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DEPARTMENT of Flight / COLLEGE of Aviation

VR-XR Diagnostics - The Blend

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INTRODUCTION

TITLE

AR XR Remote Diagnostics

The Blend

First Principles

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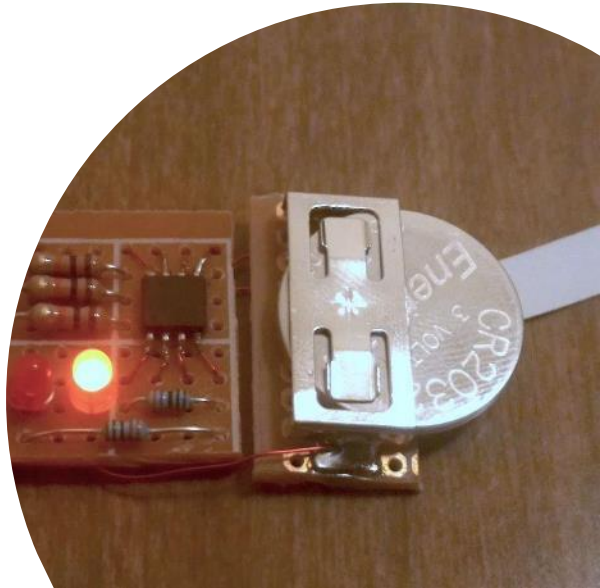
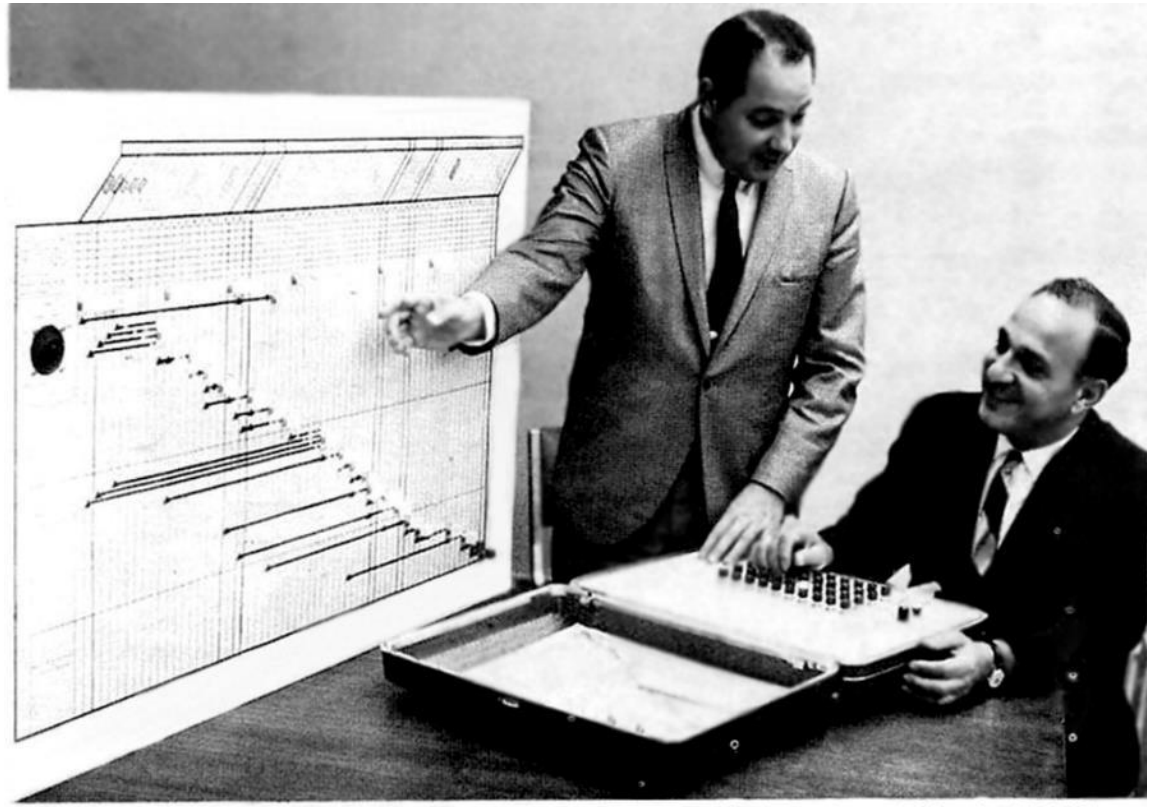
First Principle



Today -- Tomorrow

History

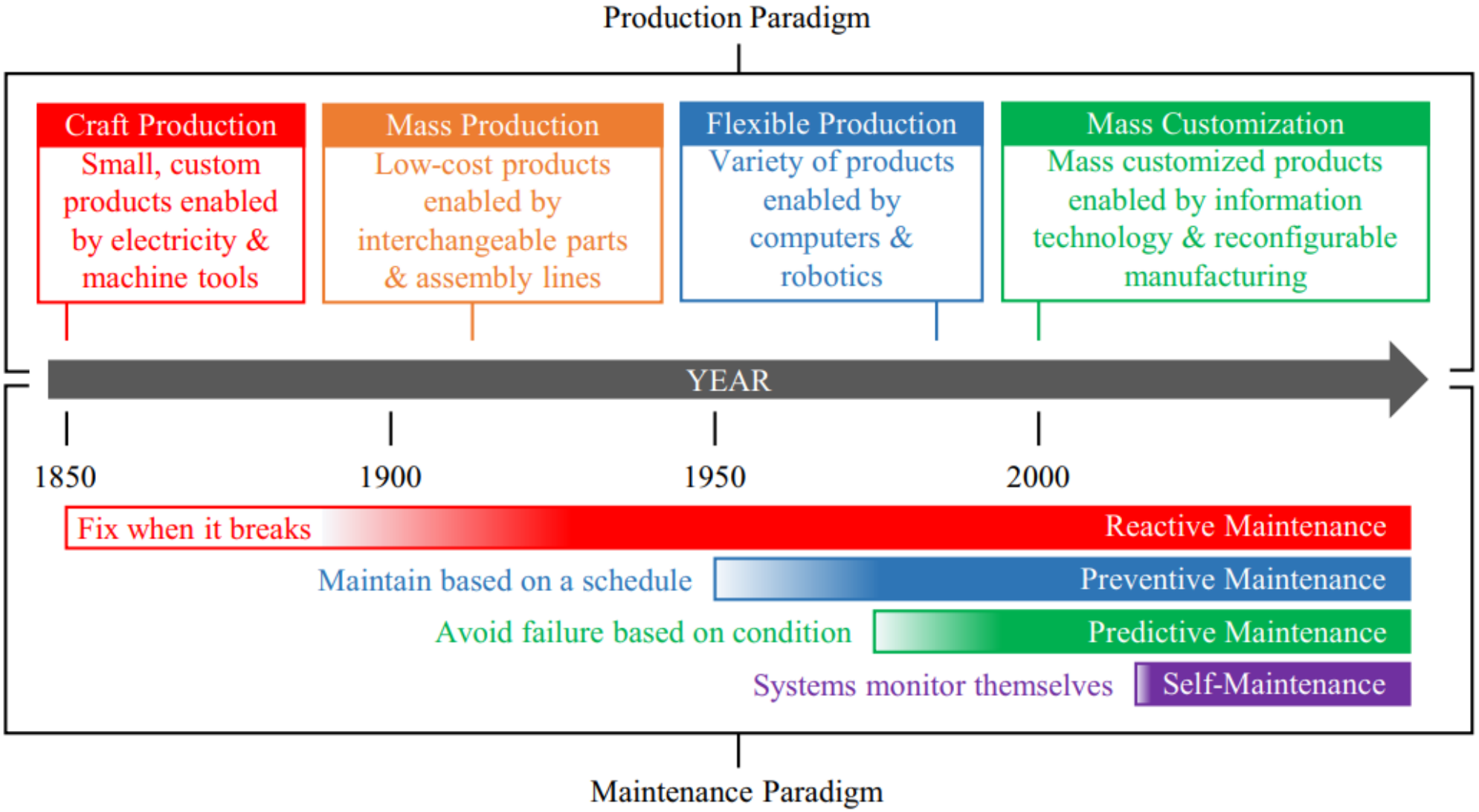


LOGIC MODEL – Ralph De Paul (standing) and Gus Daskalakis display logic model for the XM140 gun, which assists in equipment maintenance. A model also has been constructed for Chaparral weapon system.

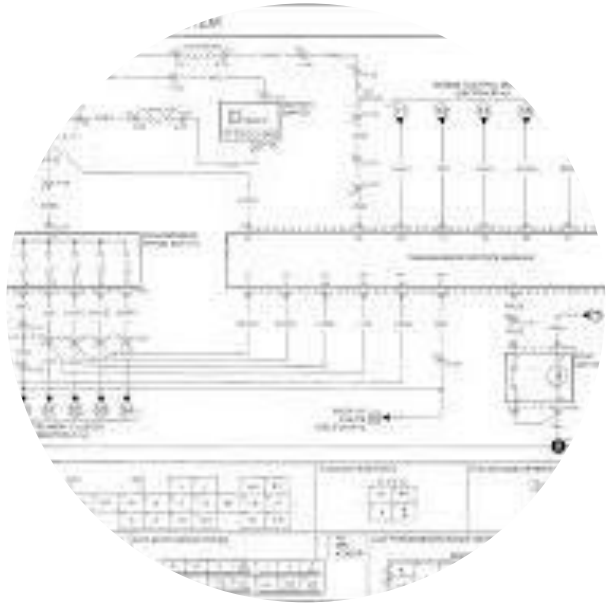
April, 1969

Pathway Forward

- Prognostics and Health Management (PHM)
- PHM DE3 Different viewpoints:
  - DEsign
  - DEvelopment
  - DEcision (DE^3)


Production Paradigm
Craft Production
Small, custom products enabled by electricity & machine tools
Mass Production
Low-cost products enabled by interchangeable parts & assembly lines
Flexible Production
Variety of products enabled by computers & robotics
Mass Customization
Mass customized products enabled by information technology & reconfigurable manufacturing
YEAR
1850
1900
1950
2000
Fix when it breaks
Reactive Maintenance
Maintain based on a schedule
Preventive Maintenance
Avoid failure based on condition
Predictive Maintenance
Systems monitor themselves
Self-Maintenance
Maintenance Paradigm


SERVICE
ENGINE
SOON
CHECK
CHECK

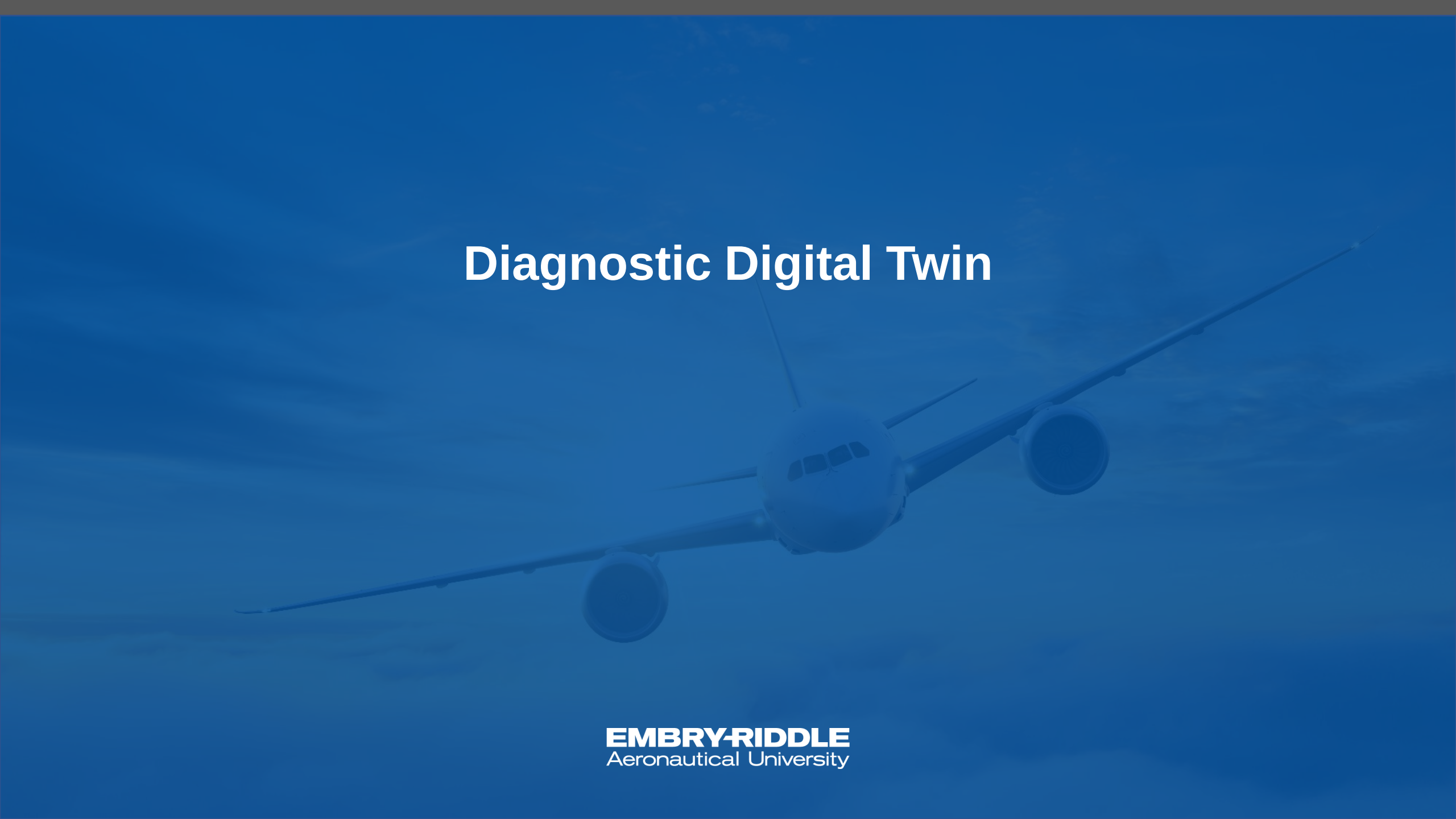



c Procedures (cont'd)

Standard


OSTIC CODES/CHECK ENGINE LIGHT

Diagnostic Digital Twin



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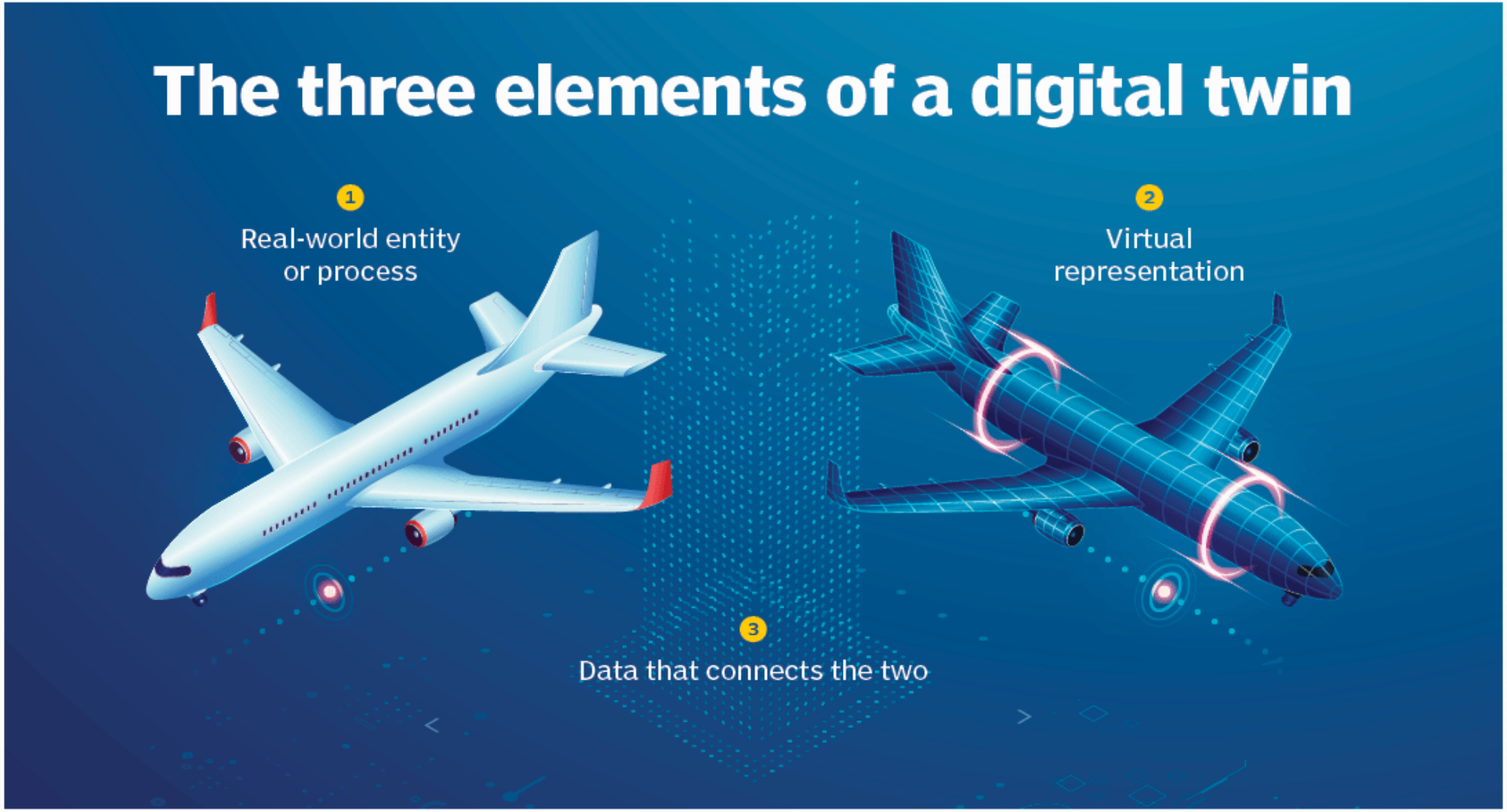

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Types of Digital Twins

Several ways of categorizing digital twins exist, but the following four categories, organized in a hierarchy, are by far the most common:

- **Component twins** (also referred to as *part twins*). The most basic level; it's not for simple parts like screws but for things like mechanical subassemblies.
- **Asset twins** (*product*). Two or more components whose interaction is represented in the digital twin.
- **System twins** (*unit*). Assets assembled into a complete, functioning unit.
- **Process twins**. Systems working together to serve a larger goal.

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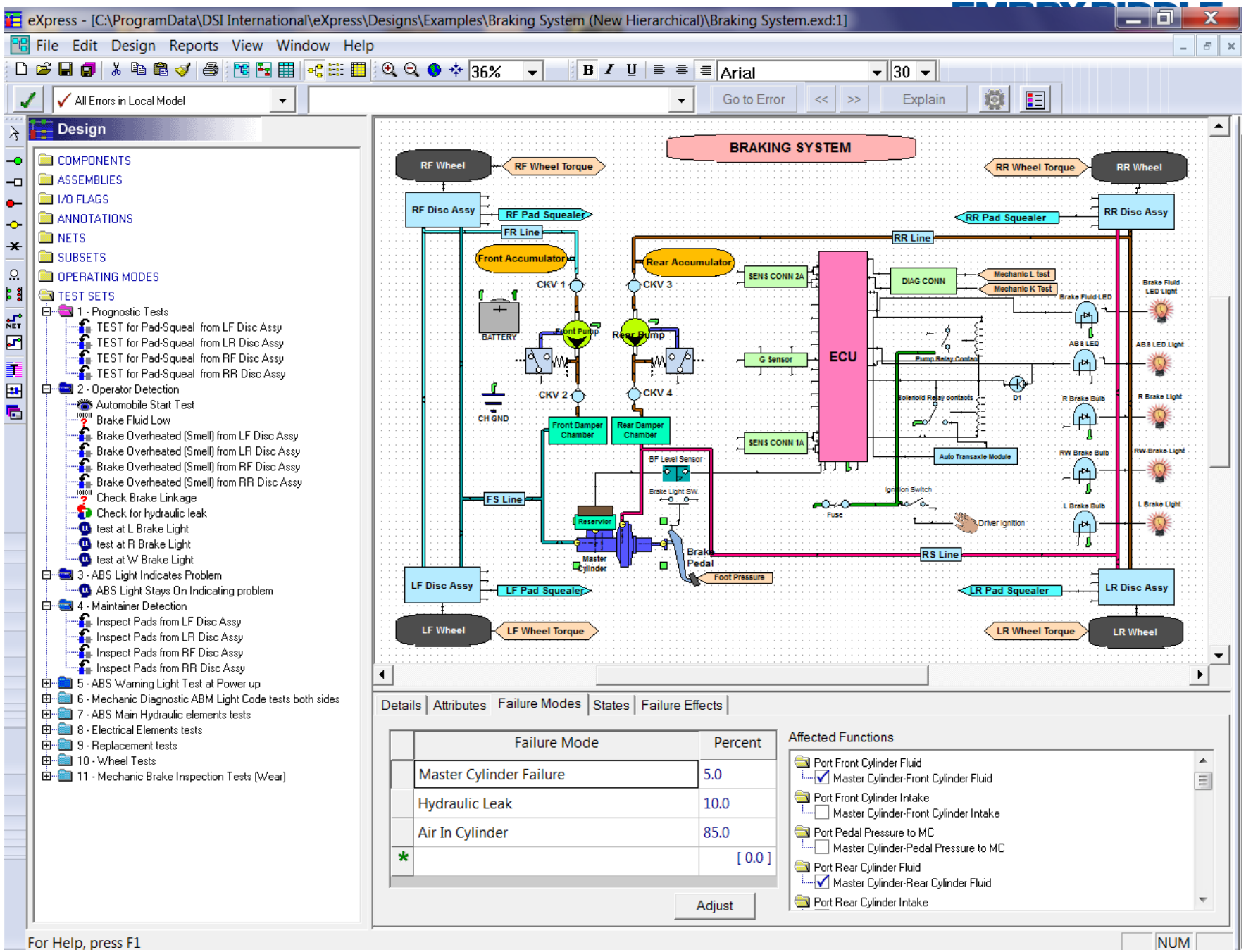
Digital Twins Challenges

Biggest Hurdles

- **Data management**
  - CAD model to IoT sensor usable data
- **Data security.**
  - Timely Digital twin mission critical data
- **IoT development**
  - IoT sensors a basic requirement
- **System Integration**
  - CAD to PLM
- **Supplier Collaboration**
  - Willingness to Share Information
- **Complexity**
  - Multiple different manufacturer and suppliers
  - Final & Current Information.

Model Based Engineering

Diagnostic Design (eXpress)



The “A” & The “I”

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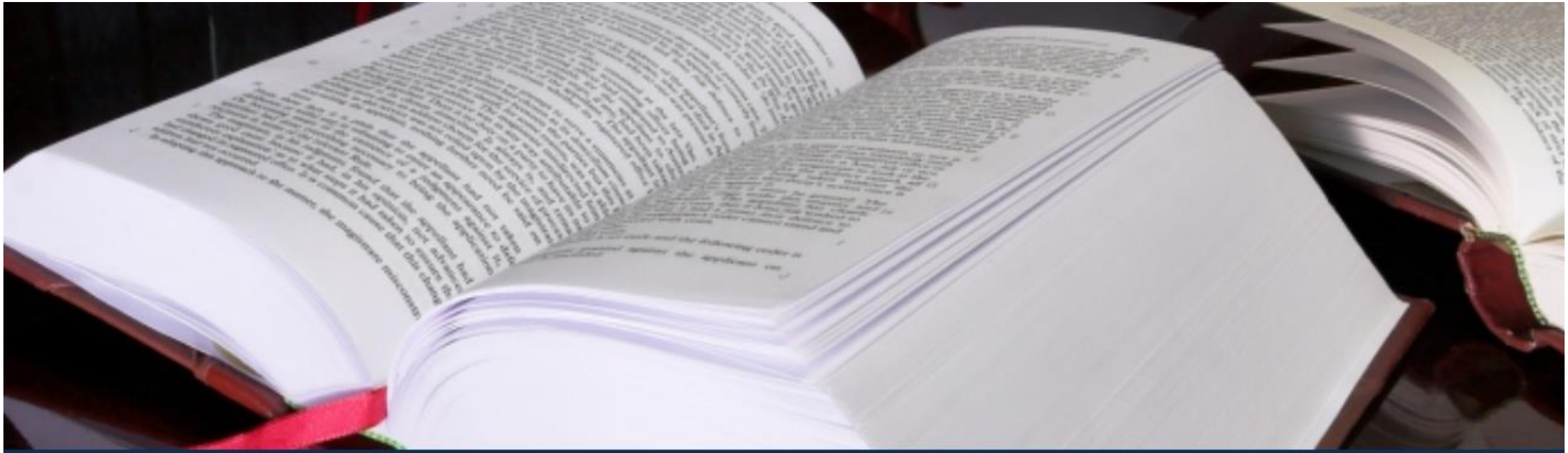
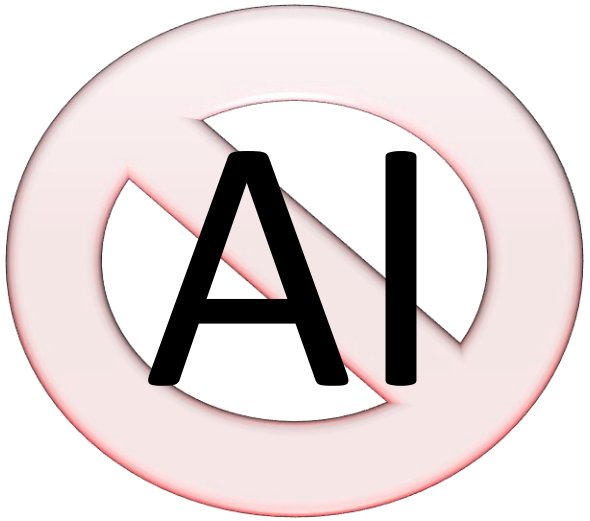


Knowledge Base

Knowledge

The "A"

- Human Actions
  - Physical
  - Cognizant
  - Emotive
- System Operations
- Environment



The "I"

- Basis for Intelligence
- Validation
- Creation
- Assurance
- Value -- Ethics

If Knowledge is King, then Diagnostics is Queen

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Diagnostics → Knowledge

DSI international, inc.

Diagnostic Environments

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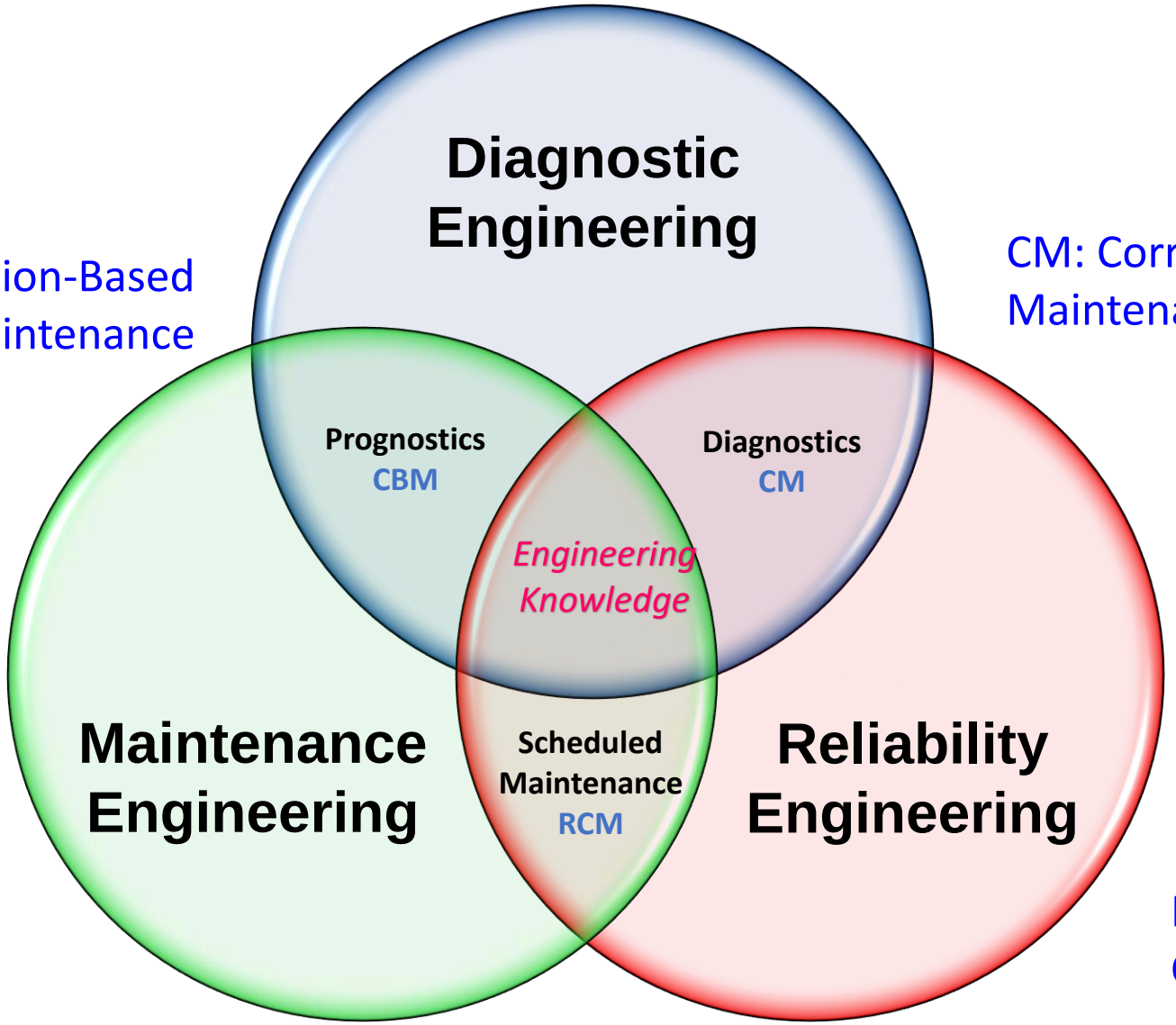
CBM: Condition-Based Maintenance



CM: Corrective Maintenance

RCM: Reliability-Centered Maintenance

DSI Workbench Preview [Braking System]

File View Reports Tools Database Help

Restart Session | Guided | Start Monitor | Monitor Control | Test Results | Panel Layout

Guided Troubleshooting

Isolating 3 Failures

End | Save and Restart

Pass | Fail | Back | Repair

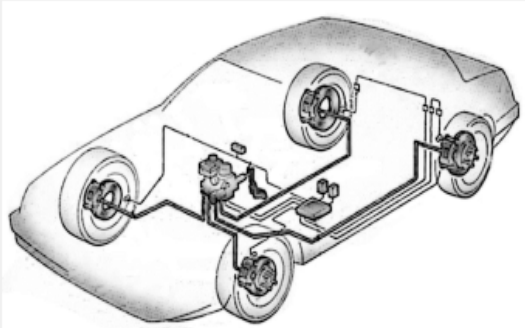
Test 1-1
Check BATTERY

Check Battery:

Wear safety g
three most co
A battery that
sulfuric acid o
car. If nothing
readers.

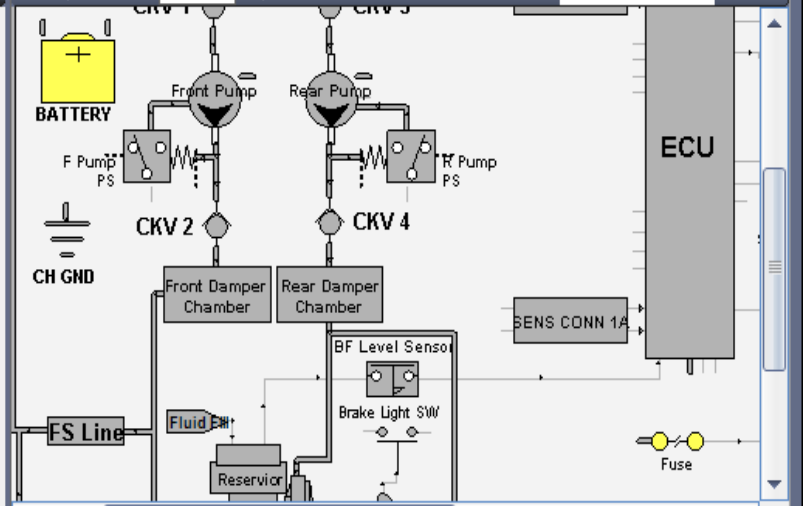
Braking System View

36%



[Braking System]

40% Search



Primary Suspects

Suspect Item / Suspect Failure	Failure Probability
BATTERY	0.697152
Battery dead	
Battery Partially Shorted Internally	
Fuse	0.174288
Battery Fuse Blown	
Ignition Switch	0.128560
Ignition Switch Stuck Open	

Primary Suspects | Suspected Connections

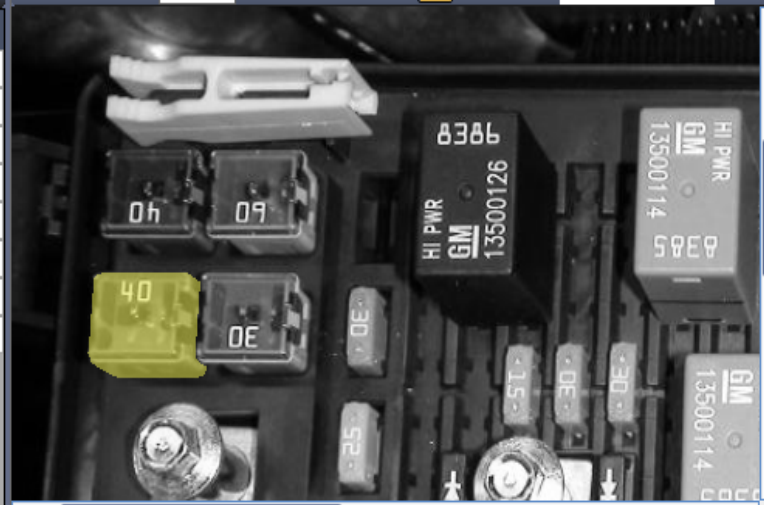
Resolution History

Date Range: Last 90 Days | Start Date: 5/23/2013

Resolution	Resolution D...
Replaced Components	8/21/2013 9:3...
Replace Fuse	8/21/2013 9:3...
Repaired Components	8/21/2013 9:3...
Clean and Reconnect Battery Cables	8/21/2013 9:3...
Reconfigured Unit	8/21/2013 9:3...
Clean and Reconnect Battery Cables	8/21/2013 9:3...
Upgraded Unit	8/21/2013 9:3...
Replace BATTERY	8/21/2013 9:3...

[Fuse Box]

106% Search



Diagnostic Status View

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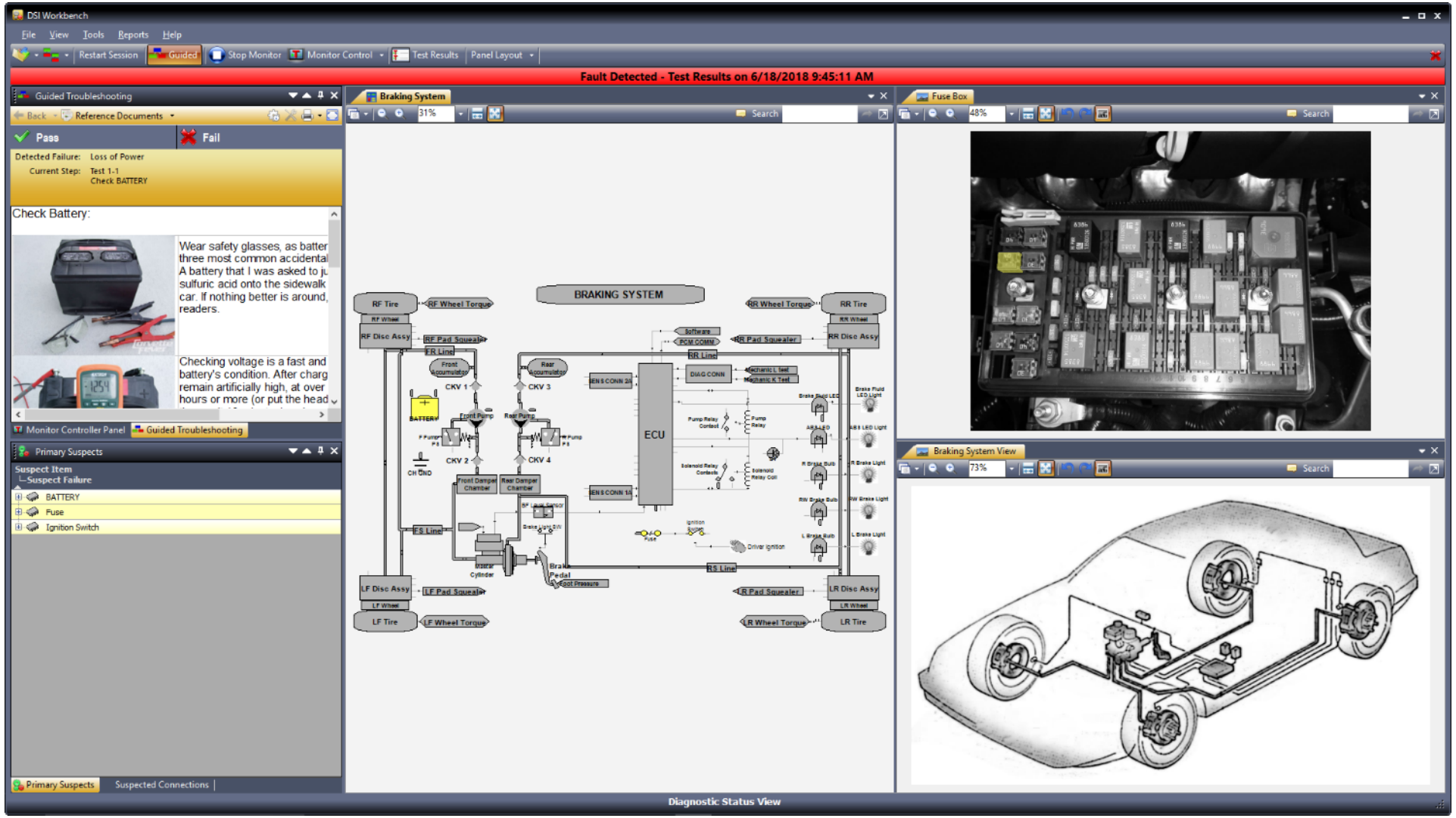
Diagnostics → Knowledge



Digital twins in the metaverse

- Digital twins are one of the building blocks of the metaverse, a broad concept that incorporates technologies such as virtual reality that enable immersive and highly interactive digital worlds. Proponents are working to re-create in the metaverse many of the elements that people interact with in the real world.
- Augmented reality, another foundational technology of the metaverse, can overlay a digital twin on the object it represents to provide field technicians with more detailed maintenance data. Digital twins could also provide some of the data for images in virtual reality.
- Both the metaverse and digital twins demand herculean efforts to capture, then digitally mirror, things in the world. For digital twins, the process is called reality capture. It's usually done with a laser scanner that directs a laser beam at an object and the surrounding space to capture measurements. Laser scan files are then combined into a *point cloud*, a set of points in 3D space that outline the geometry of the scanned object. Color is often added and the point cloud is imported into CAD software for further enhancement.
- Reality capture technology has expanded beyond laser scanners to include smartphone software and drones, among others, which should help expand its use in digital twin development.

The VRevolution…

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VR, AR, MR and XR Technologies

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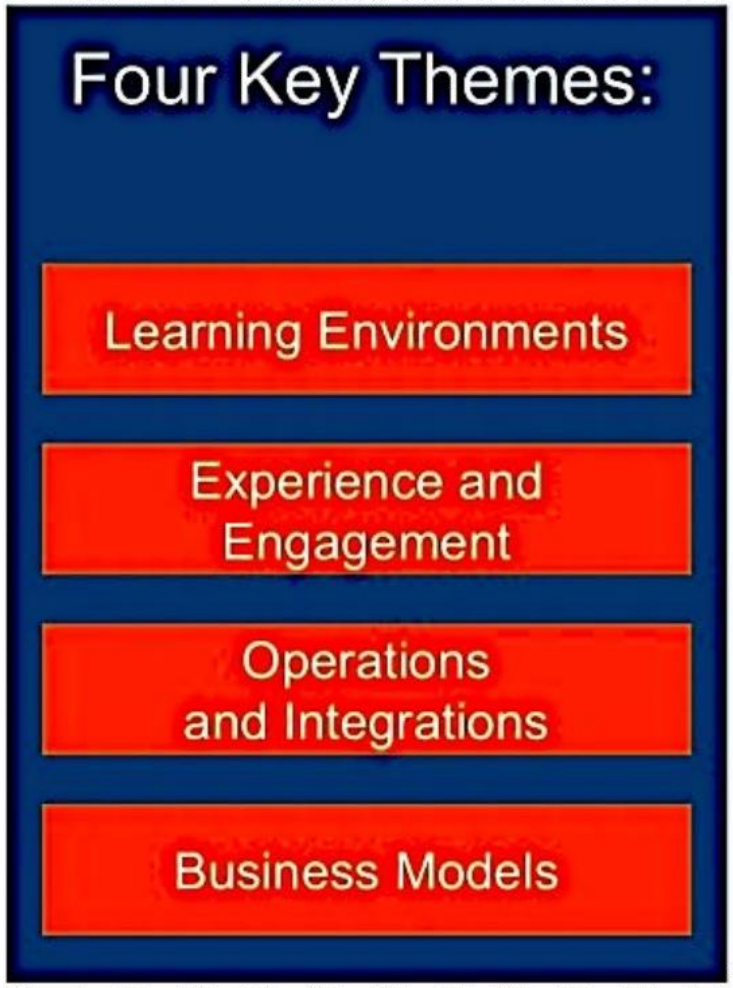
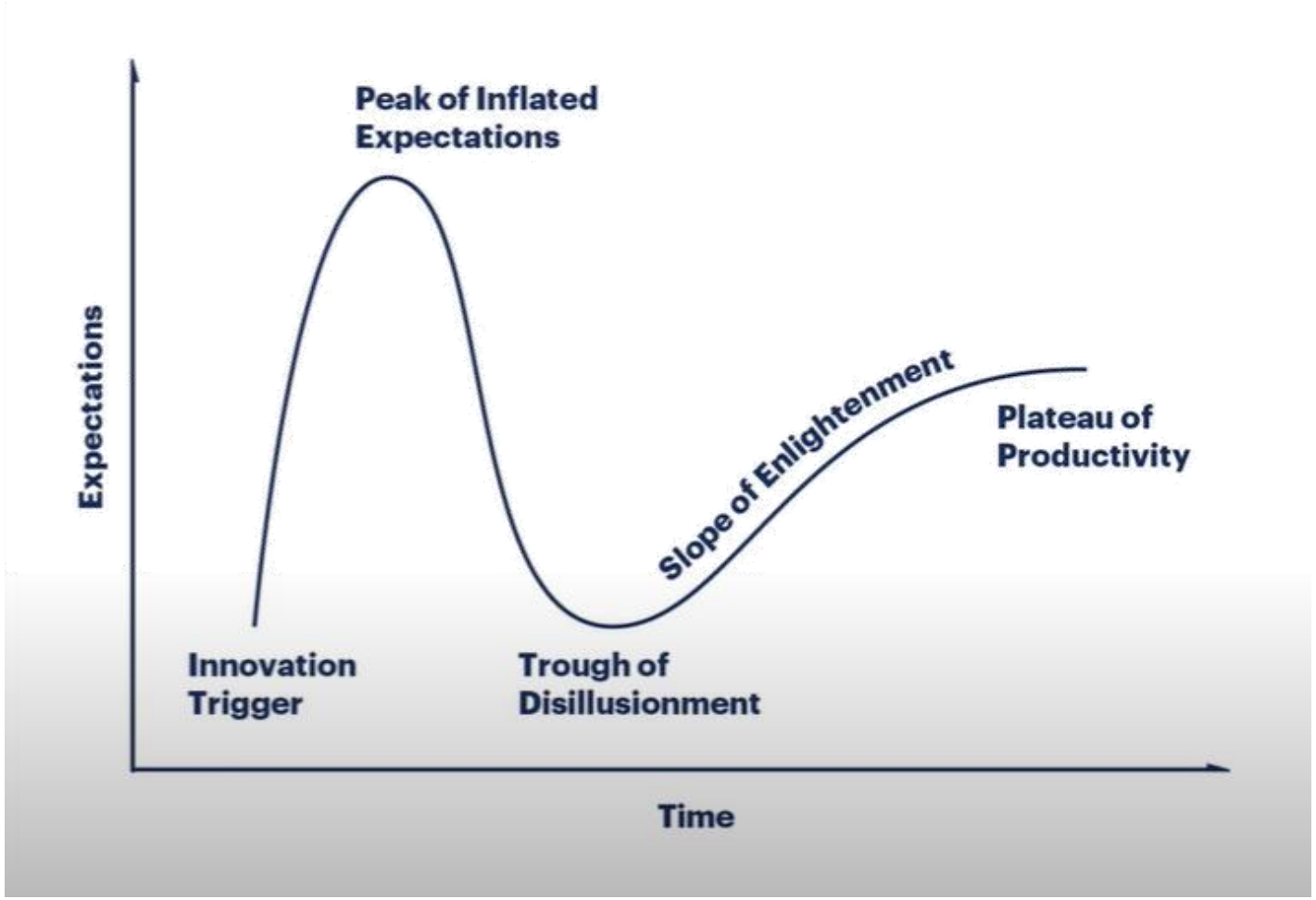
AR/VR devices can provide remote diagnosis and repair while minimizing travel costs and dependence on skilled technicians to be onsite. AR and VR headsets with custom software can boost service operations by increasing technical response time and faster return to service time.

VR, AR, MR and XR Technologies

Gartner Hype Cycle





Source: Hype Cycle for Higher Education, 2022,18 July 2022 (G00768912)

Source: Hype Cycle for Higher Education, 2022,18 July 2022 (G00768912)

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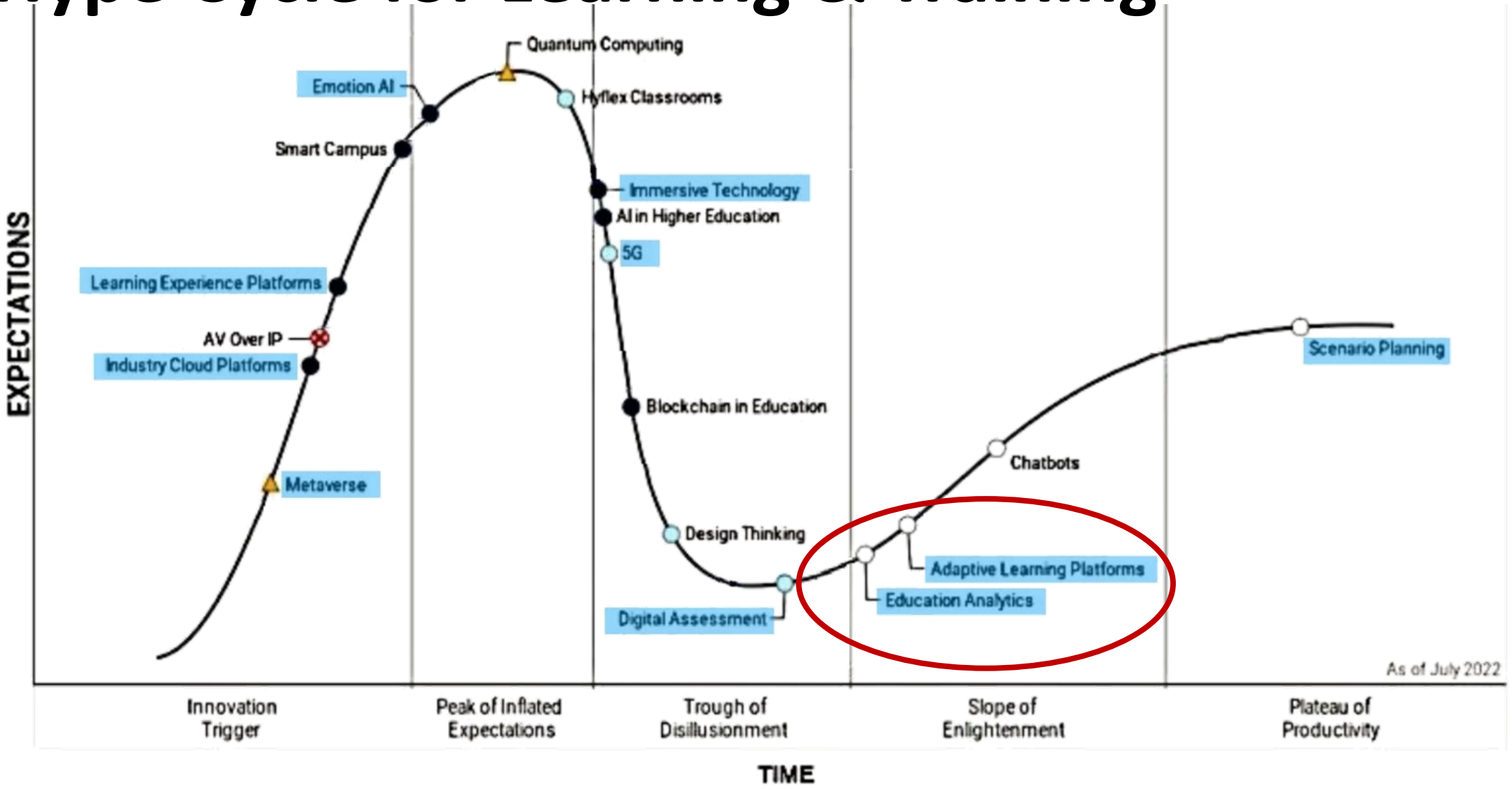
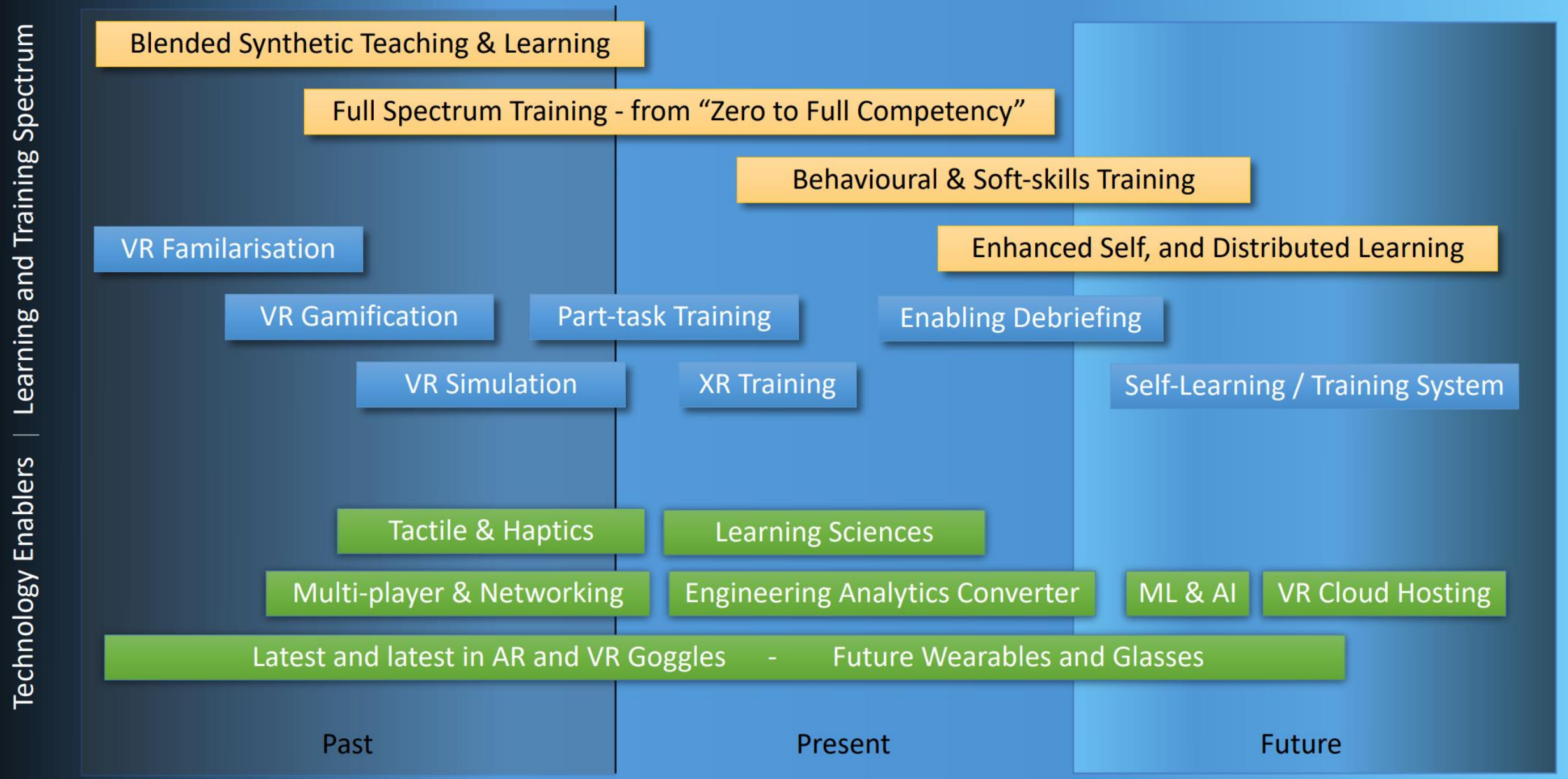
Hype Cycle for Learning & Training



VR Training Technology Roadmap - Past, Present and into the Future



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AR – VR – XR Application

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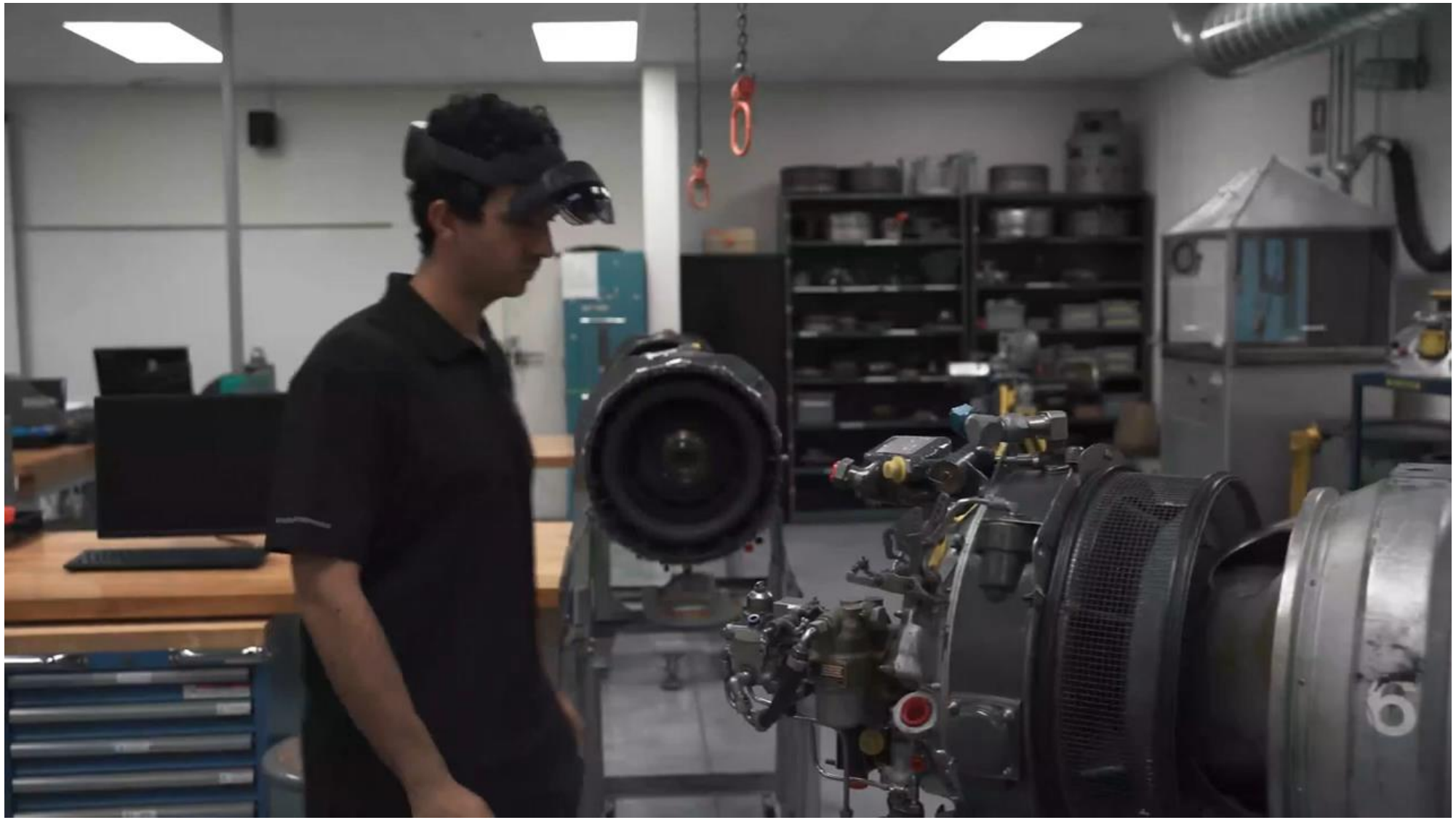
Opportunities

Repair

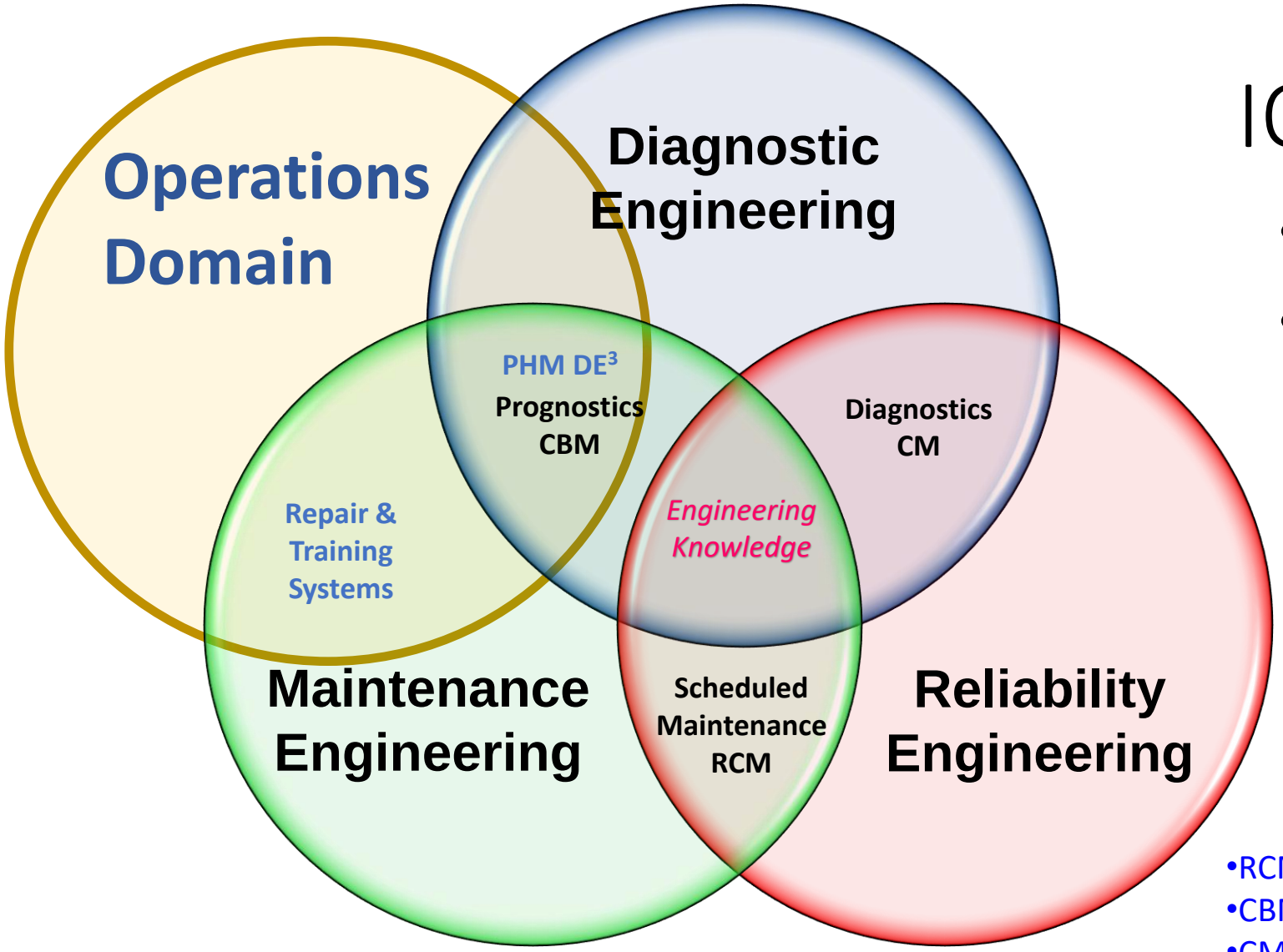
Training

Opportunities

Repair



Intersecting Environments



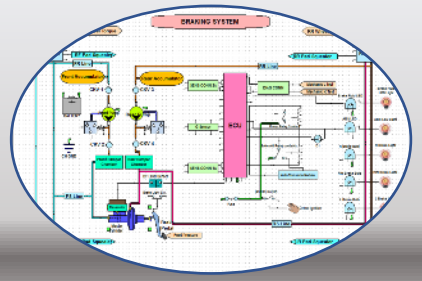
IOT New Frontiers

- Aircraft systems
- Mission and Personnel critical performance

•RCM: Reliability-Centered Maintenance
•CBM: Condition-Based Maintenance
•CM: Corrective Maintenance
•PHM: Prognostics & Health Management

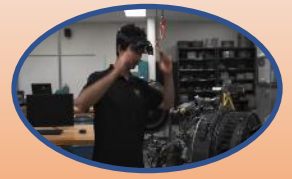
The Blend

Engineering & Production Infrastructure



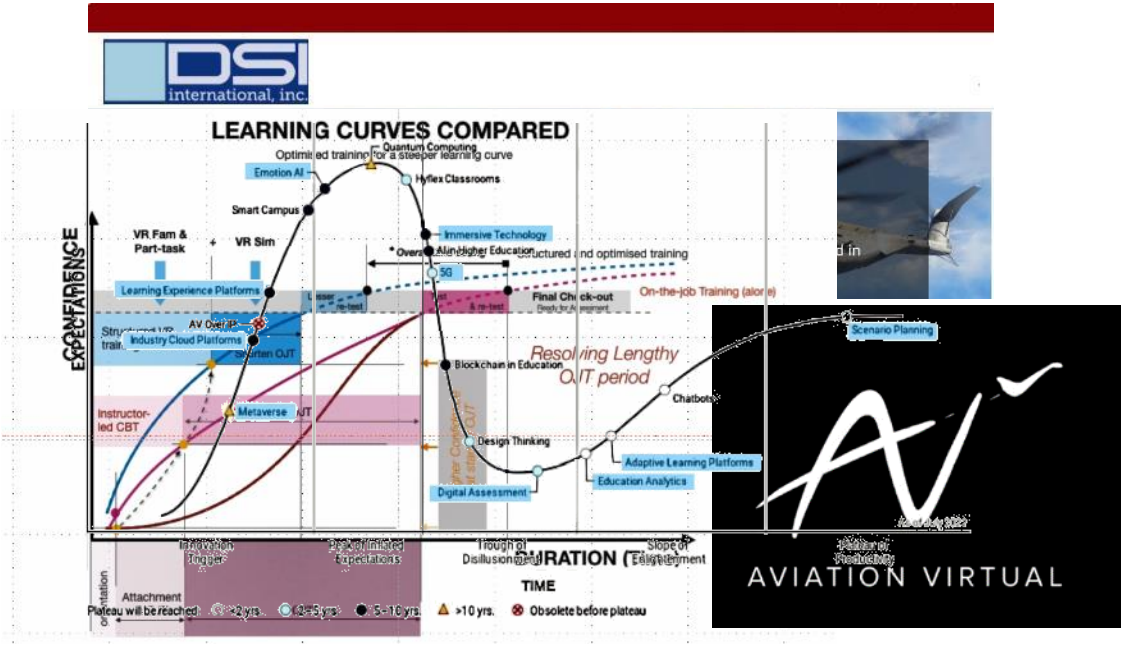
On Board Diagnostic Health Management

Sense & Response Support Center



Making The Blend

- Knowledge vs A-I
  - Bridge Design into Maintenance, Support Logistics & Operations Centers via Automated Analysis
- Digital True Twins
  - Diagnostic Models with System Knowledge
- VR-XR Opportunities
  - Hype Cycle
  - Learning



QUESTIONS?

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THANK YOU

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