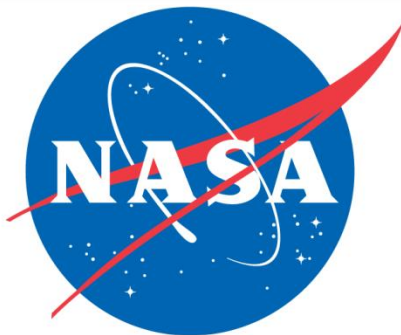




# FLIGHT PROJECTS DIRECTORATE

## CROSS-CUTTING RISK FRAMEWORK: MINING DATA FOR COMMON RISKS ACROSS THE PORTFOLIO



**GERALD A. KLEIN, JR.**  
**VAL RUARK**

IEEE 2017 AEROSPACE CONFERENCE



## MINING DATA FOR COMMON RISKS ACROSS THE PORTFOLIO

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# OVERVIEW

- **Background**
- **Concept**
- **Approach**
- **Initial Findings**
- **Success and Failures**
- **Results**
- **Lessons Learned**

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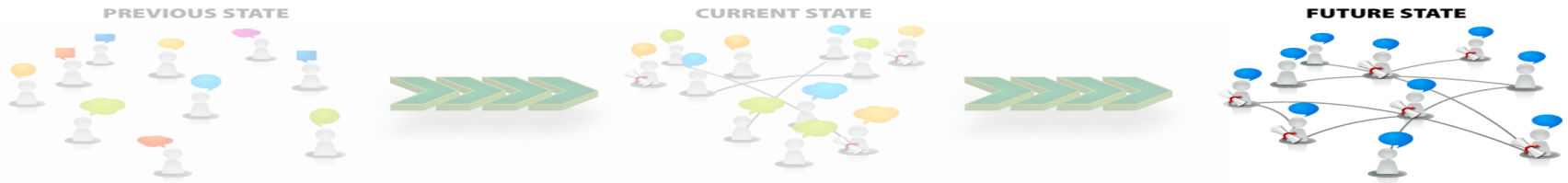
# BACKGROUND

- The National Aeronautics and Space Administration (NASA) defines risk management as an integrated framework, combining risk-informed decision making and continuous risk management to foster forward-thinking and decision making from an integrated risk perspective; therefore, decision makers must have access to risks *outside of their own project* to gain the knowledge that provides the *integrated* risk perspective.
- In the Summer of 2013, through the Goddard Space Flight Center (GSFC) Flight Projects Directorate (FPD) Business Change Initiative (BCI), discussions began to integrate project risks into one repository to facilitate access to risk data between projects, the cross-cutting risk framework (CCRF) team was formed
- The creation of the consolidated risk repository, in parallel with the initiation of monthly FPD risk managers and risk governance board meetings, are now providing a complete risk management picture spanning the entire flight projects portfolio

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# BUSINESS CHANGE INITIATIVE

The Business Change Initiative (BCI) is a comprehensive evaluation of program planning and control (PP&C), as well as programmatic communication and information sharing mechanisms to improve cost, schedule, and overall performance across the Flight Projects Portfolio



### Disparate Community

- Rising costs and schedule delays
- Varying processes and tools
- Increasing competition
- Oncoming retirement wave and corresponding knowledge gap risks
- Expanding reviews and data requests
- Confining pockets of PP&C excellence

#### RESULTS

- Numerous re-plans
- Redundant activities and systems
- Limited new business
- Limited experts/diversity
- Poor communications and visibility into project performance
- Insufficient willingness and mechanisms to share expertise

### Breaking Barriers

- Envisioning desired end state
- Defining stakeholder/project team needs
- Designing plans and material
- Developing guidance, tools, and resources
- Deploying and communicating changes across FPD and partners
- Sustaining process improvements

### Integrated Community

- Increased visibility and accountability
- Advanced tools and resources
- Common policies and requirements
- Enhanced training and knowledge sharing
- Expanded risk management
- Improved cost and schedule performance across mission portfolio

#### RESULTS

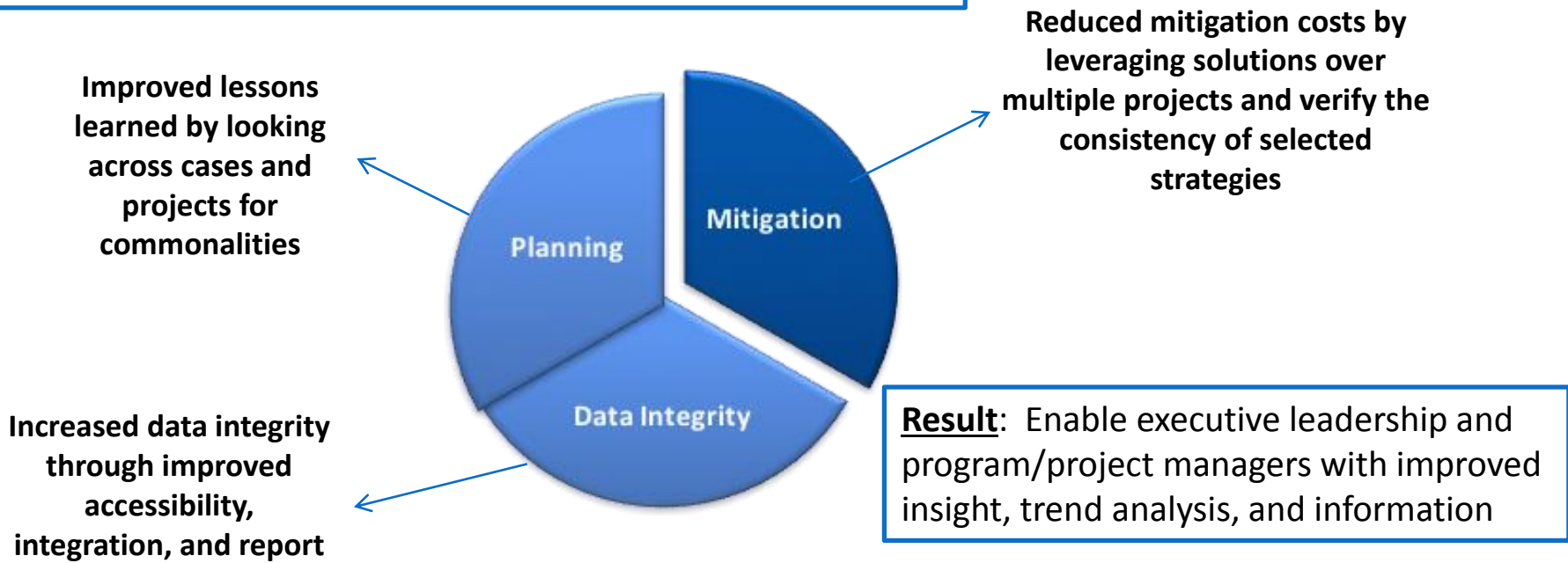
- Efficient PP&C
- Accurate data
- Consistent application of practices
- Skilled, diverse workforce
- Early risk identification and mitigation
- On-time delivery and cost effectiveness to ensure mission success

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# GETTING OFF THE GROUND

FPD sponsored the effort as part of the BCI, enlisting the help of GSFC’s Safety and Mission Assurance Reliability Office to define, design, develop, and deploy an approach to streamline the process of identifying “cross-cutting” risks

**Objective:** Establish a portfolio-level analysis for the strategic and tactical study of common risks

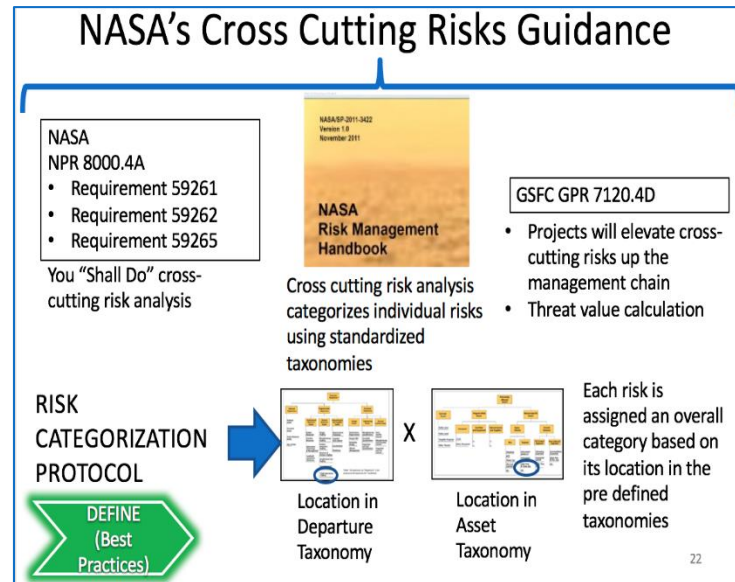


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# FEASIBILITY STUDY

A cross-cutting Excel Workbook was developed, structured around the guidance provided in the NASA Risk Handbook. Historic and current risks were downloaded from select project risk registers. Individual risks were categorized; 1,130 unique risks on 5 projects were used to develop a proof of concept. Filters were designed to quickly narrow the field of risk information for detailed cross-cutting review and analysis to identify:

- Tactical opportunities for improving mitigation process at the portfolio level
- Strategic opportunities for identifying system improvements



The results of a feasibility study assisted to identify critical next steps:

- Determine a home for the data
- Launch RM focus group meetings
- Request data from all FPD programs/projects
- Organize the data for further use
- Establish a repeatable, monthly process for the cross-cutting risk framework (CCRF)

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# APPROACH

The data would be maintained through the creation of a monthly collection of month-end risk register submissions from all program/projects; a CCRF monthly process was established:



Initial data entry was completed in the FPD cross-cutting risk database for the FPD mission portfolio by the **FPD front office**; all project were organized under their respective division office and line of business; milestone dates were inserted from the FPD master schedule and MSR reporting



Risk data is exported from project risk registers monthly and saved in a Microsoft Excel format; **the project** uploads into a document library as part of the monthly project tag-up/MSR process



The **FPD SharePoint administrator** initiates input from the document library into the FPD cross-cutting risk database; the database recognizes all new and updated risk entries to formulate a report for the **independent risk lead(s)**



The **independent risk lead(s)** categorizes all risks noted in report (new and updated) into appropriate "departure" and "asset" categories and saves in the FPD cross-cutting risk database



**FPD Risk Community of Practice** uses data to run queries on risk information and formulate monthly risk reports for the FPD risk governance board



The **FPD governance board** meets at month-end to review monthly risk report from **FPD Risk Community of Practice**; results are shared at **FPD Program Managers Staff** and the top cross-cutting risks are reported at the last Wednesday Weekly Tag-up



All monthly reports are archived and accessible by **FPD program/project leadership**; database accessibility remains open with controlled access to **FPD leadership** throughout the monthly process to run individual reports and data queries; **FPD front office maintains the database**

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# CROSS-CUTTING RISK DATABASE V.1

## Controlled Access

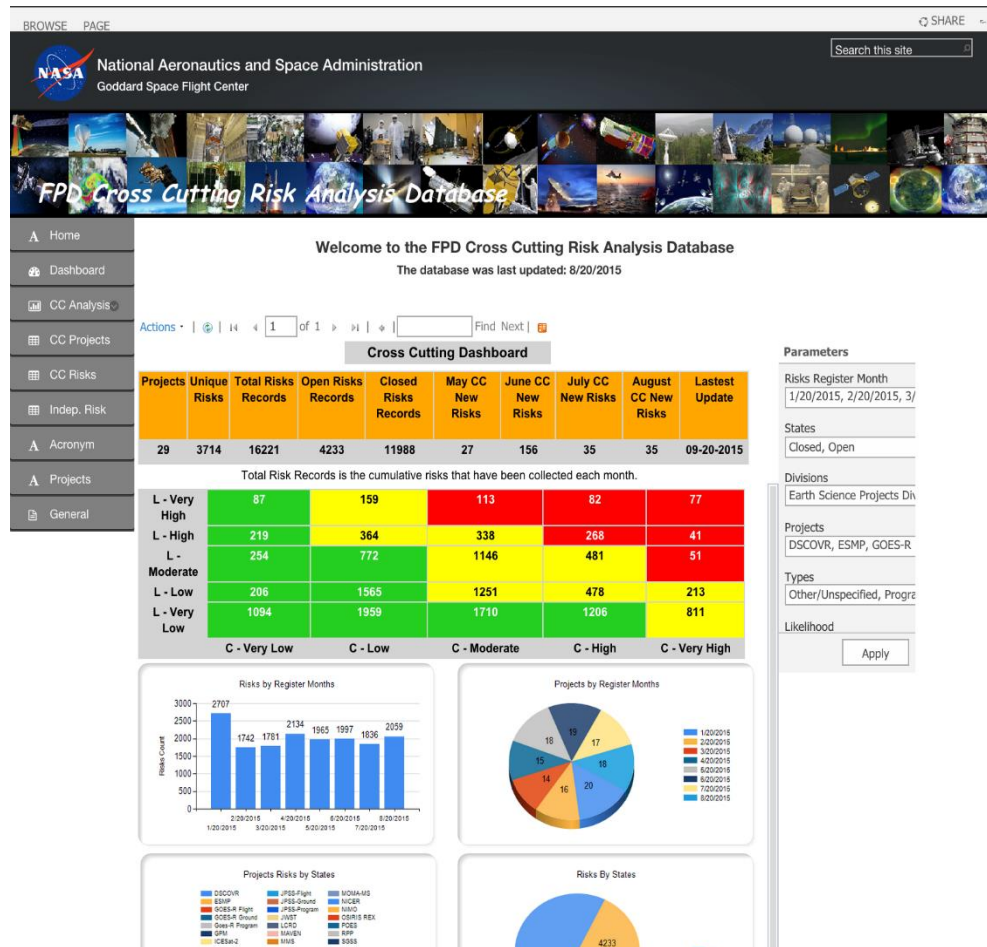
- Identified user groups (editorial, contribute, and read-only)
- Monitored use by user
- Logged and tracked monthly updates

## Accessibility

- Availability of cross-cutting risk data to FPD leadership and risk managers
- Visibility into risk management planning and lessons learned

## Analysis

- Features to trend and benchmark against other risks, projects, and lines of business
- Queries and reports to drill into related risks to identify cross-cutting trends
- Dashboards to assess the current risk posture of the flight projects mission portfolio





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# ASSET AND DEPARTURE HIERARCHY

Data organization began with grouping by FPD division, followed by program and project; for the next level of risk organization, the team grouped risk data into two major categories, Assets and Departures, as suggested in NASA Risk Management Handbook, Section 4.3.3.1.1 Cross-Cutting Risks



## EXAMPLES

- External
  - Programmatic
  - Economic
  - Acts of God
- Programmatic
  - Human Resource
    - Design Staffing
    - Launch Support Staffing
  - Subcontractor
- Technical
  - Design
    - Design V&V
    - Reliability Design
  - Engineering
  - Process Control

- External
  - Public Lives
- Program Wide Assets
  - Personnel
  - Facilities and Equipment
    - NOAA
    - Other
- Mission Specific Assets
  - Space Vehicle Bus
    - Communication
    - Propulsion
  - Space Vehicle Flight System
    - Launch Vehicle
  - Ground Segment Space Vehicle Control
  - Ground Element Data Collection

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# INITIAL FINDINGS

Early results allowed the team to convey common risks across multiple projects. Searches on risk type (cost, schedule, technical) produced initial findings

CROSS-CUTTING > DEPARTURES > EXTERNAL > POLITICAL > **SEQUESTRATION/CR FUNDING**

### Risk Summary Data

- Count of risks
- % budget at risk
- Budgeted \$ at risk
- Risk details

### Filtered by (any or all combinations) to Uncover Commonalities

- 3 Levels of Departure Drill Down
- 3 Levels of Asset Detail Drill Down
- Date opened
- Project Phase Opened
- Project Name
- Risk state (Open, Closed)

External 2							53
Political							37
<input type="checkbox"/>	DSCOV						2
		FY 14 Sequestration Reduction	DSCO55	Watch	1/22/2014	Phase C	1
		Mechanical Ground Support Equipment needed for TVAC	DSCO65	Watch	11/27/2013	Phase C	1
<input type="checkbox"/>	GOES-R Flight						1
<input type="checkbox"/>	GOES-R Ground						4
<input type="checkbox"/>	GPM						5
<input type="checkbox"/>	ICESat-2						2
		Change of GPS signal structure on L2	ICESat-2-RISK-MISSION-0052	Close	2/28/2011	Phase B	1
		Continuing Resolution Funding	ICESat-2-ISSUE-MISSION-0055		1/7/2011	Phase B	1
<input type="checkbox"/>	JPSS-1						7
<input type="checkbox"/>	JPSS-2						1
<input type="checkbox"/>	JWST						2
<input type="checkbox"/>	MAVEN						3
		External Programmatic Instability (Schedule)	107		9/26/2012	Phase D	1
		Lockheed Martin Pension Harmonization	101	Watch	4/5/2012	Phase D	1
		Sequestration or Other External Programmatic Instability (Funding)	106	Watch	9/14/2012	Phase D	1

## AUTOMATING THE SEARCH FOR CROSS-CUTTING RISKS

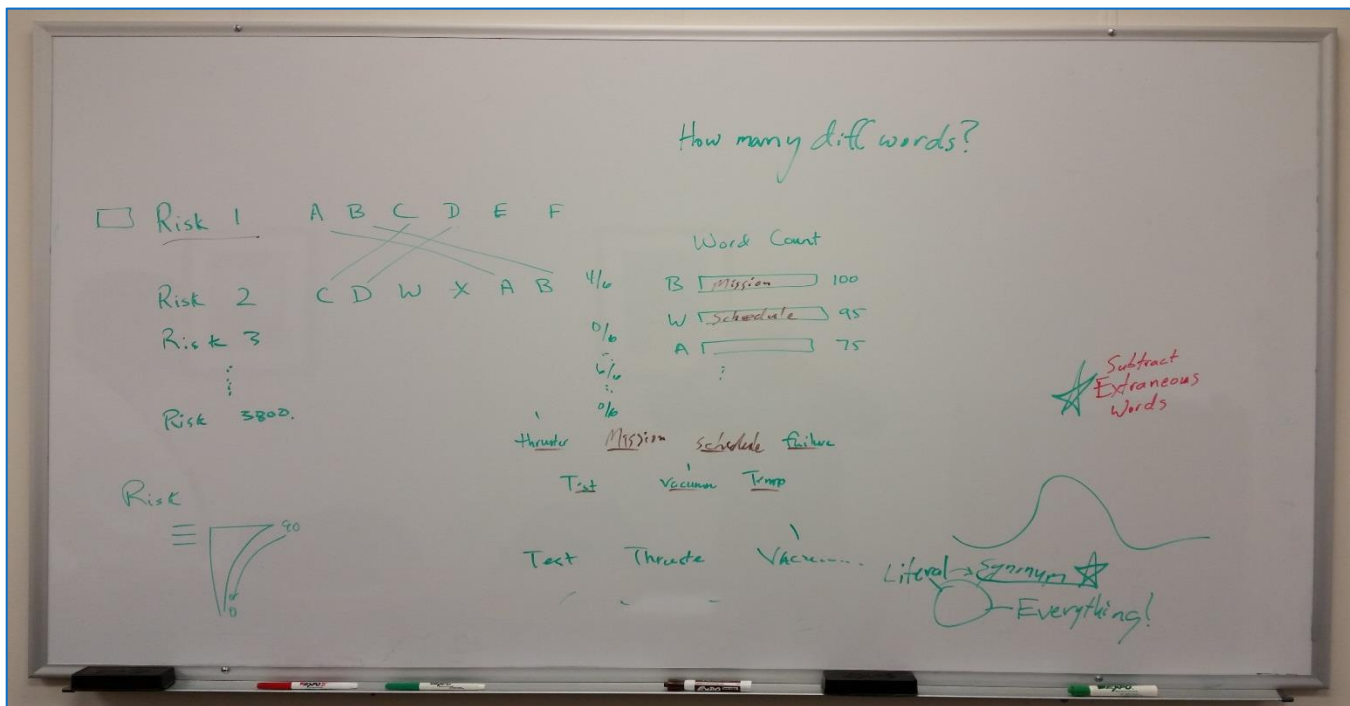
- The “Independent Risk Team” was established to leverage all the risk data in one location; the Team focused on:
  - Automating the search for cross-cutting risks
  - Identifying trends, strengths, weaknesses, and opportunities
  - Providing monthly briefings to FPD and SMA management, and soliciting feedback
- Initial analysis revealed a high percentage of risks being classified as “Other;” this caused the Team to re-examine the categorization approach from a “clean-slate” perspective
- In parallel, commercial-off-the-shelf (COTS) data analysis software packages were evaluated; open-source word count software was identified and evaluated
- Approach to prototype the word count function in the SharePoint CCRF tool was approved; a prototype was developed based on a Team brainstorming session

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# WORD COUNT FUNCTION

The word count concept: if the user is not sure what word they need to use for their database search, they could view a list of words found in the database, listed in order of frequency, with the most common words at the top of the list

## WORD COUNT FUNCTION BRAINSTORMING WHITEBOARD



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# CHALLENGES

- Initial word count results revealed the extent of the challenge: the number of different words contained in the collection of project risks was overwhelming
- Since guidance to the projects had not included standard nomenclature, use of a single word may, or may not, return the desired results
- The Team determined that the word count function would benefit from “inclusion” and “exclusion” lists to return results from synonyms similar to Google searches

Word/Phrase Search	Results
project integration and test phase	Integration and Test Integration & Test I&T I and T InT Integration Test
valve	pyro valve ball valve cutoff valve isolation valve pyrotechnic valve shutoff valve shut-off valve cut-off valve




## Word Count Report

- Dashboards
- Data Connections
- Libraries
- PerformancePoint Content
- Recent
  - UniqueRisksReports
  - UniqueRisksMaster
  - UniqueIssues
  - UniqueRisksMaster
  - UniqueIssuesMaster
- Word Count Report**
- Word Count Configuration
- Site Contents

Word Count Configuration Page [Configure excluded words](#) [Configure phrases/synonyms](#)

Retrieve Word Count Data

Select a project: 

 Filter mode [\[+\] Add comparison project](#)  
 Comparison mode [\[-\] Remove comparison project](#)

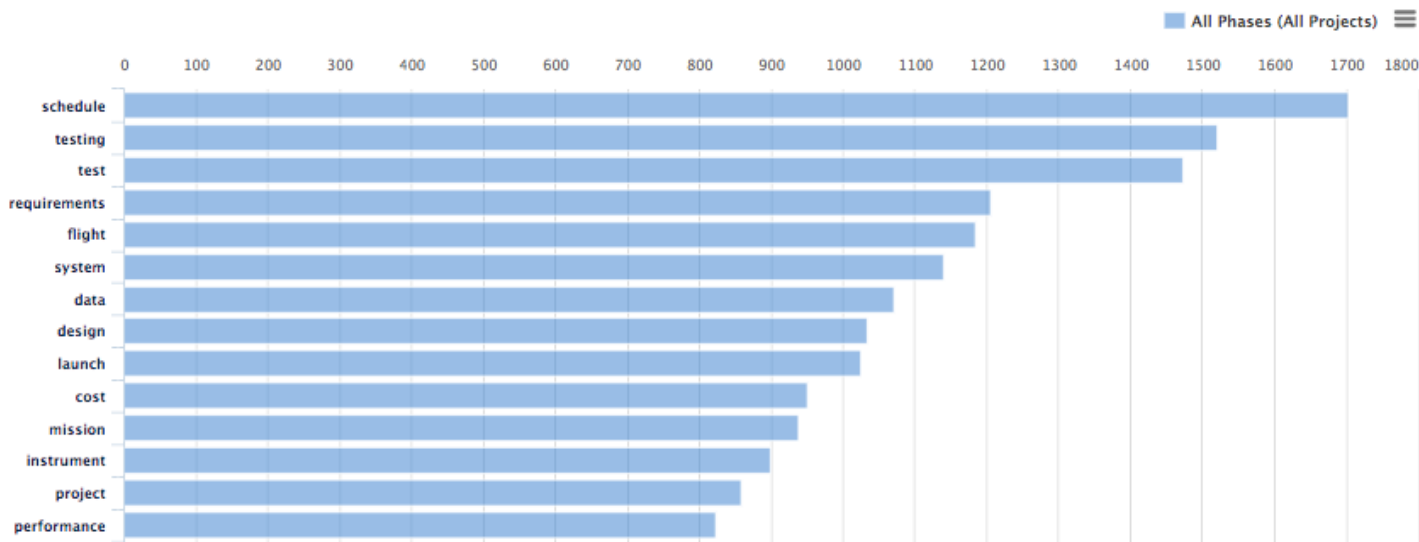
Include project phase data   
  Include newest risks only   
  Count keywords only  
 Filter by Responsible Division

Click on a bar or bar segment to drill down and see details.  
 To see a list of unique risk IDs that contain a word, drill down to see the word's details, and click on the word in the legend in the upper right of the graph to see risks from all projects, or on a project's bar to see risks only from that project.




Enter search terms (comma separated) above.

<< First < Prev 1 of 20 Next > Last >>



## MINING DATA FOR COMMON RISKS ACROSS THE PORTFOLIO

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# REEXAMINING THE CATEGORIZATION TECHNIQUE

- Too many risks ending up in the “Other” category; the original Assets and Departures approach was re-examined; the categories needed to more closely mirror the GSFC workflows
- Project work breakdown structures (WBS) were compared to Asset and Departure categories; a risk breakdown structure based on the project’s WBS was deemed to be an improvement
- After drafting a prototype, the Team solicited feedback from other RM subject matter experts; through this collaborative effort, established the replacement data structure for evaluation
- The last set of new risks was chosen to be the test data for the evaluation; the Team met to collectively categorize the approximately 30 new risks
- The result was unexpected: the Team was having the same difficulty categorizing the risks as they had had when using the Asset and Departure structure
- The risks were written in a manner that allowed any analyst to bin them in more than one category; time after time, if there were four analysts reviewing a new risk, each of them would select a different category
- The Team concluded that, since there had not been any restrictions on nomenclature, the data was too random to categorize consistently; often the terminology used in risk titles, risk statements, and context statements was inconsistent



Tier 1	Tier 2	Tier 3	Tier 4	Tier 5	Tier 6	
Observatory/Host	Spacecraft	Thermal	Blanket			
			Radiator			
			Heat Shield			
			Heater			
			Interface			
			Cooling System	Cryogenic Dewar		
		Cryocooler				
		Cable/Harness	Connector			
			Harness	Power		
				1553		
		Mechanisms	Deployables	Latch		
				Hinge		
				Bearing		
				Gimbal		
				Antenna		
		Comm	Waveguide	Transmitter/Rec		
				Power Amp		
				Switch		
				Coding	Validation Testing	
					Varification Testing	
		Flight SW	Maintenance & Sustainment			
			Structure	Design		
		Fabrication				
		Assembly				
		Interface				
					Structural	
					Acoustic	



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# USE OF KEY WORDS WAS EXPLORED

- It is standard practice to assign key words to configuration-controlled documents as a method of simplifying searches for like items; assignment of key words to the CCRF risks was evaluated
- By now, the Team was wary of adding any CCRF tool automated functionality (essentially creating a word exclusion list for each risk automatically during the ingest process) without first validating the concept; the Team tested the concept on known cross-cutting risks
- The Team removed extraneous words in each risk, then compared the correlation of remaining words; the expectation was a correlation above 50 percent (greater than a coin-flip)
- The test was performed on two pairs of cross-cutting risks; the first pair yielded only a 20-30 percent word correlation and the second pair yielded a slightly *lower* correlation
- When the experiment was repeated between a set of risks chosen completely at random; the results were almost identical to the comparison of known cross-cutting risks
- The Team concluded that this was another case of the data randomness hindering efforts to automate the search for cross-cutting risks
- The evaluation of COTS analysis packages fared no better, even those with “neural network” capabilities (using algorithms to identify underlying data relationships in a way the human brain would use in a manual analysis process)

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# CROSS-CUTTING RISK DATABASE V.2

Today, there are 3,793 risks in the database with a total of 325 issues

**Cross Cutting Risk Dashboard**

Number of Divisions	Number of Projects	Number of Risks	Latest Update
11	26	3846	12-19-2016

All Projects

	C - Very Low	C - Low	C - Moderate	C - High	C - Very High
L - Very High	38	35	26	14	18
L - High	54	91	85	50	15
L - Moderate	83	146	232	108	18
L - Low	83	367	354	115	56
L - Very Low	513	384	473	277	211

Risks not included: 0  
(Unreported Likelihood or Consequence)

Export as CSV

Title	Risk ID	State	Originate Date	Date Closed	Likelihood	Consequence
+ DSCOVR						77
+ ESMP						72
+ GOES-R Flight						196
+ GOES-R Ground						102
+ GOES-R Program						57
+ GPM						224
+ ICESat-2						258
+ JPSS-Flight						320

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### RESULTS

Nineteen risk managers participate in sending risk registers to be included in the database. By September 2016, we had completed 13 risk manager meetings and 13 Risk Governance Board meetings that discussed commonalities that appeared across program/project risks monthly and strategize additional improvements.

The process has already begun using the forums to educate GSFC's RM community about the benefits of:

- ✓ Standard nomenclature
- ✓ Consistency with the risk title, risk statement, and context statement in each risk record
- ✓ Use of key words assigned by the program/project risk manager in each risk record

This education has been integrated into NASA GSFC "ABC's of Risk Management" training course, and risk managers are being encouraged to integrate it into their program/project-specific RM training material

## MINING DATA FOR COMMON RISKS ACROSS THE PORTFOLIO

### LESSONS LEARNED

- It is a difficult, time consuming task to analyze very large data sets that have significant randomness and independent processes – ***it requires a phased strategy with flexibility to tailor to kick-start the analysis and collect a complete data set***
- ***Organizations will benefit from having all project risk data in one database, minimally in a single, common repository***
- The process of organizing data is too subjective “after-the-fact” than when it is originally written – ***key words should be assigned to each risk by the project risk manager***
- The development of automatic analysis reports produced minimal results due to complex customization – ***search and word count functions from standard nomenclature in project data does benefit analysis to seek consistency and commonalities between risks (e.g., titles, statements, and classifications)***
- Commercial software becomes increasingly ineffective as data randomness increases – ***tools should be designed around unique organizational requirements to leverage large amounts of RM information and assist in making effective, risk-informed decisions***
- ***RM forums remain the most effective method of identifying cross-cutting risks***

## MINING DATA FOR COMMON RISKS ACROSS THE PORTFOLIO

### TERMINOLOGY

- **Portfolio** – the collection of FPD-managed missions; projects with FPD-held program authority, yet externally managed; projects with FPD-provided instrument contribution, yet externally managed; and FPD projects that are developed in-house to include spacecraft, instrument, or both
- **Portfolio-level analysis** – strategic and tactical examination of the elements of FPD’s mission portfolio by categorizing the missions by lines of business (grouping like projects and programs)
- **Cross-cutting risk** – an individual risk with attributes and impacts found in multiple levels of the organization, or in multiple organizations within the same level
- **Departure** – a statement about what might occur at a future time, a possible change from the (Agency, program, project, or activity) baseline project plan; it is the uncertainty in the occurrence or non-occurrence of the departure that is the initially identified source of a risk
- **Asset** – an element of the organizational unit portfolio, analogous to a work breakdown structure (WBS); assets represent the primary resource that is affected by the individual risk

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### AUTHOR INFORMATION



Gerald (Jerry) Klein functions as NASA Goddard Space Flight Center Flight Projects Directorate's risk management discipline lead and subject matter expert, the Joint Polar Satellite System Program risk manager, and the Instrument Projects Division risk management lead across their extensive instrument project portfolio, and teaches Center-wide risk management courses

Gerald.A.Klein@nasa.gov



Val Ruark (Lunz) is a business integration manager for NASA Goddard Space Flight Center's Wallops Flight Facility. Previously, she was the Special Assistant to the Flight Projects Directorate at NASA Goddard Space Flight Center. She was the integration manager for the Business Change Initiative and led a cross-functional team responsible for implementing project planning and control practices across various disciplines

Val.Ruark@nasa.gov