Accelerating the MBE Ecosystem Through Cultural Transformation

NIST MBE Summit 2020

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Daniel Seal
Senior Manager, PLM
The Boeing Company
St. Louis, MO, USA

Jason Hatakeyama
BDS Chief Architect
and Director, PLM
The Boeing Company
El Segundo, CA, USA

Don Farr
Senior Technical Fellow
Boeing Research & Technology
The Boeing Company
Huntsville, AL, USA

Data   **Models**   **Twins**

DIGITAL THREAD

PLATFORM PRODUCT • PRODUCTION SYSTEM • SUPPORT & SERVICES

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Don Farr - Biography

Don Farr

- 29 years at Boeing, 5 years at General Dynamics
- Senior Technical Fellow in Model Based Engineering at Boeing Research & Technology in Huntsville, Al
- System Engineer for over 35 years on dozens of programs:
  - F-22, F-16, F-111, and A-12
  - RAH-66 Comanche Helicopter
  - F-15 Eagle, F/A-18 Super Hornet
  - 777x, 737, 787 Dream Liner
  - Ground Based Missile Defense
  - Systems of System Programs
  - Research and Development Programs
- BSEE from Lamar University, Texas
- MSEE from University of Delaware

Technology and Cultural Transformation are Interrelated

Technology [tek-**nol**-*uh*-jee]

noun,

1. the branch of knowledge that deals with the creation and use of technical means <u>and their interrelation with life, society</u>, and the environment, drawing upon such subjects as industrial arts, engineering, applied science, and pure science.

2. the <u>application of this knowledge</u> for practical ends.

3. the <u>terminology</u> of an art, science, etc.; technical nomenclature.

4. a scientific or <u>industrial</u> <u>process</u>, invention, <u>method</u>, or the like.

5. the sum of the ways in which <u>social groups</u> provide themselves with the material objects of their civilization.

Boeing's digital transformation… it's cultural

Boeing — the aerospace giant — attended last month's Cloud Foundry Summit in Basel, and spoke to Information Age about its digital transformation efforts

Enterprise transformation is daunting. It is important for whoever is leading it, to invest in the right places; or accelerate and invest further in the places where you see more value.

"Culture eats strategy for lunch"
- attributed to Peter Drucker

Technology and culture are intertwined. You cannot accelerate the MBE ecosystem without addressing workforce cultural transformation
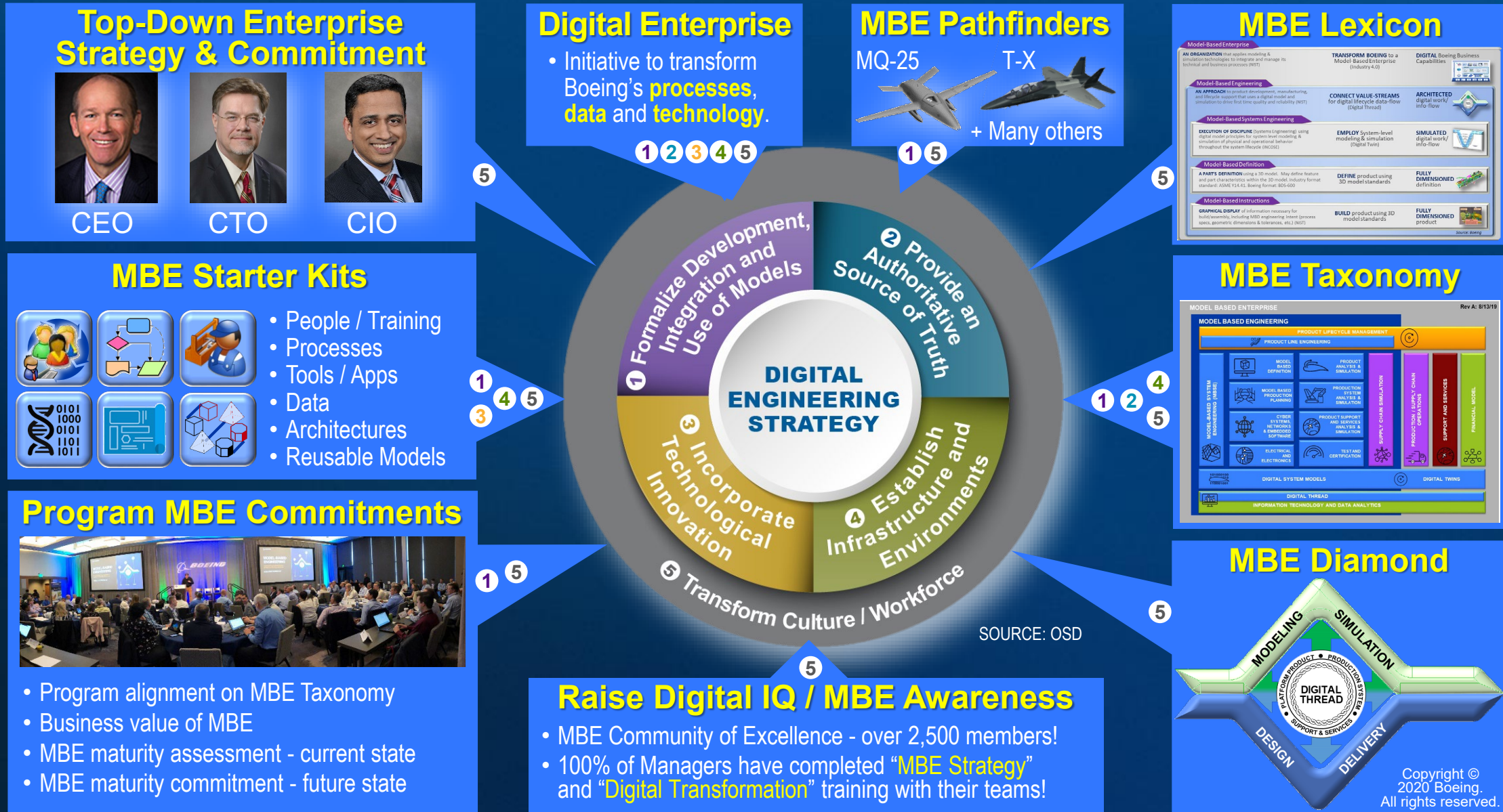
DATA-DRIVEN DECISION MAKING

DATA ANALYTICS (INSIGHT)

DIGITAL TWINS (INTELLIGENCE)

DIGITAL THREAD (CONNECTIVITY)

The Digital Value Chain

Approved for Public Release (RROI 19-00155-BDS)

Boeing's Cultural Journey to MBE Ecosystem Acceleration

Top-Down Enterprise Strategy & Commitment

CEO   CTO   CIO

Digital Enterprise

- Initiative to transform Boeing's **processes**, **data** and **technology**.

① ② ③ ④ ⑤

MBE Pathfinders

MQ-25   T-X

+ Many others

① ⑤

MBE Lexicon

⑤

MBE Starter Kits

- People / Training
- Processes
- Tools / Apps
- Data
- Architectures
- Reusable Models

① ④ ⑤
③

MBE Taxonomy

① ② ④ ⑤

Program MBE Commitments

- Program alignment on MBE Taxonomy
- Business value of MBE
- MBE maturity assessment - current state
- MBE maturity commitment - future state

① ⑤

Central diagram

DIGITAL ENGINEERING STRATEGY

1. Formalize Development, Integration and Use of Models
2. Provide an Authoritative Source of Truth
3. Incorporate Technological Innovation
4. Establish Infrastructure and Environments
5. Transform Culture / Workforce

SOURCE: OSD

MBE Diamond

MODELING   SIMULATION
DIGITAL THREAD
DESIGN   DELIVERY

⑤

⑤

Raise Digital IQ / MBE Awareness

- MBE Community of Excellence - over 2,500 members!
- 100% of Managers have completed "MBE Strategy" and "Digital Transformation" training with their teams!

Boeing "Digital Enterprise" Initiative

TRANSFORMING HOW WE WORK AT BOEING

Multidiscipline collaboration · First time quality · Speed to market · Increased revenue · Top-tier margins · Global Industrial Champion
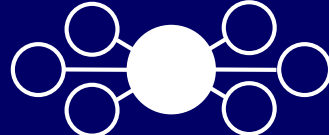
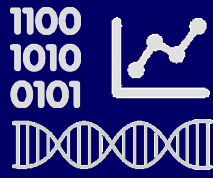### Foundational Capabilities (Bedrocks)

PLM · **MOM** · **ERP** · **HR**

Focused on Transforming

Technology · **Process** · **Data**

Where the savings will come from

Technology 30% · Process 30% · Data 40%
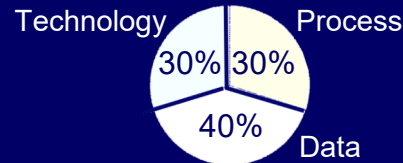
OUR STRATEGY

1 **Common Architecture** *that easily adapts to changing business priorities.*

2 **Digital Thread** *that increases visibility of work throughout our value streams.*

3 **Process Improvements** *that standardize the way we work.*

4 **Agile Work Processes** *that drive efficiency, productivity and faster insights.*

5 **"Out-of-the-Box"** *capabilities without the need for customization.*

6 **Culture** *that empowers cross-functional collaboration through process, data and technical integration across Boeing.*

*A **company-wide** initiative transforming Boeing through **process** improvements, **data** management and **technology** enhancements.*

Boeing's Model-Based Lexicon - *A Common Language*

Model-Based Enterprise

AN ORGANIZATION that applies modeling & simulation technologies to integrate and manage its technical and business processes (NIST)

TRANSFORM BOEING to a Model-Based Enterprise (Industry 4.0)

DIGITAL Boeing Business Capabilities

Model-Based Engineering

AN APPROACH to product development, manufacturing, and lifecycle support that uses a digital model and simulation to drive first time quality and reliability (NIST)

CONNECT VALUE-STREAMS for digital lifecycle data-flow (Digital Thread)

ARCHITECTED digital work/ info-flow

Model-Based Systems Engineering

EXECUTION OF DISCIPLINE (Systems Engineering) using digital model principles for system level modeling & simulation of physical and operational behavior throughout the system lifecycle (INCOSE)

EMPLOY System-level modeling & simulation (Digital System Model)

SIMULATED digital work/ info-flow

Model-Based Definition

A PART'S DEFINITION using a 3D model. May define feature and part characteristics within the 3D model. Industry format standard: ASME Y14.41. Boeing format: BDS-600

DEFINE product using 3D model standards

FULLY DIMENSIONED definition
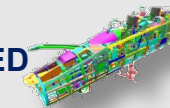
Model-Based Instructions

GRAPHICAL DISPLAY of information necessary for build/assembly, including MBD engineering intent (process specs, geometric dimensions & tolerances, etc.) (NIST)

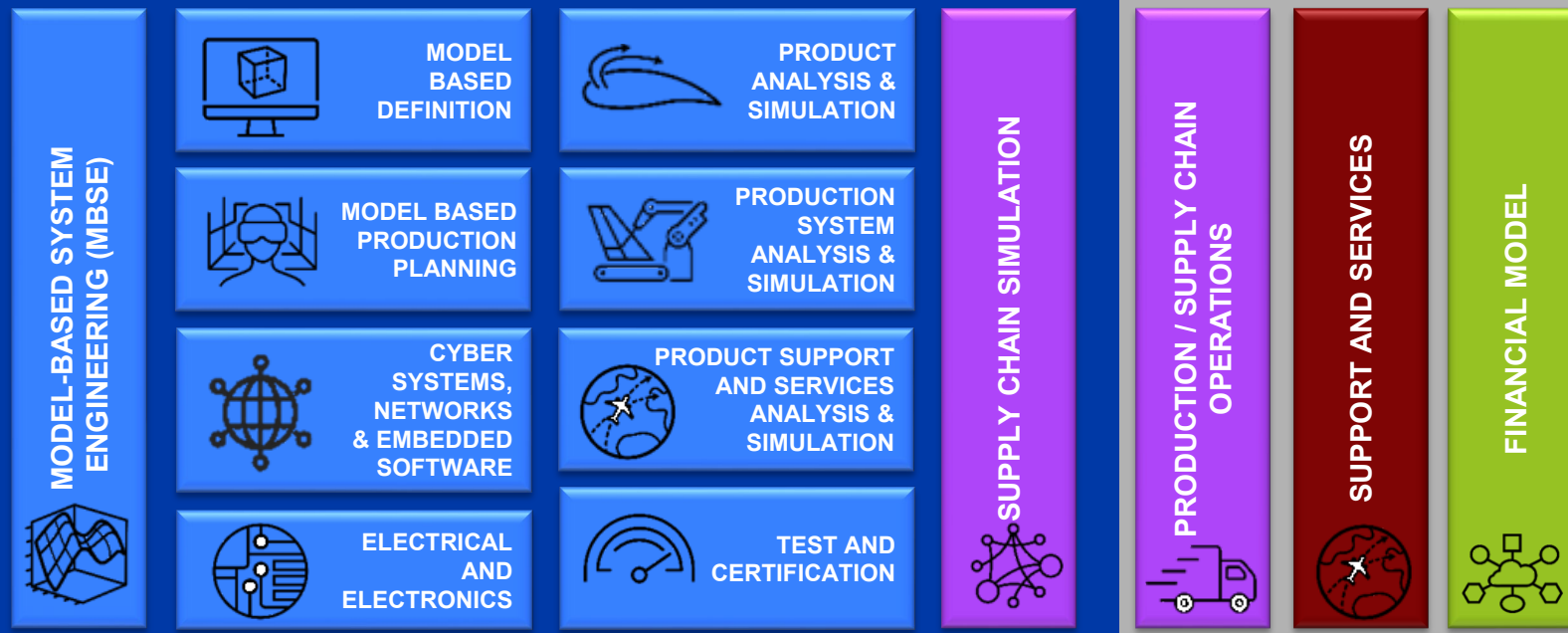**BUILD** product using 3D model standards

FULLY DIMENSIONED product

Source: Boeing

Boeing MBE Taxonomy - *an Enterprise MBE Framework*

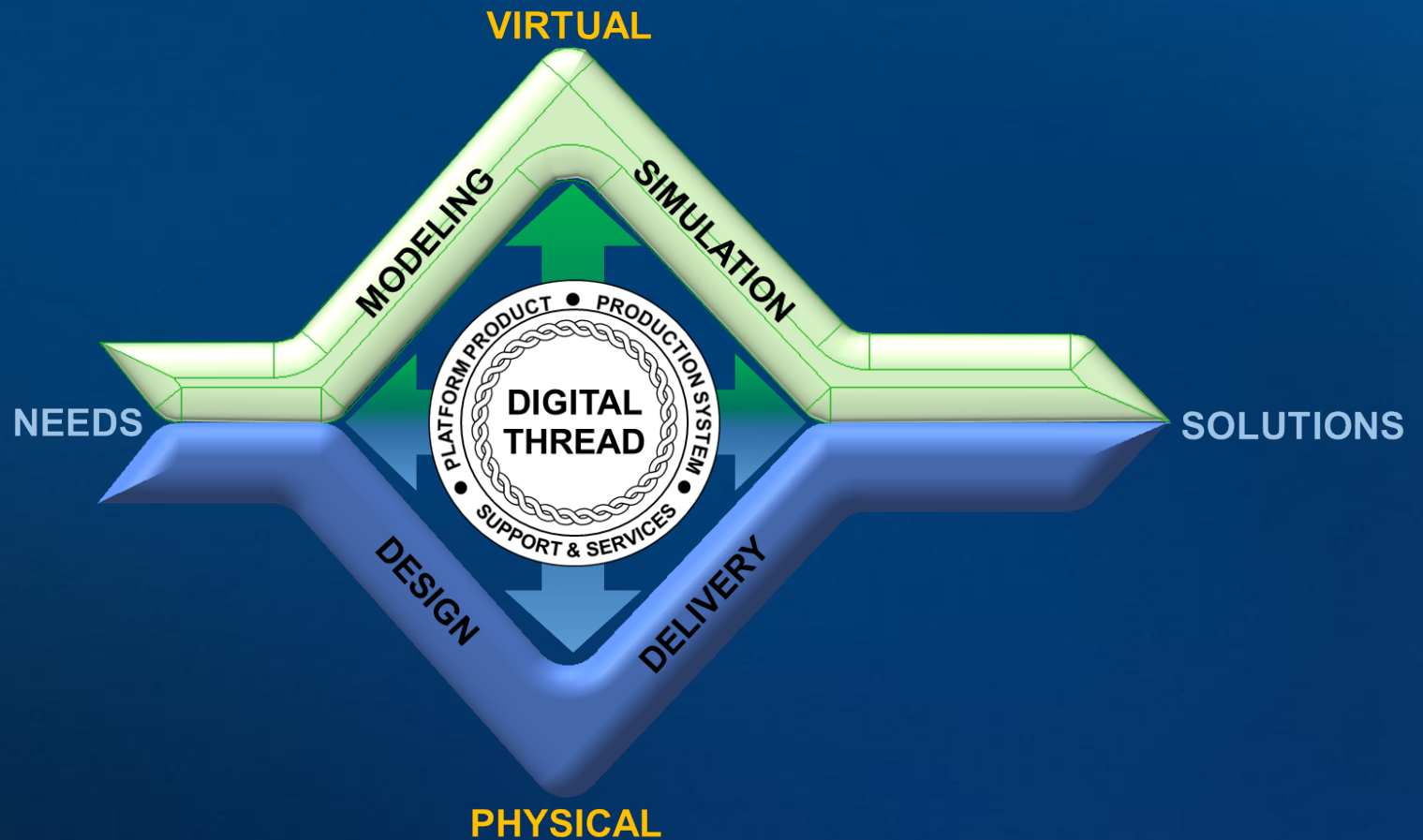**MODEL BASED ENTERPRISE**

Rev A: 8/13/19

MODEL BASED ENGINEERING

PRODUCT LIFECYCLE MANAGEMENT

PRODUCT LINE ENGINEERING

MODEL-BASED SYSTEM ENGINEERING (MBSE)

MODEL BASED DEFINITION	PRODUCT ANALYSIS & SIMULATION
MODEL BASED PRODUCTION PLANNING	PRODUCTION SYSTEM ANALYSIS & SIMULATION
CYBER SYSTEMS, NETWORKS & EMBEDDED SOFTWARE	PRODUCT SUPPORT AND SERVICES ANALYSIS & SIMULATION
ELECTRICAL AND ELECTRONICS	TEST AND CERTIFICATION

SUPPLY CHAIN SIMULATION

PRODUCTION / SUPPLY CHAIN OPERATIONS

SUPPORT AND SERVICES

FINANCIAL MODEL

DIGITAL SYSTEM MODELS

DIGITAL TWINS

DIGITAL THREAD

INFORMATION TECHNOLOGY AND DATA ANALYTICS

Legend
- Product Lifecycle Mgmt
- Domain Engineering
- Operations Mgmt
- Support & Services
- Enterprise Services

MBE Diamond Symbol - *a Framework for MBE*

- **The bottom-half of the Diamond represents Physical System** (retaining traditional SE "V" flow)

- **The top-half of the Diamond represents the "Virtual" Systems** (i.e. the virtual representation of the physical systems)

- **The interior of the Diamond represents the "Digital Thread" linking models/simulations to the physical systems design**

VIRTUAL

MODELING SIMULATION

NEEDS SOLUTIONS

DESIGN DELIVERY

PHYSICAL

DIGITAL THREAD

PLATFORM PRODUCT • PRODUCTION SYSTEM • SUPPORT & SERVICES •

Workforce Training - *"Raising the Digital IQ" / MBE Awareness*

MBE Community of Excellence

Over 2,500 members enterprise-wide!

MBA Awareness Training

- **"Digital Transformation"** (18 hrs) - Foundational awareness of Boeing's Digital Transformation. Employees should understand MBE core concepts and value to develop their own Digital Literacy.

- **"MBE Strategy & Transformation Awareness" Learning** (3 hrs) - Outlines the strategy, benefits, opportunities and common terminology behind the enterprise wide implementation of MBE.

  - **100% of Boeing Engineering Managers have completed this MBE Training with their teams!**

- **"MBE Strategy & Transformation Awareness"** (1 hr) Training on the importance of MBE and the move towards a more agile environment.

- **"Demystifying Digital Transformation"** (1 hr) – CTO presentation on Digital Transformation at Boeing.

Program MBE Commitment Event

- 2 day event for program Chief Engineers

- Gain program alignment on MBE Taxonomy

- Understand the business value of MBE

- Assess current state of MBE implementation on programs (i.e. MBE Maturity Assessment)

- Obtain program commitments to future state MBE implementation
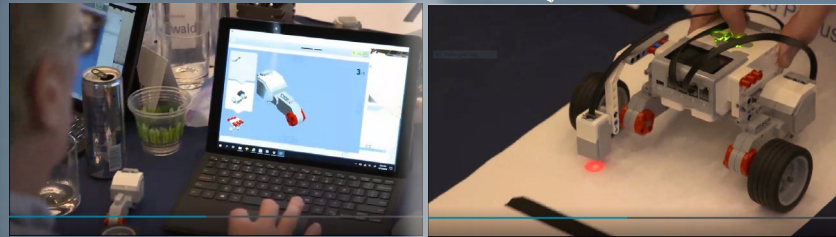
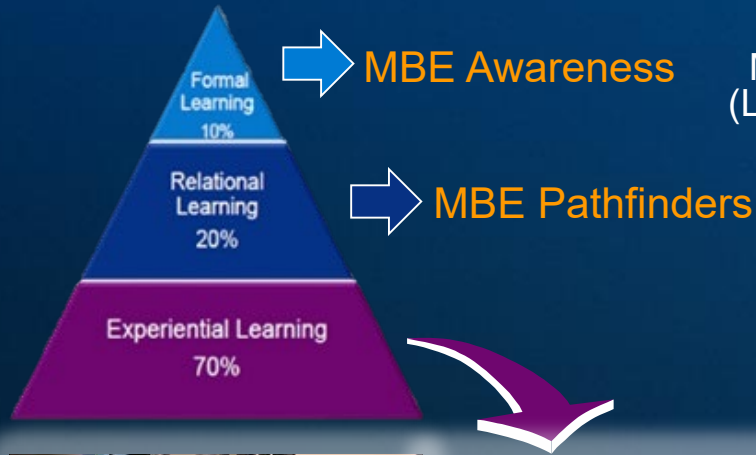**Hands-on MBE demo using Lego Mindstorm**
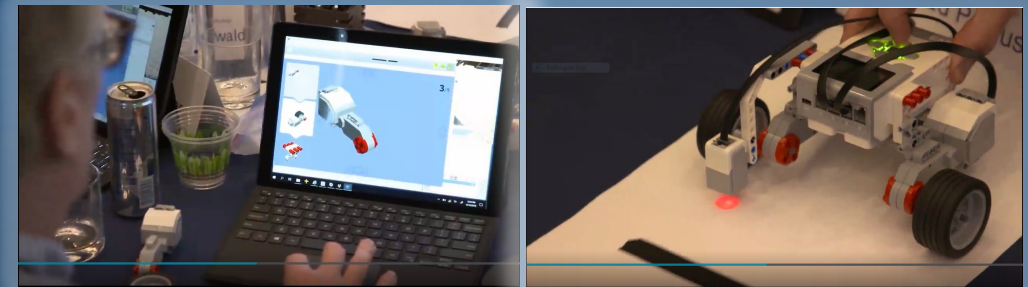
Learn MBE fundamentals by doing MBE!

MBE Fundamentals Using Lego MindStorm

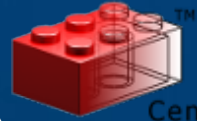FUNCTIONAL - start, stop, drive forward/backward, steer, detect, sense / avoid?...

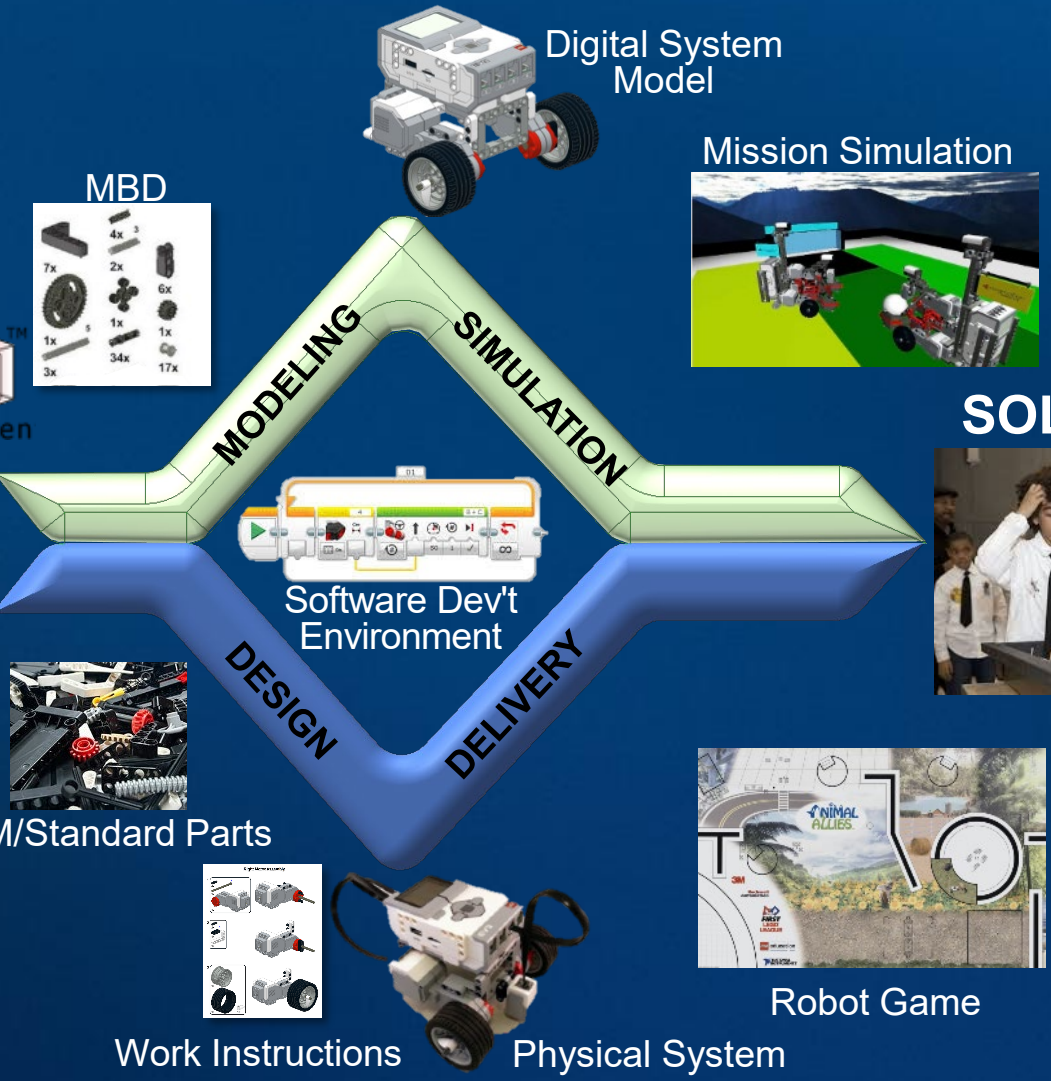LOGICAL - motor, wheels, steering, light sensor, computer, software, power source (batteries), wiring,...

Functional Models

MBD

Digital System Model

Mission Simulation

MBE Awareness

Mission Needs (Lego Challenge)

MBE Pathfinders

NEEDS

MODELING

SIMULATION

SOLUTIONS

Software Dev't Environment

DESIGN

DELIVERY

Formal Learning 10%

Relational Learning 20%

Experiential Learning 70%

BOM/Standard Parts

Work Instructions

Physical System

Robot Game

"Learn MBE by doing MBE!"

MBE "Starter Kits" - *Accelerating MBE Deployment in Boeing*

- An "MBE Starter Kit" is a **set of resources** (people, processes, tools, training, architectures, models) to implement a specific portion of the **MBE value chain**.

- MBE Starter Kits **connect models across multiple engineering domains** to extract the maximum value from the **Digital Thread** and enable programs to **operate differently** to achieve **champion-level performance**.

- MBE Starter Kits are created from **artifacts** (e.g. playbook, tip sheets, checklists, templates, etc…) **proven successful by MBE pathfinders**.

- MBE Starter Kits enable programs to **start (or continue) their MBE journey** along a proven-successful path to digital transformation.

- MBE Starter Kits will be **developed and managed by Enterprise Functional Leaders** and will continue to evolve and be updated as a result lessons learned from utilization, technology or regulatory changes.
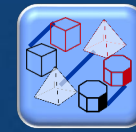
MBE Starter Kits

- People / Training
- Processes
- Tools / Apps
- Data
- Enabling Architectures
- Reusable Models

Questions?

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