ORS OPEN MANUFACTURING

The Next Generation of Space Manufacturing: Model Based and Digitally Assured

Bryce Garbo
SSC15-XI-4
Raytheon Missile Systems

• World’s largest volume weapons producer
  – $6.6 Billion in Sales
  – 35,000 weapons delivered in 2014
  – 14,000 employees

• Manufacture Operations
  – Air, Sea, Land, and Space based products
  – 6 technology-based strategic manufacturing centers with 17 manufacturing facilities
  – 23 active production programs
  – 1.75M ft² in manufacturing space
  – 3,400 employees

• World class OSHA safety

• Support organizations
  – Manufacturing and Test Engineering
  – Facilities Services
  – Environmental, Health, Safety, and Sustainability (EHSS)
Operation’s Manufacturing Locations

Manufacturing sites in 7 States

- Rancho Cucamonga, California
- Missile Systems Headquarters
  - Tucson, Arizona
    - Airpark
    - Airport Plaza
    - Rita Road
    - ReyWest
- Raytheon-Dine', New Mexico
- Albuquerique, New Mexico
- McKinney, Richardson and Dallas, Texas
- McAlester, Oklahoma
- Camden, Arkansas
- Huntsville, Alabama
- Louisville, Kentucky
- Glenrothes
- Broughton
- Waddington
- Harlow
- London
- Malaga
# Products and Capabilities

## Production Competencies
- Weapon Integration
- RF Missile Integration
- EO Missile Integration
- GPS / INS Missile Integration
- Missile Ordnance Integration
- Missile Electronics Systems
- Electro-Optical Sensor Assembly
- Precision Machining
- Composite Airframe Fabrication

## Product Areas
- Air-to-Air Missiles
- Air-to-Ground Missiles
- Surface-to-Air Missiles
- Cruise Missiles
- Guided Munitions
- Guided Projectiles
- Kinetic Kill Vehicles
- Small Space Systems
- Missile Launching Systems
- Close In Weapon Systems
- Man Portable Systems
Next Generation Space Manufacturing Fusion

Partnership sponsored by Operationally Responsive Space Office

Key Members
- ORS
- MEI
- AMI
- SDL
- RMS

ORS/MEI
Extensive satellite integration experience

RMS
Model Based System Engineering Production Capabilities

SDL
Satellite Design 6U

AMI
Innovative Continuous Chain of Custody

Top Level Mission Objectives:
- Demonstrate semi-autonomous manufacturing of low-volume, high value assets
- Validate the ability of autonomous digital techniques to provide mission assurance
Model Based Systems Engineering Collaboration

- Integrated ORS teams leverage MBSE to help guide system design
- MBSE process enables rapid acceleration from concept to functioning system and design
  - Quickly adapt to changes in scope, budget, and technical capability
  - MBSE enabled model modifications to be made between the SDL, AMI, RMS, and ORS

- Graphical Language using SysML - Magic Draw
  - Easily exportable to web-based format
  - Pictorial view of requirements, use-cases, and functional block diagram
Next Generation Space Factory

• Evolving missile business drove changes to Raytheon manufacturing
  – Automated factory capabilities

• Adapted Assemble/Test for Small Space Products
  – Backbone of assembly workstation to includes proven production systems
  – Robotic material handling
  – Thermal vacuum chamber
  – Vibration and thermal chambers
  – Solar simulator
  – Star field generator
  – GPS antenna test
  – Inertial measurement test
  – 3-axis magnetometer
ORS Open Manufacturing – Digital Assurance

- Continuous Chain of Custody
  - Vision System
    - High definition cameras (16) and microphones (3) creates continuous chain custody of satellite components, build and test processes
    - High definition machine vision system cameras (4)
      - Recognize and categorize components/assemblies
- Archived and searchable Agile Manufacturing Object Graph (AMOG)
- Open Manufacturing Information System (OMIS)
- Digital capture systems provides a innovative Mission Assurance solution
Summary and Acknowledgments

• By combining a robust capability with innovative digital assurance systems the ORS partnerships have created a competitive and reliable small satellite factory

• This novel approach opens the door for small space designers

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