Innovation at a Large Scale

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The Men and Women of Lockheed Martin

- 140,000 Employees
- 70,000 Scientists and Engineers
  - 25,000 IT Professionals
- Operations in 1,000 Facilities, 500 Cities, 50 States and 75 Countries

Partners to Help Customers Meet Their Defining Moments
Redefining What Is Possible

Hypersonics

Biometrics

Return of Crew Space Exploration

Persistent Surveillance

Information Fusion

Unmanned and Autonomous Systems

A Passion for Invention
Large Scale Friction Stir Welding (FSW) for Performance & Cost

LO2 Barrel Welds (OB)
4 each 8-feet long
Tapered Thickness

LH2 Barrel 1 (Longeron Welds)
4 each 15-feet long
Tapered Thickness

Barrel Welds
8000 inches out of 36,000 total inches

LH2 Barrels 2, 3 and 4 Welds
24 each 20-feet long

LH2 Barrel 1 Welds (HB1)
6 each 15-feet long
FSW – An Amazing Innovation!

Friction Stir Welding

The Concept

Produced by Graphic Services
Lockheed Martin Space Systems Company
Michoud Operations
Friction Stir Welding vastly reduces and simplifies the process variables.
FSW Barrel Weld Tool

Manufacturing Process Simplicity on a Large Scale
Shop Floor Innovation: Flexible, Reconfigurable Factories

- Modular workstations with quick-connect utilities wired underneath the floor
- The workstations are daisy chained together forming work cells
- The stations are mobile, can be customized, and can be set to a variety of heights and configured with numerous shelving options
- They can be converted to class 10K flow booths to meet production needs
- The workstations and cells are so flexible that entire cells can be reconfigured in two hours
Fire Control Factory
Engineered Workstations

- Standardized approach and design engineered for flexibility and functionality
- Integrated casters and utility chase allow workstations to be disconnected, relocated and reconnected in a matter of minutes
- Utility chase for power, air, phone and LAN
- Need a class 10K flow booth? Simply wheel the portable flow booth to the workstation

Lean + Agility = Affordability

Engineered Workstation

10K Flow Booth Option

Relocate, Connect and Go
Fire Control Factory  
Engineered Equipment  

- Factory equipment designed to support rapid rearrangement & flexibility  
- Custom designed oven set-up and mix station incorporate filtration system eliminating need to vent to the outside environment  
- Casters and standard 110v power operation further simplifies rearrangement  

*Self-contained Oven and Mix Booth*
Integrated Composite Technology for Large Aircraft Structures

- Variable Stiffness Tailored Laminates
  - Increased design freedom
  - Load path optimization

- Future Mobility Platforms
- Future High Altitude UAV

Vacuum Assisted Resin Transfer Molding
- Integrated caps
- Sandwich stiffened
- Elimination of fasteners

CLC Software
- Optimize Cured Laminate Compensation (CLC) Process
  - Highly Accurate Thickness Control
  - Integral to Cure Process
  - No Machining Required
  - Supports LO

Variable Stiffness Tailored Laminates
- Increased design freedom
- Load path optimization
Common “Digital Thread” Is Key to Reduced Cost, Schedule and Risk

- Solid Model Data Source
  - Single Exact Definition
  - Reduces Span Time for Creation
- Data Re-Use
  - Eliminates Interpretation Error
  - Reduces Task Span Times
- Digital Product / Process Verification
  - Form, Fit, & Producibility Verified Prior to Build
  - Improves Quality
  - Reduces Cost and Risk
- Concurrent Development Process
  - Reduces Program Span Time

Form, Fit and Producibility of Parts and Tools To Be Verified in the Digital Mock-up Prior to BTP Release
Exploiting the “Digital Thread”
Begins with Modeling & Simulation
Large Scale Assembly Innovations Using Common Digital Thread

**Automated Drilling Systems**
- Real Time Updates to Associated Data
- Projected at the Point-of-use
- Eliminates Need for Discreet Work Instructions/Drawing Access

**Digital/Optical Wire Harness Assy.**
- Optically Identifies Connector Locations for discrete Wire locations
- Reduces Assembly Span Time by 50%
- Reduces Error in FACT Test Errors by over 100%

**Electronic Mate / Assy.**
- Laser Tracking / Real Time Location
- High Tolerance Servo-Driven Jacks
- Eliminates Massive / Inflexible Tools

**Laser Projection Systems**

**Automated Robotic Paint/Coating Systems**
- Accurate / Repeatable Application
- Digitally Driven from Engineering Data
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