

# JSC Safety and Mission Assurance Space Shuttle Program Legacy Report



***A legacy is something from the past that is passed on to a beneficiary. It is the hope of the S&MA community that the graphics in this report will provide instant visibility for lessons learned, which can be quickly assimilated and applied to future human spaceflight programs.***



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# PURPOSE

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- ❑ Share lessons learned on Space Shuttle Safety and Mission Assurance (S&MA) culture, processes, and products that can guide future enterprises to improve mission success and minimize the risk of catastrophic failures.
  
- ❑ Present the chronology of the Johnson Space Center (JSC) S&MA organization over the 40-year history of the Space Shuttle Program (SSP) and identify key factors and environments which contributed to positive and negative performance:
  - Staffing skills/qualifications
  - Budget
  - Paradigms
  - Requirements
  - Program interfaces and expectations
  - Communications
  - Proactive/reactive processes
  - Lessons learned



# APPROACH

- ❑ Capture the findings of the formally-chartered boards that reviewed the Space Shuttle Program following the *Challenger* and *Columbia* incidents.
  
- ❑ Interview S&MA and program workers and managers from the past and present.
  
- ❑ Focus on culture, processes, and products.
  - Evaluate the S&MA culture, processes and products that existed at times of successes and failures.
  - Review the evolution of S&MA processes and products.
  - Identify actions that ultimately transformed the JSC S&MA organization into an effective contributor to the shuttle program team.
  
- ❑ Use graphics to provide instant visibility of lessons learned and significant incidents during the Space Shuttle Program, so lessons learned can be quickly assimilated and applied to future human spaceflight programs.



# KEY FACTORS

## ❑ Culture

- History of significant S&MA funding fluctuations, driven by accidents and periods of mission success.
- An organizational shift to a program support structure (SSP, ISS, CxP, etc.) versus a discipline structure (Safety, Reliability, Quality Assurance) improved S&MA relationships with the program offices and increased overall S&MA effectiveness.
- Established Program S&MA office – Integrated S&MA across centers

## ❑ Processes

- Risk analysis processes evolved over time and were eventually utilized in SSP decision-making forums.
- The establishment of the S&MA Technical Authority (STA) in 2004 resulted in a more focused role for the safety community in SSP risk decisions.

## ❑ Products

- Maturing of probabilistic risk assessment (PRA) and other analysis techniques improved the quality of risk assessments and overall effectiveness of S&MA.
- Risk assessment and risk trade skills improved over time and were better utilized near the end of the program.



# CONCLUSIONS

- ❑ An effective S&MA organization identifies and recommends risk-based solutions to problems and is not merely a compliance organization (“yes if” vs. “no because”).
  
- ❑ In order to be relevant, a safety organization must produce and deliver high quality risk analysis products (both quantitative and qualitative) to be utilized by both S&MA and program management in the decision making process.
  
- ❑ The establishment of the S&MA Technical Authority was effective in addressing a number of deficiencies within the S&MA community.
  - Improved the appeal path for dissenting opinions.
  - Led to a more technically competent S&MA organization due to improved relationships and interface with the engineering community.
  - Addressed limited S&MA career path by providing high-profile technical leadership positions within the S&MA organization.



# CONCLUSIONS (cont.)

- ❑ The integration of program S&MA functions across all participating centers has increased organizational effectiveness.
  - Better coordination and sharing of technical data resulted in improved timeliness and quality of S&MA risk assessments.
  - Early coordination and resolution of technical issues resulted in better S&MA support to the SSP and Office of Safety & Mission Assurance.
  
- ❑ A process is needed to periodically assess the health of the S&MA organization, taking into consideration:
  - Budget trends/staffing levels
  - Personnel turnover
  - Anomaly trends/close calls
  - Use of dissenting opinion process
  - Review of S&MA products



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# GRAPHICS

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## **S&MA Space Shuttle Program Legacy Graphic**

- ❑ Depicts the chronology of the S&MA function from the early SR&QA organization to the current S&MA configuration.
- ❑ Graphic is centered around a notional depiction of S&MA effectiveness over time.
- ❑ Annotations have been added to the timeline to explain variations and provide summaries of formal investigation committee reports.
- ❑ Information sources include interviews with current and past shuttle and S&MA employees, formal reports, and organizational/budget records.

## **Space Shuttle Program Significant Incidents Graphic**

This graphic is extracted from the *Significant Incidents and Close Calls in Human Spaceflight* graphic to reflect only the Space Shuttle Program incidents. It is presented to characterize and better define the situational environment during the shuttle era from a risk awareness perspective.





# Significant Incidents and Close Calls in Human Spaceflight: Space Shuttle Program

Columbia

Challenger

