Innovation at a Large Scale

Ed Morris
Director, Hardware and Manufacturing

Lockheed Martin
Corporate Engineering and Technology

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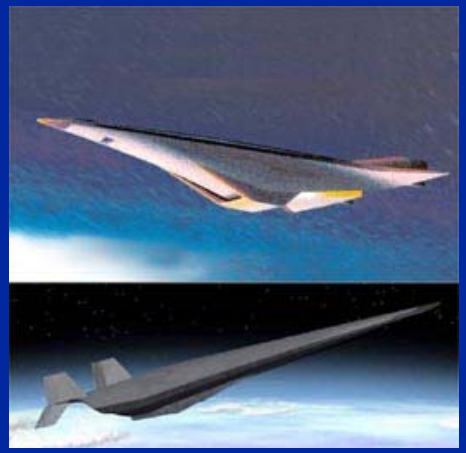
The Men and Women of Lockheed Martin

- *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

A Passion for Invention

Lockheed Martin Business Areas

LOCKHEED MARTIN

Aeronautics

Electronic Systems

Space Systems

Information Systems & Global Services

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

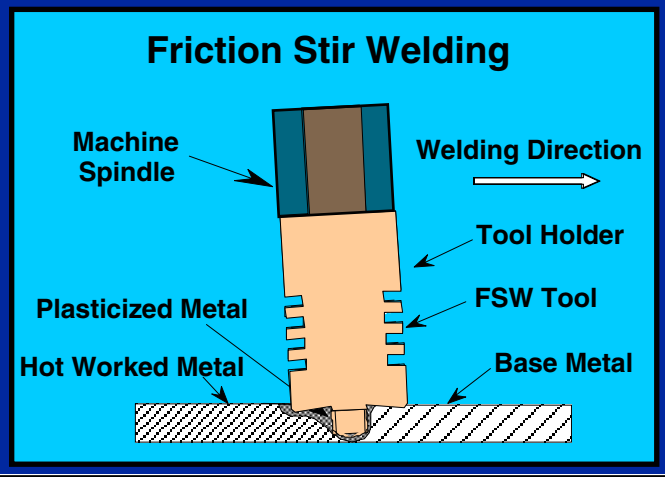
Barrel Welds
8000 inches
out of
36,000 total inches

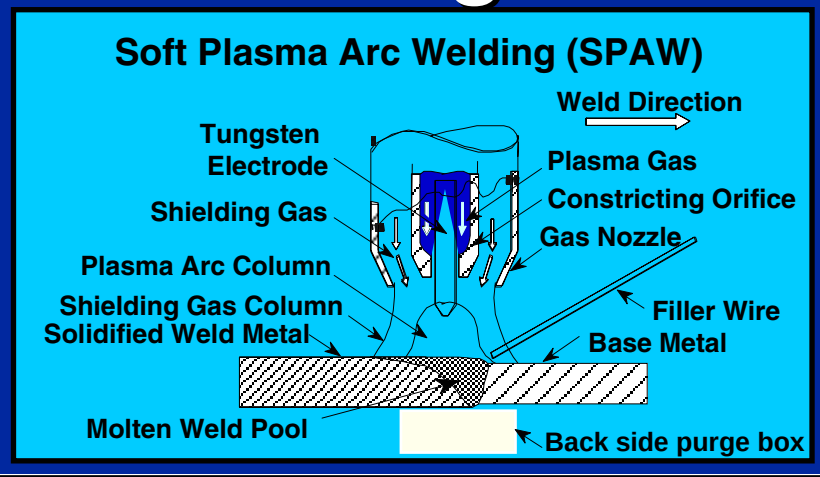
LH2 Barrels 2, 3 and 4 Welds
24 each 20-feet long

LH2 Barrel 1 Welds (HB1)
6 each 15-feet long

FSW – An Amazing Innovation!

FSW Versus Fusion Welding

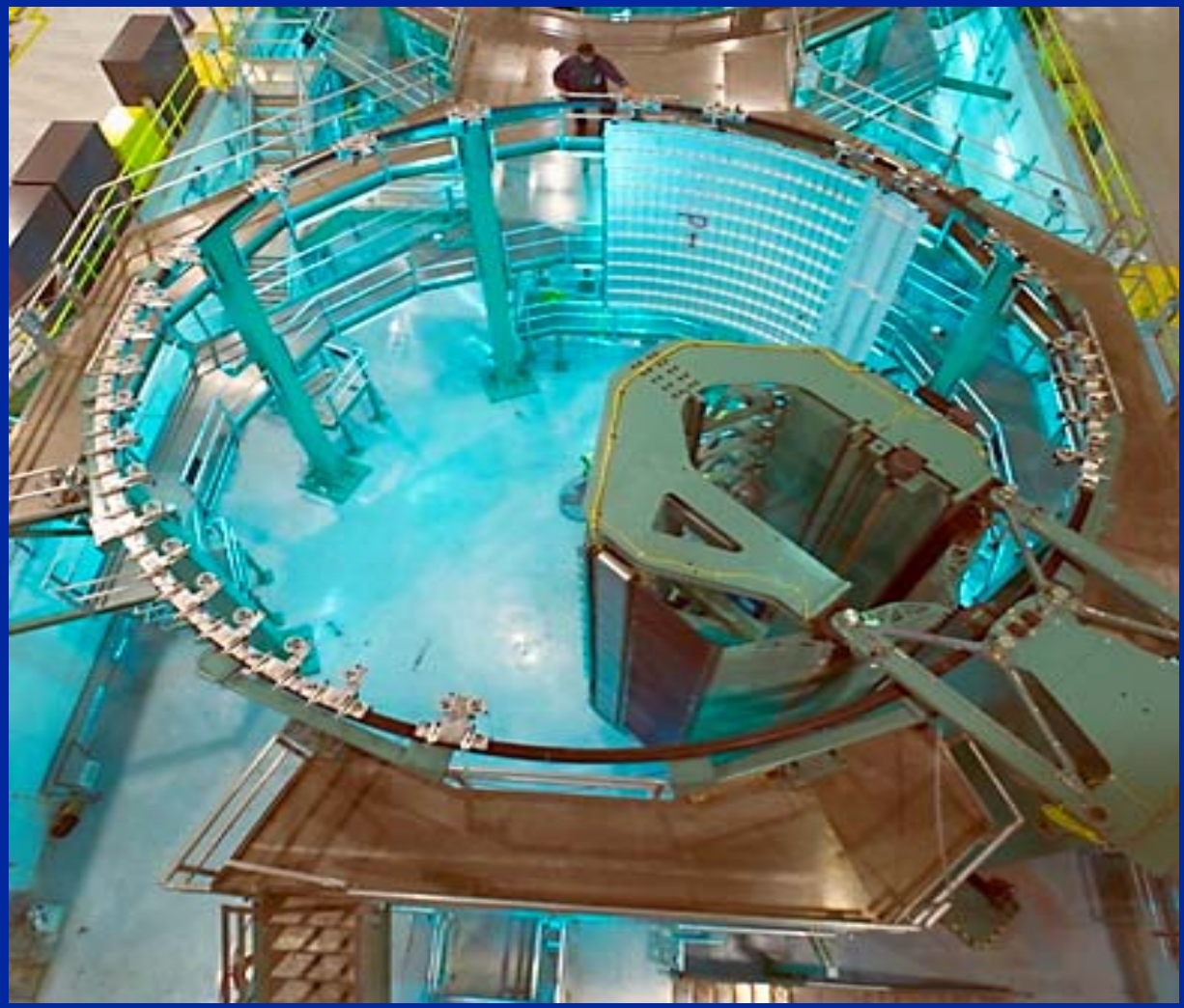




	FSW	Fusion
Weld Set Up	Schedule Selection Pin Tool Selection	Schedule Selection Shield Cup Design Orifice size Tungsten position Tungsten size/type Wire alloy and diameter
During Welding	Plunge depth/load Rotation speed Weld speed Centerline position Pin length (tapers)	Current Voltage Travel speed Wire feed rate APC/AVC Additional Reverse Current Plasma gas and flow Shield gas and flow Back side Purge gas and flow Pulse Frequency/Duty Cycle Arc gap Oscillator width (Cover pass only) Oscillator dwell (Cover pass only) Oscillator speed (Cover pass only)

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

Engineered Workstation

- **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

10K Flow Booth Option

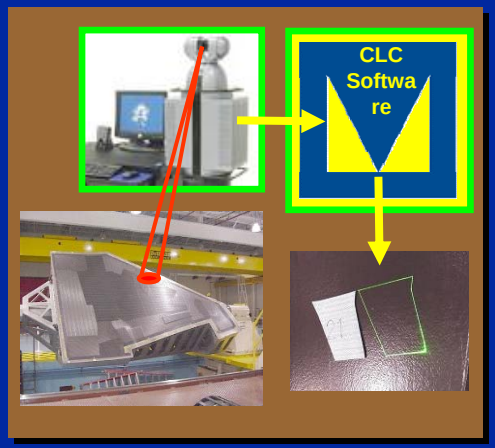
Relocate, Connect and Go

Fire Control Factory Engineered Equipment

Self-contained Oven and Mix Booth

- 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

Integrated Composite Technology for Large Aircraft Structures

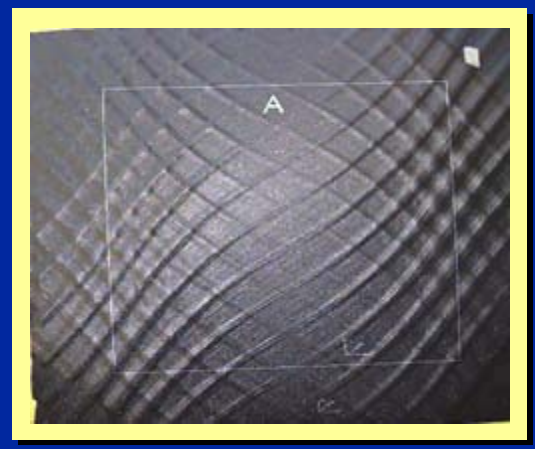


Optimize Cured Laminate Compensation (CLC) Process
- *Highly Accurate Thickness Control*
- *Integral to Cure Process*
- *No Machining Required*
- *Supports LO*

Future Mobility Platforms

Future High Altitude UAV

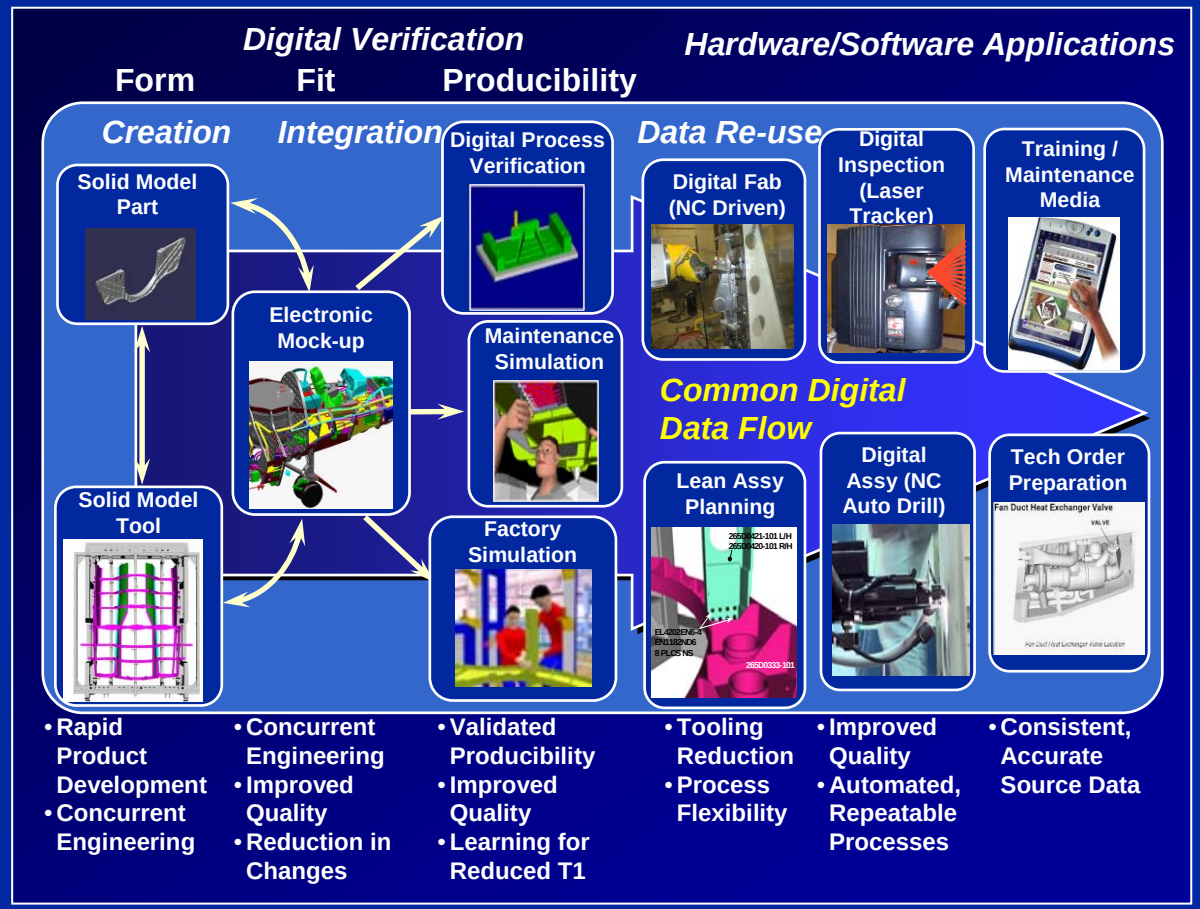
Vacuum Assisted Resin Transfer Molding
- *Integrated caps*
- *Sandwich stiffened*
- *Elimination of fasteners*



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

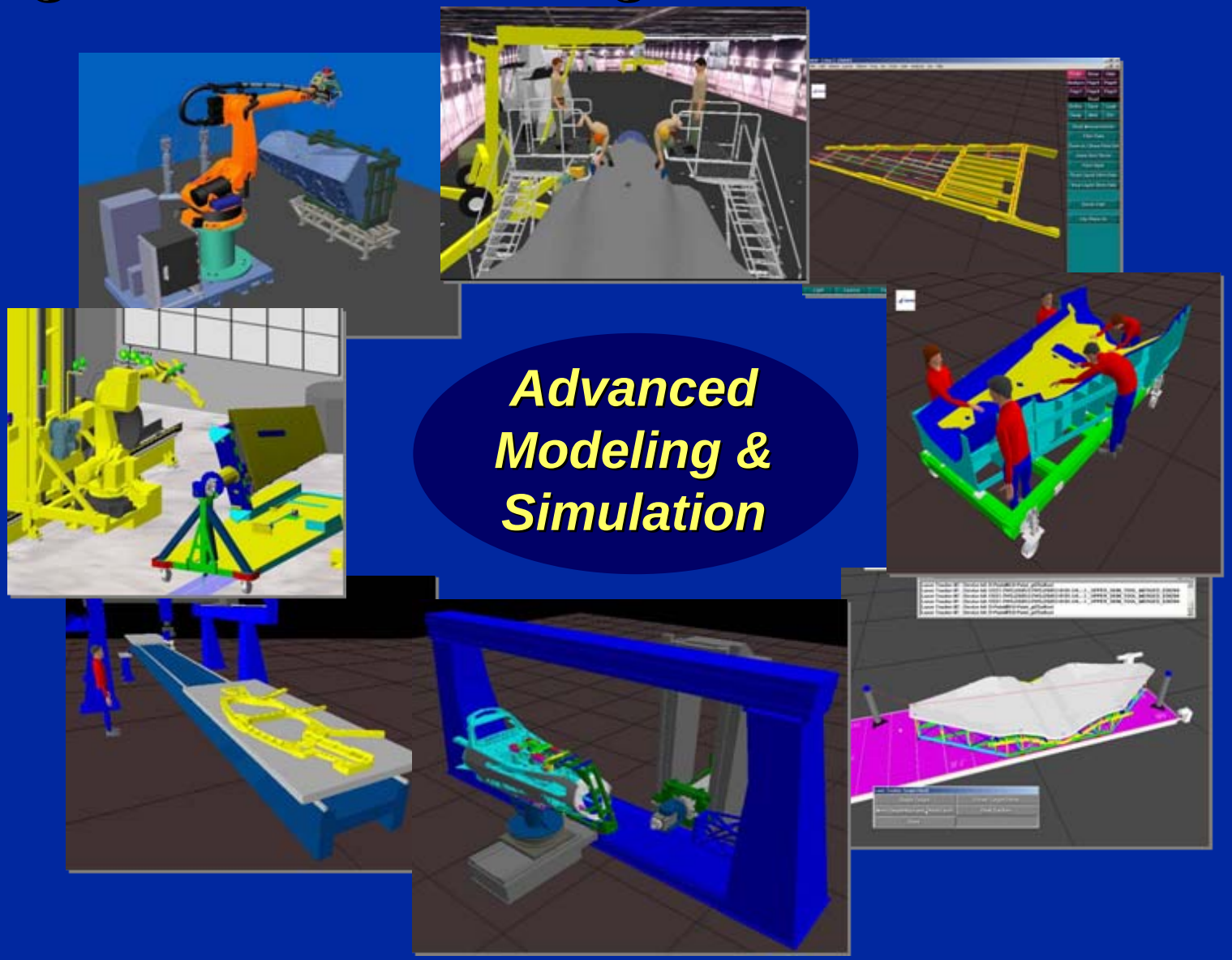
Common "Digital Thread" Is Key to Reduced Cost, Schedule and Risk

- **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



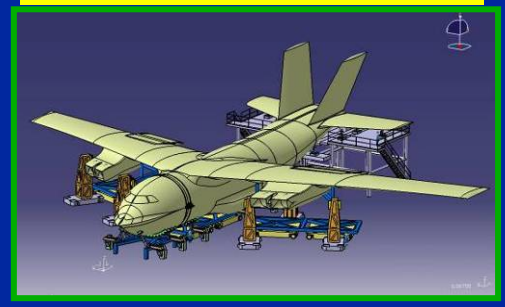
Large Scale Assembly Innovations Using Common Digital Thread

Automated Drilling Systems

Digital/Optical Wire Harness Assy.

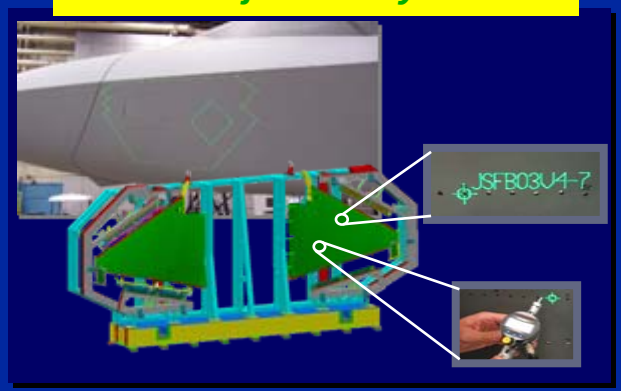
- Optically Identifies Connector Locations for discrete Wire locations
- Reduces Assembly Span Time by 50%
- Reduces Error in FACT Test Errors by over 100%.

Electronic Mate / Assy.



- Laser Tracking / Real Time Location
- High Tolerance Servo-Driven Jacks
- Eliminates Massive / Inflexible Tools

Laser Projection Systems



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

Automated Robotic Paint/Coating Systems

- Accurate / Repeatable Application
- Digitally Driven from Engineering Data

Ed Morris
Director, Hardware and Manufacturing
Lockheed Martin Corporate Engineering and Technology
973-603-9710
ed.morris@lmco.com