

# Design Review Improvements Product Overview

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Mark Braun, Raytheon  
Robert Lyon, SSL

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# Design Review Improvements

## *Product Overview*

Frank Roller, Lockheed Martin Corporation  
Richard Covington, The Aerospace Corporation

May 7, 2015

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U.S. SPACE PROGRAM MISSION ASSURANCE IMPROVEMENT WORKSHOP  
LOCKHEED-MARTIN | SUNNYVALE, CA | MAY 5 - 7, 2015

# Agenda

- Motivation for Design Review Improvement Topic
- Charter
- Product Overview
- Topic Details
- Product Implementation Recommendations
- Topic Follow-on Recommendations
- Team Membership and Recognition



# Motivation for Design Review Improvements Topic

- Design escapes continue to impact program cost, schedule and mission performance
- Our design review and development test programs have failed to identify issues early enough to mitigate program or mission impacts
- Detecting and correcting design defects early in a product life cycle is becoming increasingly difficult as space systems become more complex
- In hindsight, many design escapes were deemed to be preventable
  - *Hypothesis: Late design escapes could be an indicator of a process gap*
    - Need to assess if process changes are needed to address any identified gaps
- Effects of late design escapes can be impactful to a company in many ways:
  - *Costly, damages reputations, strains customer relations, embarrassing*
    - E.g., RF cross talk in a unit resulted in an 18-month impact to the program
  - *Preventable with the right set of reviewers at the right time*



# Design Review Improvement Charter

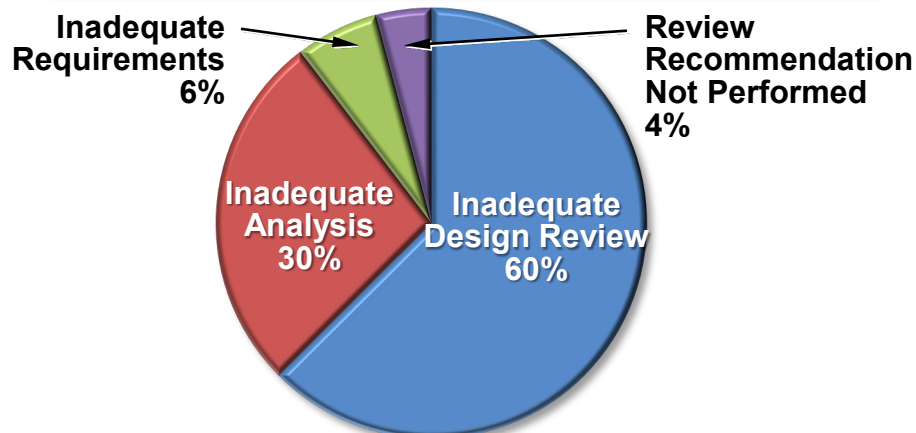
- Identify the deficiencies or weaknesses in the existing design review process that allowed design escapes to take place by leveraging existing case studies and escapes
- Identify design review process improvements
- Survey and assess the practices utilized across industry and government agencies to prepare for and conduct design reviews
  - *Surveyed team member companies – 49 test cases*
  - *Reviewed Aerospace on-orbit anomaly data (Classified) – 121 test cases*



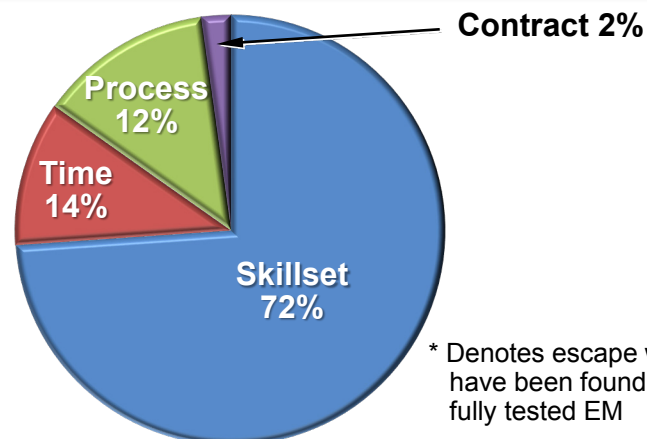
# Escape Analysis (1 of 2)

- Majority due to inadequate design review (60%)
  - RF crosstalk in unit\*
  - *Other causes include:*
    - Inadequate analysis (30%)
      - *Gyro life test failure \**
    - Inadequate requirements (6%)
      - *No coupling requirement for military earth coverage (MEC) signals to earth coverage signals (EC)\**
    - Review recommendation not performed (4%)
      - *Power-on reset circuit\**
- Reviewer skillset (72%) implicated in cause of inadequate reviews
  - *Not getting help, not the right person(s), not raising issues*
  - *Mixed technology units require multi-discipline SME reviewers*

## Design Review Escape Cause



## Inadequate Design Review Cause



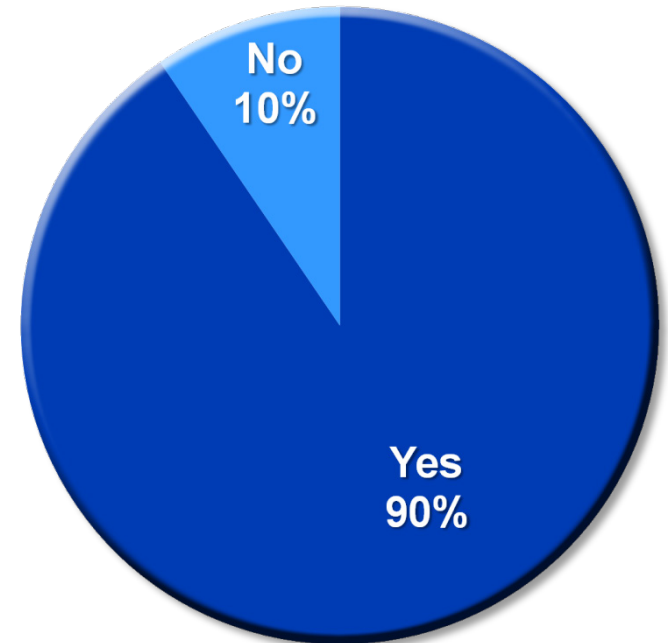
\* Denotes escape would have been found by a fully tested EM



## Escape Analysis (2 of 2)

- 21 of 49 escapes did not have a fully tested EM prior to CDR
- 19 of 21 escapes noted above could have been detected with a fully tested EM
  - *Designers indicated that the escapes would have been found had they utilized a fully tested EM prior to CDR*
  - *An EM provides*
    - Opportunity to discover design defects
    - Analytical model validation
    - Requirements validation
    - Build process validation
    - Demonstrate interface compatibility
    - Validate test and operation procedures

Would an EM have Caught the Defect?





# Design Review Improvements Overview

## *Development Processes of Seven Companies Were Reviewed*

### ***Strengths:***

- Contractor team members who are familiar with their own company's Command Media stated that they had a formalized development process
- Reviewers are trained in the development process (command media) and what to expect in the data products
- Contractor team members have lessons learned databases as part of the development process (by both the design team and review team)
- Have identified a best practice for folding Lessons Learned into the Design Development Process Command Media

Note: Development Process is a general concept that encompass both the actual design process and the design review



# Design Review Improvements Overview

## **Weaknesses**

- The scope, criteria, and reviewer guidance for conducting a design review were inconsistent across industry with opportunities for improvement
  - *No reviewer minimum experience for participating in a review*
  - *No minimum lead time for reviewer to have material*
    - Is not always specified by contract
  - *No explicit requirement for reviewer relevant experience*
  - *The context of lower level reviews becomes lost as the unit development process matures and becomes overly summarized*
  - *Review process tailored by program-driven constraints (time, schedule, dollars) preserves the intent of any given milestone even though the design review is not ready*
- No effective command media for mixed technology units (digital, RF, analog/ power/ ground, and FSW are all separate disciplines, reviewed separately)
- Action item closure with originator approval not consistent
- No requirement for having a fully tested EM before CDR



# Findings Summary

- The key to a successful product development is the experience and skills of the development engineers
  - *The expectation that a codified process can catch all escapes is unreasonable*
  - *It depends on both a robust process and the skills of those involved*
  - *Just as you cannot expect to review in quality—you cannot expect to “review” in a good product*

# Example of Recommendations

## Reviewer Skill Set:

- Ensure that the development process defines the minimum relevant domain experience to be a Lead or Senior Reviewer
  - There should be recognized subject matter experts with the relevant material under review

## Design Changes for Obsolescence or Application:

- Design changes due to obsolescence or revectoring for a new application (how used) needs a rigorous-heightened review supported by test

## Immature or Incorrect Data Products or Unknown-Unknowns:

- Utilize a fully tested EM in support of CDR
  - Forces early discovery of defects while maturing data products

## Inadequate analysis in context with the desired application:

- Ensure that the development process provides for the reviewer to review the analysis scope in context to the requirements as part of the design reviewer's tasks



# Design Review Improvement Product Traceability

Deliverable Requested	Location Covered in Product
Identify strengths and weaknesses of the current design review process at the component/unit/box level and below	Section 4.1: Current Design Review Practices
Recommend codified changes and/or upgrades to the process that will effectively and efficiently identify and/or prevent design errors early in the program lifecycle	Section 3.1: Recommended Design Review Changes
Recommend updates to the entrance and exit criteria for the design review process	Section 3.1.1: Entry and Exit Criteria
Recommend criteria for the selection of independent design reviewers with the proper subject matter expertise	Section 3.1.2: Design Reviewer Selection
Define the level of technical rigor required to successfully prepare for and conduct a thorough design review	Section 3.1.3: Technical Rigor
Define the actions to be taken when deemed not ready to proceed with the design review	Section 3.1.4: Reviewer/Lead Responsibilities
Identify programmatic benefits for conducting a thorough technical design review	Section 4.3 Program Benefits



# Intended Product Use

- What is the intended use of the product?
  - *Who is the target audience?*
    - Engineers, program office, mission assurance professionals, designers, systems engineering, suppliers, subcontract management, customers, and senior leadership
  - *How should/could it be used?*
    - The recommendations should be used to augment the current design review process in order to reduce escapes, costs, and schedule
- Specific recommendations for industry:
  - *What should industry do with the product near term/long term?*
    - Consider adopting recommendations to contractor process
    - Collect and develop best practices for development and review of mixed technology units
- Specific recommendations for government:
  - *What should government do with the product near term/long term?*
    - Consider adopting recommendations for government participants in review process
    - Understand risk areas for escapes to better understand trades (e.g., EMs)



# Design Review Improvements Team Members

Name	Company
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## Design Review Improvements Product Overview

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