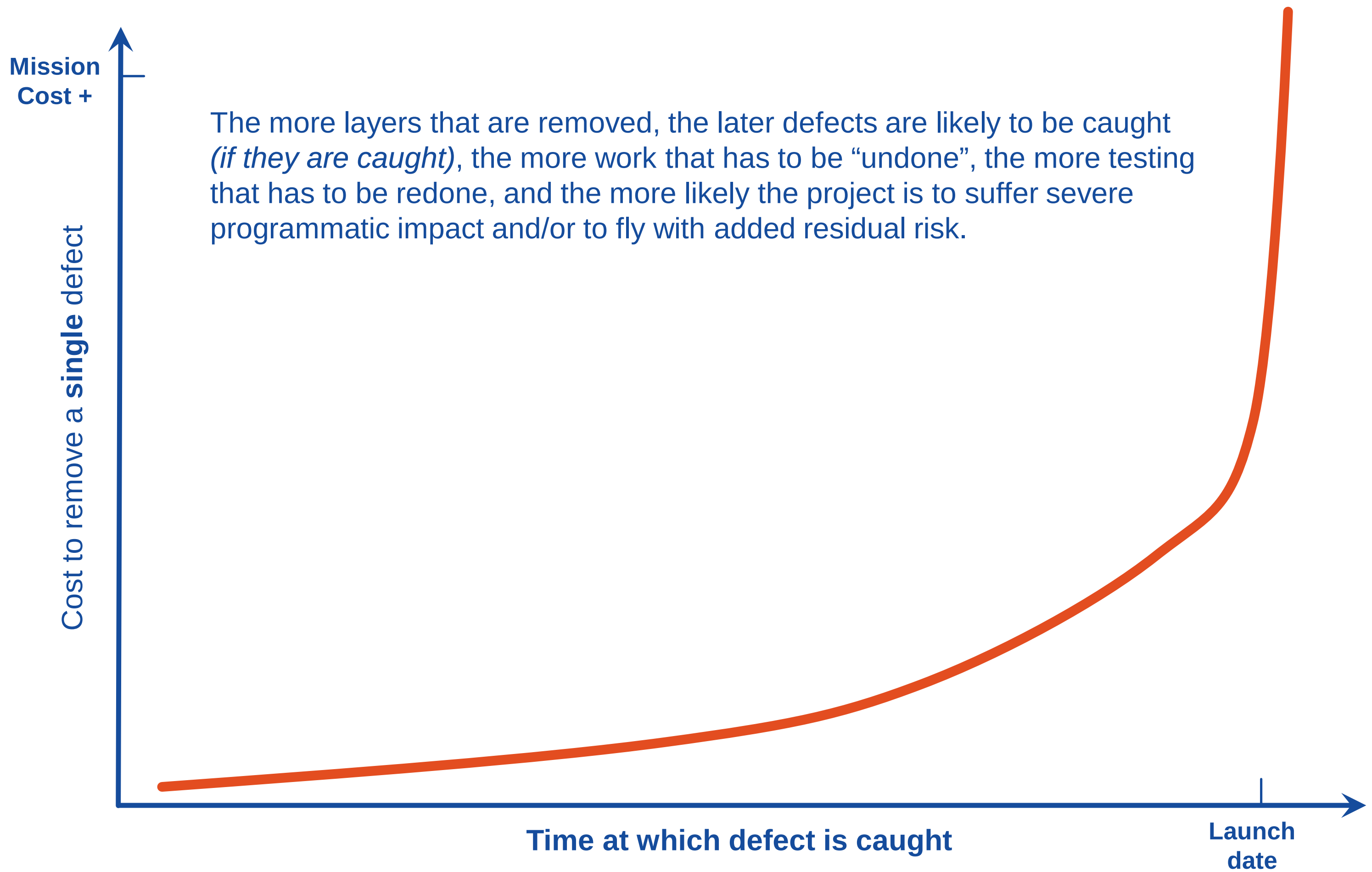
Backups to Draw From

Risk as a Development Tool



Cost vs Time to eliminate a defect

Removing layers results in some defects not being caught, and some being caught later.



Risk Classification—All Levels

- **Class A missions can have Class D elements**
  - Non-critical
  - Highly redundant
  - Deliveries with acceptable “defects”

- **Class D mission can have Class A elements**
  - Critical elements
  - Only available
  - Spares from other projects

Class D (*and below*) Categories

Science Mission (NPR 7120.5)	Research/Technology (NPR 7120.8)	Do No Harm
• Cost > = mission success • Schedule flexible (low priority) • ~6 mo.–2 yr. life • Project failure = mishap • Medium technical risks (may fly with many yellow risks)	• Very low cost individual projects • Schedule flexible (low priority) • High technical risk • Very short lifetime (< ~3 months) • Success is determined over multiple projects, e.g., 85% success over one year's worth • Project failure is not a mishap	• Only requirement—do no harm to personnel or other property (e.g. ISS) • Schedule flexible (low priority) • Very high technical risk • Lifetime is best effort • Project failure is not a mishap

Center Challenges and Perceived Challenges for Low Cost Implementation In-house at GSFC

- **GSFC directives and standards** (more detail in backup)
  - A dozen or so GPRs, Center wide PGs and standards for workmanship, environmental test, and GOLD rules
  - Mostly handled by common practices
  - Risk classification is not handled well for those that have significant impact
  - Software requirements are the biggest burden, without particular basis in risk

- **NASA directives and standards**
  - Numerous NPRs, NPDs, and standards
  - Similar statement to above applies

- **Engineering resource budgeting**—not closely tuned to streamlined implementation

The GSFC Quality Triangle

CRAE: Commodity Risk Assessment Engineer

Commodity: Tangible or intangible entity that has a major impact on risk, cost or schedule for GSFC projects

- Expert in key discipline area with background and experience with reliability and risk
- Responsible and empowered to assign risks based on warnings, alerts, environments, and "what we are stuck with"
- Establishes testing programs and protocols to keep up with current design practices and common parts and components
- Sets the policies for the risk-based decisions on use of parts, components, and processes
- Establishes layers of risk reduction based on risk classification (ownership of GPR 8705.4)
- Determines the acceptability and risk of alternate standards or requirements, or deviations and non-conformances
- Answers, "are we okay?", "why are we okay?", "how okay are we?"
- Provides risk assessment to the project for the project to decide how they want to disposition

Commodity Areas

- Standard Spacecraft Components
- Printed Circuit Boards
- Digital Electronics (especially FPGAs and ASICs)
- Power Systems
- Capacitors/inductors
- Transistors
- Resistors
- Hybrid microcircuits
- Optocouplers
- On-board processors
- Workmanship/Printed Wiring Assemblies/Packaging/Components
- Software
- Materials
- Radiation
- Environmental testing
- Contamination
- Connectors
- ESD

What is Risk-Based SMA?

The process of applying limited resources to maximize the chance for safety & mission success by focusing on mitigating specific risks that are applicable to the project vs. simply enforcing a set of requirements because they have always worked

Risk-based SMA is now GSFC policy—GPR 8705.4

Attributes of Risk-Based SMA

- ***Upfront assessment*** of reliability and risk, e.g. tall poles, to prioritize how resources and requirements will be applied
- ***Evaluating all risk categories*** (safety, technical, and programmatic) together to assure all factors are considered
- ***Early discussions*** with developer on their approach for ensuring mission success (e.g., use of high-quality parts for critical items and lower grade parts where design is fault-tolerant) and responsiveness to feedback
- ***Judicious application*** of requirements based on learning from previous projects and the results from the reliability/risk assessment, and the operating environment (Lessons Learned—multiple sources, Cross-cutting risk assessments etc.)
- ***Careful consideration*** of the approach recommended by the developer
- ***Characterization of risk*** for nonconforming items to determine suitability for use—project makes determination whether to accept, not accept, or mitigate risks based on consideration of all risks
- ***Continuous review*** of requirements for suitability based on current processes, technologies, and recent experiences
- ***Consideration*** of the risk of implementing a requirement and the risk of not implementing the requirement.

Note: Always determine the cause before making repeated attempts to produce a product after failures or nonconformance's

Risk of Conformance vs. Risk of Nonconformance

- Were requirements imposed based on an understanding of the risks within a project?
- What are the risks associated with the enforcement of requirements?
- What is the risk associated with a particular nonconformance?
- Should we immediately assume that a nonconforming item is risky for the application?
- In many cases there is a good reason why a product is nonconforming

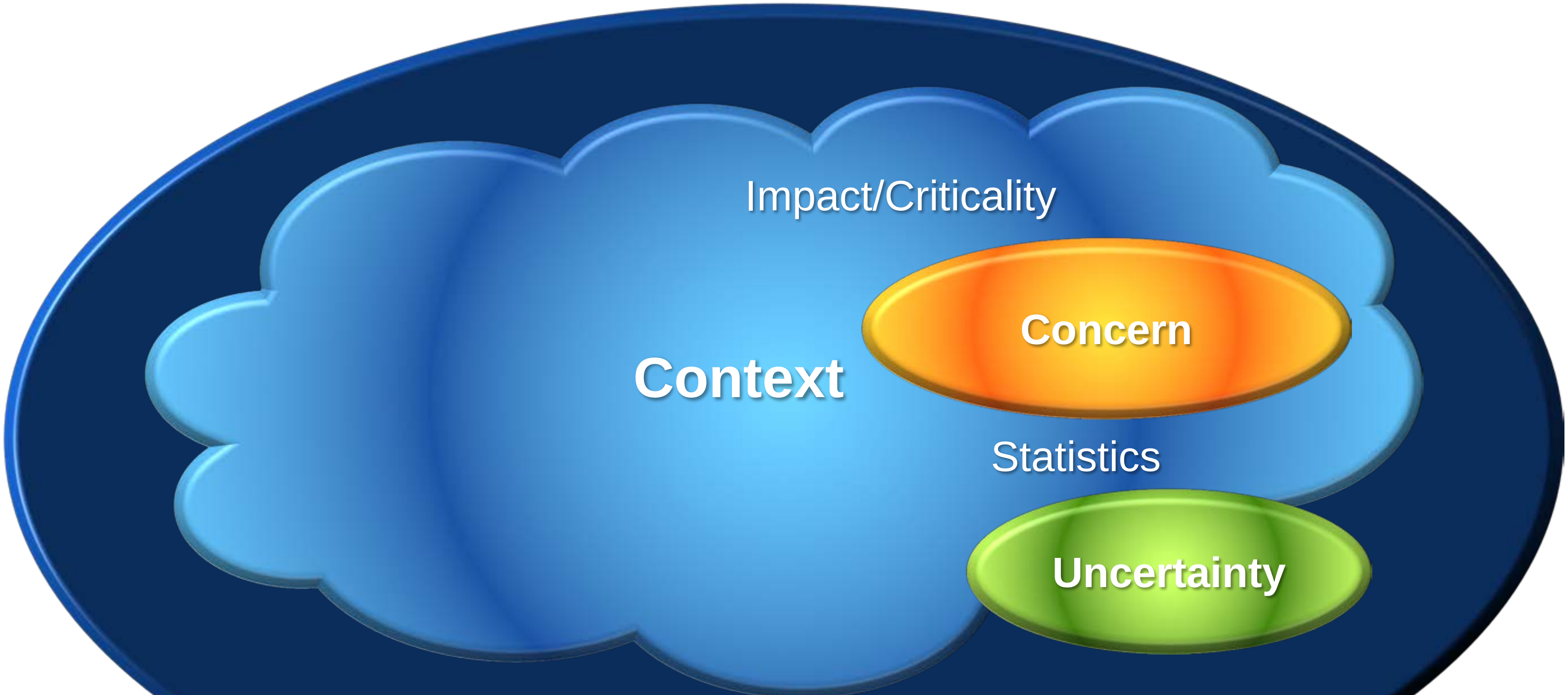
Do not reject a nonconforming item without understanding the risk.
Determine the cause of NC before reproducing the item.

NASA

What is Risk?

- Definition: the combination of
  - a) the probability (qualitative or quantitative) that an undesired event will occur, and
  - b) the consequence or impact of the undesired event
  - In short, risk is an expectation of loss in statistical terms
- Flavors of risk (consequences)
  - Technical (failure or performance degradation on-orbit)
  - Cost ($ it will take to fix the problem)
  - Schedule (time to fix the problem)
  - Safety (injury, death, or collateral damage)

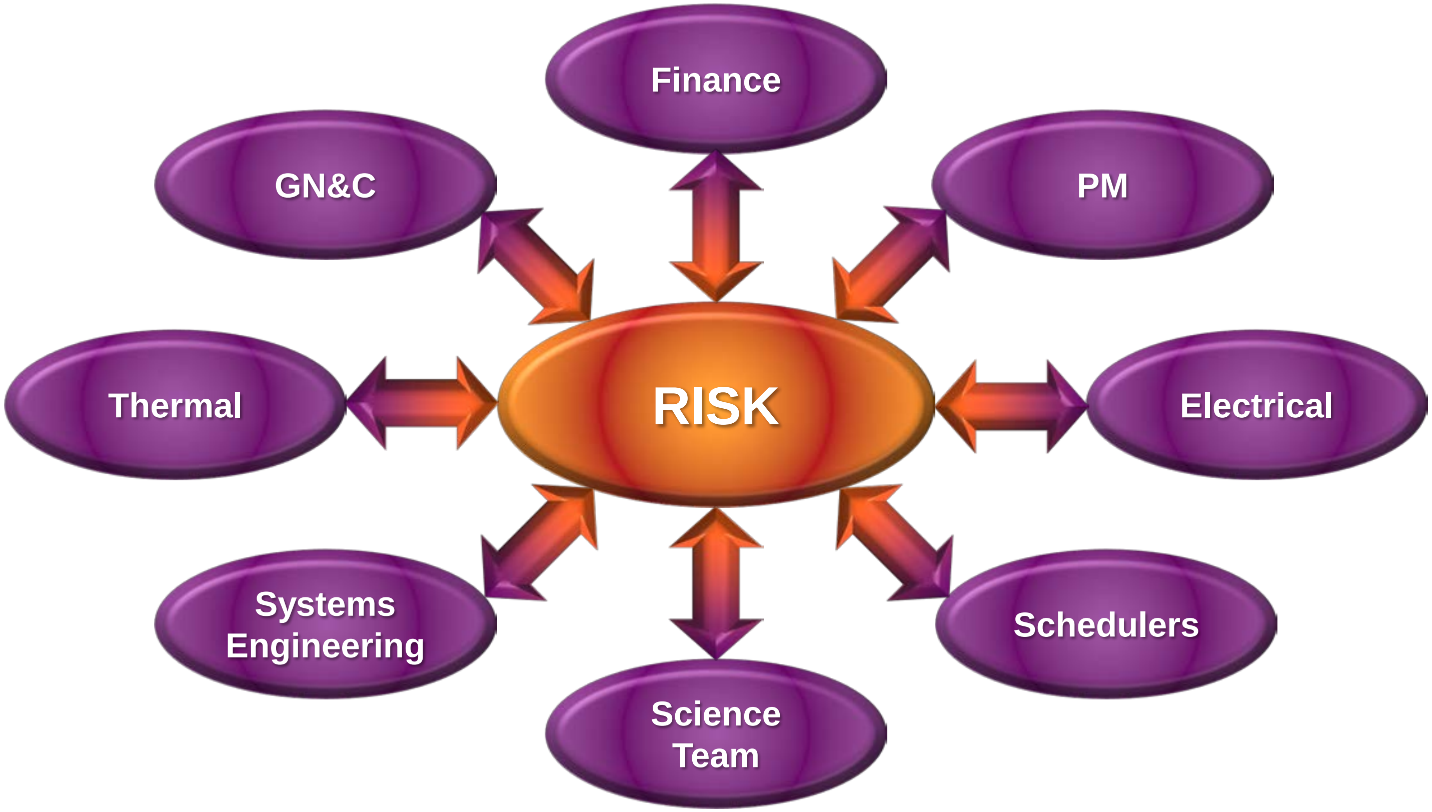
Anatomy of a Risk



- Structured risk statement
- Likelihood
- Consequence

Risk as a Common Language

- Risk is the common communication language between all of the technical and nontechnical disciplines in a project



Baseline and Credible Risk

- Baseline risk: the normal level of risk in developing and assembling a product
  - This can be considered as risk that is accepted by a project initiation without further tracking or debate
  - Generally we do not track risks within the baseline
  - Experienced developers mitigate baseline risks

- Credible risk: risk having likelihood category of at least “1” on the pertinent risk scale (note that in GSFC’s risk scale there are 5 categories and 1 is the lowest risk category)
  - There are an infinite number of risks that are not credible for any project

Breakdowns of Risk in Space Systems

- Risk can be broken down in many ways
- Within space systems such breakdowns are necessary to address various concepts
  - Risk classification
  - Risk-based engineering and SMA
  - Risk-informed or risk-based decision making
- The following charts will illustrate some of these breakdowns

Uncertain vs Statistical Risk Breakdown

Uncertainty-based Risk:
Risk based on the unknown: we haven't tried this or tried it this way before

Dominated by "Unknown unknowns"

Statistically-based Risk:
Risk based on prior history, known failure rates

Uncertain vs Statistical Risk

Detailed elements

Uncertainty-based Risk:

- Alternate practices
- Reduced testing margins
- Use of COTS parts and components with limited history
- Fear of the unknown
- Blind single-string design

Statistically-based Risk:
- Heritage similarity
- Prior failure/anomaly history
- Reliable design

Risk vs. Possibility

- Failure modes and mechanisms can appear through
  - Analysis and simulation
  - Observation
  - Prior experiences
  - Brainstorming "what if" scenarios
  - Speculation
- These all constitute ***possibilities***
- There is a tendency to take action to eliminate severe consequences regardless of the probability of occurrence
- When a possibility is combined with an environment, an operating regime, and supporting data, a risk can be established—this is core to the engineering process
- Lack of careful and reasoned analysis of each possibility in terms of the conditions that results in the consequence and the probability of occurrence **will** result in excessive cost and **may** increase the overall risk

Balanced Risk
(maintaining a level waterbed)

- A systems approach of looking across all options to ensure that mitigating or eliminating a particular risk does not cause much greater risk somewhere in the system

Try to maintain the level waterbed

Pushing too hard on individual risks can cause other risks to be inordinately high

Unbalanced Risk Example

- General safety requirements dictate that anything considered "safety" requires 3 inhibits.
- Unfortunately, many elements prior to launch vehicle separation that are tied solely to mission success are put under the safety umbrella.
- This means that by default, many items such as premature deployment of solar arrays or other appendages are considered a safety issue for the on-orbit portion, even if they have no range safety effect, and they prompt a decision that it is always better to have more inhibits even if such a design prompts an even greater risk of mission failure due to one of the inhibits not releasing.
- Ultimately, under the guise of “safety” we may end up with a less reliable system that is not more safe if we are not diligent with system-level thinking

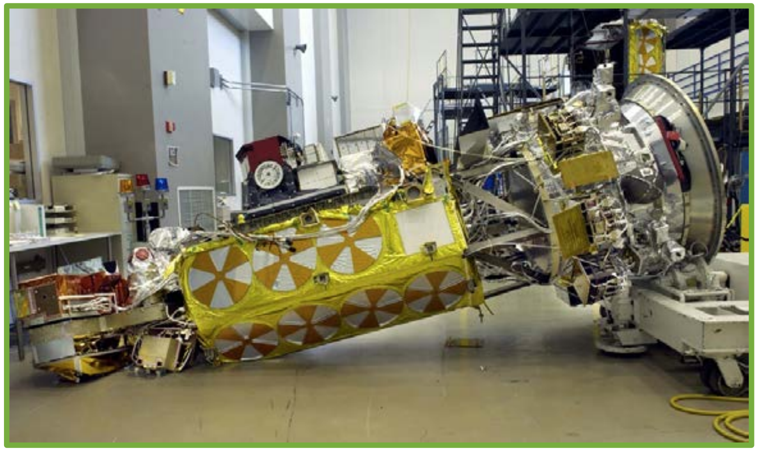
Perspectives of Risk—What Attributes are Used to Paint the Risk Picture?

Stakeholder

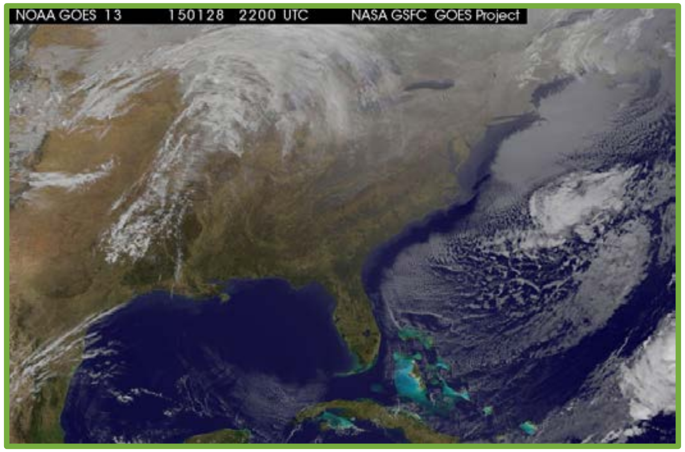
- Well-established requirements and processes followed
- Assessment from independent review team
- Project risks presented
- Problem records
- Waivers

Developer

- Early design phase brainstorming
- Experiences in integration and test
- Project risks tracked
- Team internal dynamics and confidence
- PI/PM/systems engineer confidence



What do you mean you're not following the NASA Lifting Standard?



We know how to do this—we've done it before.

Risk Acceptance at Different Levels and Times

- The primary stakeholder(s) (MDAA, Center Director, NOAA, user community, etc.) accept(s) risks for project mission success
- Risk acceptance is delegated to the project to manage real-time, day-to-day development
  - Stakeholder has right of refusal through risk communication
- Safety and Mission Assurance ensures the risks are properly captured and communicated
- Many risks based on programmatic concerns are accepted from day one
- Most technical risks need not be accepted until launch
  - Many risks involve items that are buried into a system such that removal will be very painful and are for all intents and purposes accepted early on
- Programmatic risks that have not been fully mitigated will frequently become technical risks, i.e., there may be a latent defect that survived through I&T

SMD Class D MAR (agency solution): Significant departures from common practices (1/3)

- GMIPs (consistent with NPR 8735.2B)
  - No predefined set of GMIPs
  - Based on upfront negotiation considering
    - assessment of developer's own inspection points
    - developer identified risks
    - project identified risks; and furthermore in response to events, such as failures, anomalies, and process shortfalls that prompt a need for further inspection.
  - Will be coordinated with the project to maximize efficiency and minimize schedule impact
- Inherited items process
  - Allows a holistic, risk-based process based on
    - Prior history
    - Changes from previous (in H/W, S/W, operation, environment)
    - Past anomalies
  - Allows prior processes to be used without waivers
  - Decisions to use or impose additional tests, etc., based on risk

SMD Class D MAR (agency solution): Significant departures from common practices (2/3)

- Workmanship
  - Required to follow only IPC-610 and J-STD-001X, where X is rev E or later
    - With further option to follow proven, comparable developer practices
  - Other standards for reference or information
- EEE parts
  - based on
    - Prior usage of the part and qualification for the specific application
    - Manufacturing variability with lots and from lot to lot for parts
    - Traceability and pedigree of parts
    - Reliability basis for parts.
  - All DLA MIL-SPEC or EEE-INST-002 level 3 compliant parts acceptable without additional actions

SMD Class D MAR (agency solution): Significant departures from common practices (3/3)

- Radiation
  - Emphasis on radiation-tolerant design
  - Part-by-part analysis and testing otherwise
- Printed Wiring Boards
  - Use own preferred standard
  - Project retains coupons or spare boards until mission disposal

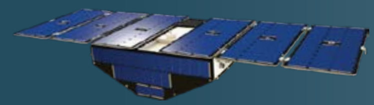
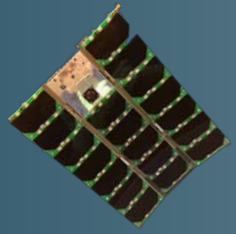
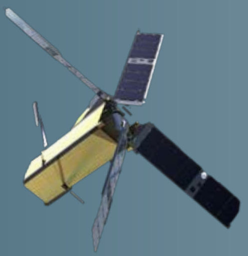
SMD Class D MAR (agency solution): Minor departures from common practices

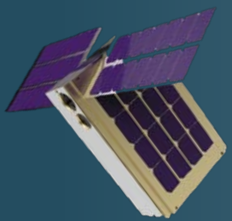
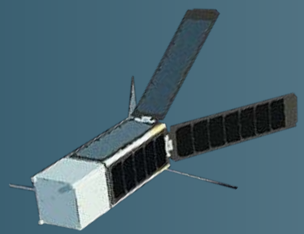
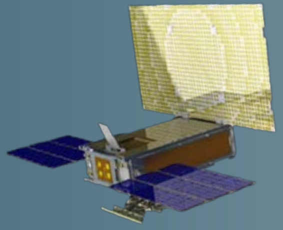
- ARB/MRB/FRB
  - Government notified and invited to participate in type I (form, fit, function)
  - Type II – Government given access to, but timely notification not required
- Reliability
  - Project completes reliability analysis (e.g., FTA, FMEA) for faults that may lead to injury to personnel or the public, or produce orbital debris, or that may affect host platforms
  - Parts stress and derating analysis per EEE-INST-002
- Software assurance
  - NASA-STD-8739.8 and IEEE 730 used as guidelines*
- Software safety
  - Safety critical elements determined from the hazard analysis and range requirements
- GIDEP: project shall take action to mitigate the effects of alerts on the project

*will require discussion w/SW assurance

SMD view of Class D

Class D Examples

	CYGNSS	MinXSS	RAVAN
IN FLIGHT			

	LunaH-Map	TROPICS	MarCO
IN DEVELOPMENT			

SMD Portfolio Defined

CLASS A

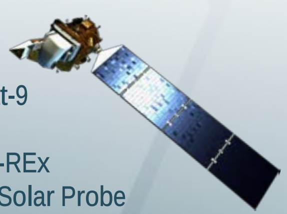
- High priority
- Very high significance
- High complexity
- Long mission lifetime
- High cost
- Critical launch constraints
- No re-flight opportunities

Cassini
Webb
Europa Clipper
Mars 2020

CLASS B

- High priority
- High significance
- High to medium complexity
- Medium mission lifetime
- High to medium cost
- Medium launch constraints

Juno
Landsat-9
InSight
OSIRIS-REx
Parker Solar Probe

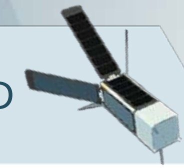


CLASS C

- Medium priority
- Medium significance
- Medium to low complexity
- Short mission lifetime
- Medium to low cost
- Few launch constraints

MMS
ICESat-2
TESS
GRACE Follow-on
ICON

CLASS D



- Low priority
- Low to medium significance
- Short mission lifetime
- Medium / low complexity
- Low cost
- Few to no launch constraints
- Re-flight opportunities

CYGNSS
NICER
TROPICS
GeoCarb
ECOSTRESS

Class D Strategy Implementation

Accepting higher risk for scientific gain by implementing a tailored, streamlined classification approach

SMD Implementation Reviews

- Lifecycle Reviews conducted by project implementing institution
- Only two NASA required reviews during the Project development lifecycle
- Delegated Decision Authority
- Review Teams as small as practicable

SMD Implementation Documentation

- Only final documentation submitted to NASA HQs for approval; no preliminary documentation
- Final Project documentation approved at the Division Director level
- Merging documentation encouraged
- Tailoring Mission Assurance Requirements (MAR), with a goal to reduce documentation deliverables and reviews

SMD Implementation Performance Management

- Formal Earned Value Management (EVM) and a certified EVM system is not required
- NASA will develop only one NASA ICE/ISE
- KDP-C decision will be made based on 60% confidence levels, and not based on the usual 70%
- 7 Basic principles apply: Per Robert Lightfoot memo 9/26/14, AO website: https://soma.larc.nasa.gov/standardao/