THE PRODUCT DIGIVERSE
LOOKING AT THE FUTURE DIGITAL ENVIRONMENT

© 2017 LOCKHEED MARTIN CORPORATION. ALL RIGHTS RESERVED.
Public Information Release Authorization (PIRA) AER201705007

Marc O’Brien
Virtual Prototyping Manager
Lockheed Martin Aero – Skunk Works
Advanced Development Programs
Palmdale, CA
Agenda

- Introduction
- The Challenge
- Current Digital Philosophy
- NextGen Digital Environment
- Conclusion
INTRODUCTION
Lockheed Martin is a global security and aerospace company that employs approximately 100,000 people worldwide and is principally engaged in the research, design, development, manufacture, integration and sustainment of advanced technology systems, products and services.
The Skunk Works team within Lockheed Martin creates revolutionary technologies that push the boundaries of what is possible. Their solutions draw upon world-class capabilities in conceptual design, systems engineering and integration, complex project management, software development, and rapid prototyping.

The Skunk Works team has developed a reputation for solving hard problems quickly, quietly, on time, and under cost requirements.
The Virtual Prototyping group, within the Skunk Works, is an engineering visualization provider of modeling and simulation services and solutions to Lockheed Martin and its customers worldwide. The group creates value through the application of its solutions to promote increased understanding of complex solutions, enable fluid communication, and reduce risk to assist customers in winning new business and performing on existing business.

Advanced Modeling, Simulation, & Visualization

Helping people understand complex systems and ideas by “bringing concepts to life.”
THE CHALLENGE
Changing Defense Industry

- Asked to develop more complex / sophisticated and integrated products
- Less, previously unrealistic, budgets to work with
- Compressed schedules
- Less tolerance of risk, uncertainty, and mistakes
- Reductions in work force (i.e. layoffs, retirements, etc.)
- Lack of qualified and experienced personnel; knowledge transfer is lacking
- Increased regulatory approaches and excessive oversight
- The need to understand and evaluate large sums of information; “Big Data” is time consuming/difficult
Attritable Aircraft Challenge

Gov't Changing Strategy

UAS to Augment Exquisite Systems (e.g. F-35, F-22)

- Product On Demand (Designer Products)
  - Tie urgent need to urgent response - Build on demand, at anytime (start/stop as needed, maybe years later)
  - Design, build, and field in a few months verses years
  - #’s of something one day, #’s of something else the next
  - Different product types (small, medium, large) in the same manufacturing environment
  - Vehicles are expendable
  - Performance driven materials
  - Leverage standard / catalogue parts
  - Simple, single purpose, designer products produced on demand
Attritable Aircraft Challenge

Gov't Changing Strategy

A truly cost imposing strategy with the ability to rapidly deploy a vehicle with a new platform and capabilities on demand

- To achieve the objectives of attritable forces requires adoption of new paradigms
  - Flexible, agile, and reconfigurable factory
  - Removal of fixed monuments (maximize the options)
  - Advanced automation capabilities
  - Removing touch labor and adding manufacturing/engineering personnel in the upfront process
  - New processes (design for automation, robotics, etc.)
  - Adoption of new advanced simulation techniques
  - Next generation digital environment

Requires Next Generation Simulation, Automation, and Digital Environment
Moving Toward Agile and Flexible

One Flexible Factory for Any Shape, Size, Configuration

Vehicle 1
Small
Configuration a,b,c

Factory Layout
Layout 1 a,b,c
Quantity x-xxxx

Vehicle 2
Medium
Configuration a,b,c

Factory Layout
Layout 2 a,b,c
Quantity x-xxxx

Vehicle 3
Large
Configuration a,b,c

Factory Layout
Layout 3 a,b,c
Quantity x-xxxx

From virtual to physical
CURRENT DIGITAL PHILOSOPHY
Digital Thread is the communication that connects elements of the engineering and manufacturing process that have traditionally been separated.

More Digital Evolution is Needed ->

Digital Thread:
- Single strand, bi-directional but Linear
- Data sharing information between engineering and manufacturing
- 2D & limited thought process

Engineering — Manufacturing
The Digital Tapestry is a framework of people, process, tools, and data which integrates the entire product lifecycle and all disciplines.

**LM DIGITAL TAPESTRY**

- Multiple stands, many interdependencies
- Still single dimensional (2D)
- Software sharing information between multiple applications/machines
- Does not address the notion of a digital twin or multiple digital twins
- Only addresses the digital aspect, not the physical aspect

More Digital Evolution is Needed ->
The Product Digiverse
The Digital Transformation Evolution

© 2017 LOCKHEED MARTIN CORPORATION. ALL RIGHTS RESERVED.
The Product Digiverse - What is it?

Framework integrating people, process, tools, materials, environment, and data linking both the physical and digital domains across the entire product lifecycle and all disciplines.

Putting Some Structure Around our NextGen Digital Environment
Digiverse – What is it?

Digiverse Mirrors the Physical World – The Complete Digital Twin of “Everything”

ECOSYSTEM HUBS

System of Systems
Open Systems Architecture

DIGITAL DNA

DIGITAL BACKBONE

ENABLING NETWORKS
ECOSYSTEM HUBS

- Each Ecosystem is a Digital Twin
- Hubs connect the Digital World with the Physical World
- Each Ecosystem connects to other ecosystems with the "right" information through a common data language
- Open system architecture approach / Plug-in play with the Physical World
- Each Ecosystem has a symbiotic relationship with the Digiverse
- Embraces the notion of organizational silos
Digiverse - Ecosystem Hubs (con't)

The Convergence of the Digital World and the Physical World
Digiverse – Ecosystem Hubs (con’t)

Manufacturing Hub Example

- Connects multiple simulations into a single virtual picture
- Translates, connects, and integrates the digital and physical domains
- Continuously compares the physical with the digital
  - Convergence of Physical & Digital (OT/IT)
- Factory digital twin data can be saved and re-used at any time
- The fully simulated factory digital twin drive the factory floor
  - A simulation of many simulations
  - Tribal knowledge is built in

DIGITAL WORLD

PHYSICAL WORLD

© 2017 LOCKHEED MARTIN CORPORATION. ALL RIGHTS RESERVED.
Common operational picture simulation that drives the physical factory.
Digiverse – Digital DNA

DIGITAL DNA
- The “Product” Digital Twin
- Multi-Dimensional (3D+)
- Complex Evolving Entity (Grows through the Product Life Cycle)
- Shares a common data language & open architecture
- Gene Editing / Cloning are possible for evolving solutions

DNA BLUEPRINT
- All the Key Components that make up the Digital Twin
  - Design Components
  - Manufacturing / Factory Components
  - Software Components
  - Sustainment Information
  - Etc.
Digiverse – Digital Backbone

Digital Backbone & Enabling Networks

NextGen Technology Enablers

Vanguard Computing
Adv. Digital Environments
Enterprise Data Policies
Adv. Collaborative Env.
Digital Assistants
Design Synthesis
Enabling Networks
Cybersecurity & Security

The Foundation for the NextGen Digital Environment
CONCLUSION
The attritable challenge goals dictate a manufacturing environment that is flexible, scalable, and responsive.

Meeting the challenge requires:
- Advanced automation
- Simulation of everything (manufacturing digital twin)
- Data management & enterprise control
- Next generation digital environment (The Product Digiverse)

Digiverse enables:
- Digital twin of everything
- Process automation for process control
- Converging the digital and physical domains (physical and virtual are mirrored)