Systems Engineering Reboot

Why?

➢ Customers’ Needs and Expectations are Changing (Agility ↑ and Complexity ↑)
➢ Design Escapes are often rooted early in the Development Life Cycle
  – Systems Engineering is crucial to avoiding them
  – Using heritage designs does not mean ignoring SE
➢ Evolving New Approaches to DoD Challenges
  – Digital Engineering
  – Mission Engineering
  – Systems of Systems development/ integration
➢ Develop the Next Generation of Systems Engineers
  – Demographic profile of SEs: heavy in the late and early career
  – Need to invigorate SE development to replace pending retirees

SE Reboot Initiative Goals/ Benefits

• Improve consistency of Systems Engineering across the Enterprise
• 100% Systems Thinking Mindset (this is for Everyone, not just SEs)
• Improve performance and efficiency; reduce design escapes
• Increase empowerment and accountability across the full life cycle
Systems Engineering Reboot Summary

**Systems Thinking**
- Systems Thinking Mindset of all engineers and management including PMs, mission orientation, and employee empowerment

**Total Systems Integration**
- Full Systems Engineering Integration (SE and Systems Test) to enable a total system design that is efficient and effective

**Proper Scope & Resources**
- Ensuring the proper resources for the Systems Engineering effort and a functional construct that drives success

**Career Development**
- Systems Engineers developed with clear competency expectations, career path options and formal/informal training

**Jan – Jun 2019:**
- Staffing, Planning, Developing

**Jul – Dec 2019:**
- Training, Engaging, Executing

**2020:**
- Implement Process Improvements

**Phase 0:**
- Strategy Formulation (8/1/18 - 12/1/18)

**Phase 1:**
- Resourcing, Staffing, Communication and Detailed Planning (Dec 2018 & 1st Qtr 2019)

**Phase 2:**
- Artifact Creation and Piloting (2nd Qtr 2019)

**Phase 3:**
- Early Execution and Maturation (3rd/4th Qtr 2019)

We Are Here
# SE Reboot Tenets (1 of 2)

## Systems Thinking

**What**
- Takes a big picture view of all activities in the proposal, design, delivery, and sustainment of our products. Special focus on boundaries, inter-connections, and optimization at the Mission/Enterprise level.
- Ensures we consider how decisions impact the broader system.

**Actions**
- Initiative Leadership Team in place
- Systems Thinking Workforce Survey
- Communications Campaign
- Training Program

**Benefits**
- Customers: Well thought-out Mission Solutions; Close Partnership for life cycle mission success
- Executive Mgmt: Better linked IRADs & new business ventures; Fewer point solutions
- Program Mgmt: Systematic solutions architected to work from the start
- Engineering Employees: More commonality/familiarity in SE execution across LM Space

## Total System Integration

**What**
- Strengthening End-to-End Systems Integration across the Program Life Cycle (Requirements, Design, Production, Test, Operations)

**Actions**
- Added SMEs to drive integration excellence (Electrical, Mechanical, HW/ SW)
- Created System of Systems (SoS) Eng’g Dept
- Testbed & Simulators Lab Survey
- Clean-Sheet Test Approach Study
- Bi-Monthly Integration Technical Forums
- Training Campaign for Integration expertise

**Benefits**
- Customers: Well-managed interfaces across mission segments
- Executive Mgmt: Increased commonality
- Program Mgmt: Fewer design escapes
- Engineering Employees: Expertise is sought after
<table>
<thead>
<tr>
<th>What</th>
<th>Proper SE Scope</th>
<th>Career Development</th>
</tr>
</thead>
</table>
| **Actions** | • Provide SEs with guidance, artifacts and support to ensure they have what they need for programs to be successful  
• Important for budget alignment and capture phase execution to help achieve consistent mission success on programs | • Provides tools and resources, in concert with increased training, to help Systems Engineers chart and follow their personal development path |
| **Benefits** | • Standard/Common SE requisition tool  
• Standard SE Scope Matrix Chart/Spreadsheet  
• SE Cost Targets model developed based on extensive program history data  
• More than 50 Systems Engineering Proposal Artifacts developed to drive consistency and reduce cycle time | • Established SE Competency Model aligned with LM Space priorities & industry standards  
• Providing career guidance & planning tools  
• Enhanced training; increased number of instructor-led and on-demand offerings  
• Enhanced Architect Development & Qualification Program (ADQP) |
| **What** | | |
| **Actions** | • Customers: Better predictability in schedule and budget performance  
• Executive Mgmt: Fewer Red programs Program Mgmt: More agile and efficient performance  
• Engineering Employees: More predictable path to the full solution | • Customers: Close partnership with all team members for mission success  
• Executive Mgmt: More “mobile” workforce  
• Program Mgmt: Engineers that understand better how to balance all program resources  
• Engineering Employees: Career path development, Increased training |
# SE Reboot 2019 Plan

## Systems Thinking (ST) Mindset
- **Jan**: Funding
- **Feb**: Skip Levels
- **Mar**: Staffed SOS Sr. Mgr.
- **Apr**: Draft Sys Think Video
- **May**: Brief LOB Executive Staff ST Survey
- **Jun**: ST Video Completed
- **Jul**: Held 1st ST Pilot Course
- **Aug**: Hold ST Courses for Eng’g Org
- **Sep**: ST Newsletter
- **Oct**: ST Courses for Eng’g Org
- **Nov**: Hold ST Courses for Eng’g Org
- **Dec**: ST Survey

## Total Systems Integration
- **Jan**: Move System Test to SE
- **Feb**: Test Lab Surveys
- **Mar**: Draft Clean Sheet Test Plan
- **Apr**: Mech Integ. Forum
- **May**: HW/SW Integ. Forum
- **Jun**: Pre-ATP “Gift” List generated
- **Jul**: Scope and Cost Leadership Forum
- **Aug**: Establish SE Cost Model
- **Sep**: Common SE Req Template Release
- **Oct**: Release Pre-ATP Aides
- **Nov**: Develop SRR “Gifts”
- **Dec**: Release SRR “Gifts”

## Proper Resources
- **Jan**: Create Standard Chief SE Req
- **Feb**: Begin Cost Data Analysis
- **Mar**: Begin Standard Req Generation
- **Apr**: Pre-ATP “Gift” List generated
- **May**: Establish SE Cost Model
- **Jun**: Common SE Req Template Release
- **Jul**: Release SE Career Guidebook
- **Aug**: Knowledge Transfer for Senior Architects
- **Sep**: Complete Pipeline Gaps Assessments
- **Oct**: Spacecraft Design Lecture Series Starts

## Career Development
- **Jan**: Establish Training Lead
- **Feb**: Develop list of 19 Webinars for early career SEs
- **Mar**: Certify Architects
- **Apr**: Hold 1st SE Boot Camp
- **May**: Finalize Technical Knowledge Mgmt Skills List
- **Jun**: Begin Architect Mentoring
- **Jul**: ST Video Completed
- **Aug**: Hold ST Courses for Eng’g Org
- **Sep**: Hold ST Courses for Eng’g Org
- **Oct**: ST Awards
- **Nov**: ST Awards
- **Dec**: ST Awards

## 2020>>
- **Jan**: Staffed SOS Sr. Mgr.
- **Feb**: Draft Sys Think Video
- **Mar**: Hold ST Courses for Eng’g Org
- **Apr**: ST Newsletter
- **May**: Hold ST Courses for Eng’g Org
- **Jun**: ST Newsletter
- **Jul**: ST Course for Eng’g Org
- **Aug**: ST Survey
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- **Dec**: ST Survey
Systems Engineering Reboot Tenets are Key to Our Future Success
- Increased agility requires more integration throughout the lifecycle
- Ensuring proper resources for Systems Engineering is crucial
- Rapid development of employees is essential to backfill retirees

Foundational Culture Change Initiative Requires Sustainable Approaches
- Support of the workforce is key
- 2019 focus areas were deemed high payoff areas
  - New focus areas will get added as current ones enter sustainment mode
  - Feedback will help shape the next round of focus areas
- Refreshed focus areas will help keep the culture change momentum going

Improvement Needed Across the Industry
- Need to emphasize that Systems Engineering is more than just requirements and coordination

Enhancing Systems Engineering Through New Perspectives and Training For More Agile and Accurate Execution
Q&A
Backup
Calvin Craig is the director of Systems Engineering with Lockheed Martin Space and is located in Waterton CO. He began his current position in August 2017. His roles and responsibilities in this role include leading a collaborative consortium of over 2,500 integrators, requirements verification, mission operations engineers, and system architects focused on designing, developing, integrating and delivering flight spacecraft and missile systems across LM Space. As part of this, Calvin is charged with pioneering the development of a world-class Systems Engineering organization.

Calvin brings over 20 years of Engineering development, leadership, and program management experience to this role. Calvin most recently served as the GOES-R Chief Systems Engineer, where he successfully led the organization responsible for the satellite requirements, architecture, and verification. Prior to that, Calvin served key roles on multiple NASA programs such as Orion, the Mars Reconnaissance Orbiter, Mars Odyssey, and the Stardust programs. Calvin also helped drive the strategy for the Raptor Avionics, which will serve as the common avionics platforms for multiple LM spacecraft.

Calvin holds a Bachelor of Science degree in Electrical Engineering from the University of Central Florida.
Common Breakdowns in Systems Thinking

**Incompatible Interfaces**
- Often Characterized by focus on lower level requirements
- Lack of a “Mission Orientation” is sometimes at play

**Solving Your Problem at the Expense of Others**
- Behavior exhibited by those valuing solutions to their issues above Enterprise or System Optimization
- Often happens in “over-constrained” or “over-taxed” organizations

**Solving a Piece vs. the Whole**
- Sometimes follows a pattern of making a good thing the **ultimate** thing
- Can be driven by a focus on the “Initiative du Jour”
## Systems Engineering Scope Matrix

**SE Functional Org Chart**
- Functions/Org Structure depends on program size/content/life cycle
- See SE Scope Matrix for More Detail and Product List

<table>
<thead>
<tr>
<th>1 SE Mgmt Functions</th>
<th>2 Technical Baseline</th>
<th>3 System Architecture</th>
<th>4 System Reqs Verif &amp; Valid</th>
<th>5 Multi-Segment Integration &amp; Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mgmt &amp; Leadership</td>
<td>Required Technical document plan/schedule</td>
<td>System Definition</td>
<td>Reqmts &amp; Regmt DB</td>
<td>External ICD/Interfaces (including CFE/CFI)</td>
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<tr>
<td>Program Planning</td>
<td>Baseline control approach</td>
<td>Trade Studies Conops / DRM</td>
<td>Spec Peer Reviews</td>
<td>Seg-Seg ICDs/Interfaces</td>
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<tr>
<td>Sys Engr CAM</td>
<td>ERB Coordination</td>
<td>Sys Perform &amp; TPMs</td>
<td>Verification planning/reports</td>
<td>Sys Cmd/Telm/Parameter Database</td>
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<tr>
<td>Customer I/F</td>
<td>Major Review Coord.</td>
<td>System Model (MBSE)</td>
<td>Validation Planning/reports</td>
<td>Intersegment Test &amp; validation plan and support</td>
</tr>
<tr>
<td>IPT/Subcontract I/F</td>
<td>IRB Interface</td>
<td>Fault Management</td>
<td>Environments Doc</td>
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<tr>
<td>Risk &amp; Opp</td>
<td>Action Item Mngt</td>
<td>Mission Planning (orbit, trajectory)*</td>
<td>Waivers &amp; Deviations</td>
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<tr>
<td>Tech Process</td>
<td>EIDP/System Cert</td>
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<tr>
<td>Standards &amp; Mngt</td>
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<tr>
<td>Peer Review Process</td>
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<tr>
<td>Metrics</td>
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<thead>
<tr>
<th>6 System Design Integration</th>
<th>7 System/ Vehicle Test</th>
<th>8 Specialty Engineering</th>
<th>9 Mission Operations</th>
<th>10 Config and Data Mgmt</th>
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</thead>
<tbody>
<tr>
<td>PHSL/MEL</td>
<td>Test Requirements</td>
<td>Special Disciplines</td>
<td>Mission Ops Planning</td>
<td>ERB &amp; CCB Admin</td>
</tr>
<tr>
<td>HW/SW Reuse, Qual and Env Test Matrix</td>
<td>Test Plan Approval</td>
<td>- Reliability, Maintain, Avail</td>
<td>Ops Procedures</td>
<td>Doc/Drw Release and Change Mngt through EPDM</td>
</tr>
<tr>
<td>DFx, Tech Insertion, Design Standards</td>
<td>TLYF Exceptions</td>
<td>- Mass Prop Anal &amp; Budgets</td>
<td>Ops Procedures</td>
<td>CDRL delivery/tracking</td>
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<tr>
<td>Compatibility analyses, I/F risk reduction</td>
<td>Test Review Support</td>
<td>- Surv, &amp; Radiation</td>
<td>Ops Reviews</td>
<td>FCA/PCA</td>
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<tr>
<td>System Power Budget</td>
<td>Test Predictions</td>
<td>- E3 (EMI/EMC/ESD)</td>
<td>Ops Rehearsals</td>
<td>CMDM Plan</td>
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<tr>
<td>Multi-functional (Mech-Elec.-x) Integration</td>
<td>Test Execution Support</td>
<td>- Human Interface Engr</td>
<td>Initial Ops Checkout</td>
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<tr>
<td>Mechanical Integr. (FOV, Align)</td>
<td>Test Flag review/ Support</td>
<td>- Nuclear Surety</td>
<td>Customer Acceptance</td>
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<tr>
<td>Electrical Integr. (Channelization, Pin-Pin)</td>
<td>Failure Review Board</td>
<td>Other Specialty Engr**</td>
<td>Operations &amp; Maint.</td>
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<tr>
<td>HW/SW Integration</td>
<td>Consent to Break of Config</td>
<td>- Parts and Materials</td>
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<tr>
<td>Payload Integration into system</td>
<td>HW/SW Integ. lab support</td>
<td>- Logistics/Sparing</td>
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<tr>
<td>Launch Segment Integration</td>
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<td>- Contamination</td>
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<td>- Cyber Security and Info Assur.</td>
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**Not a Program Organization Chart!!!**

- Item typically managed by non-SE Org
- Item typical in program SE but not part of central SE

5-31-2019