

EMBRY-RIDDLE
Aeronautical University

DEPARTMENT of Flight / COLLEGE of Aviation

VR-XR Diagnostics - The Blend

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INTRODUCTION

T I T L E

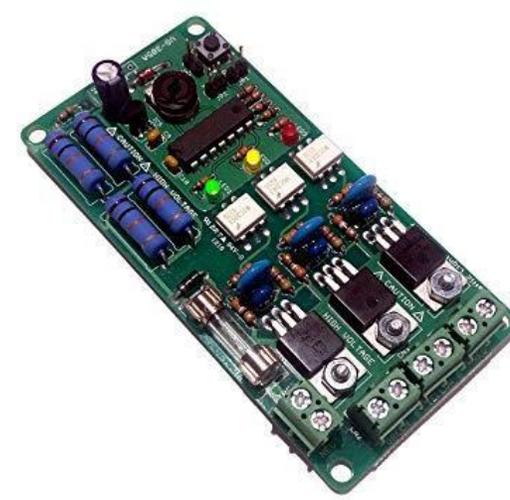
AR XR Remote Diagnostics

The Blend

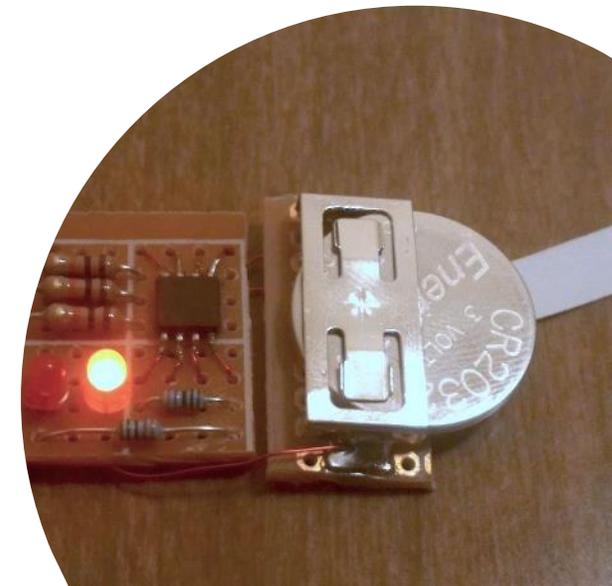
First Principles



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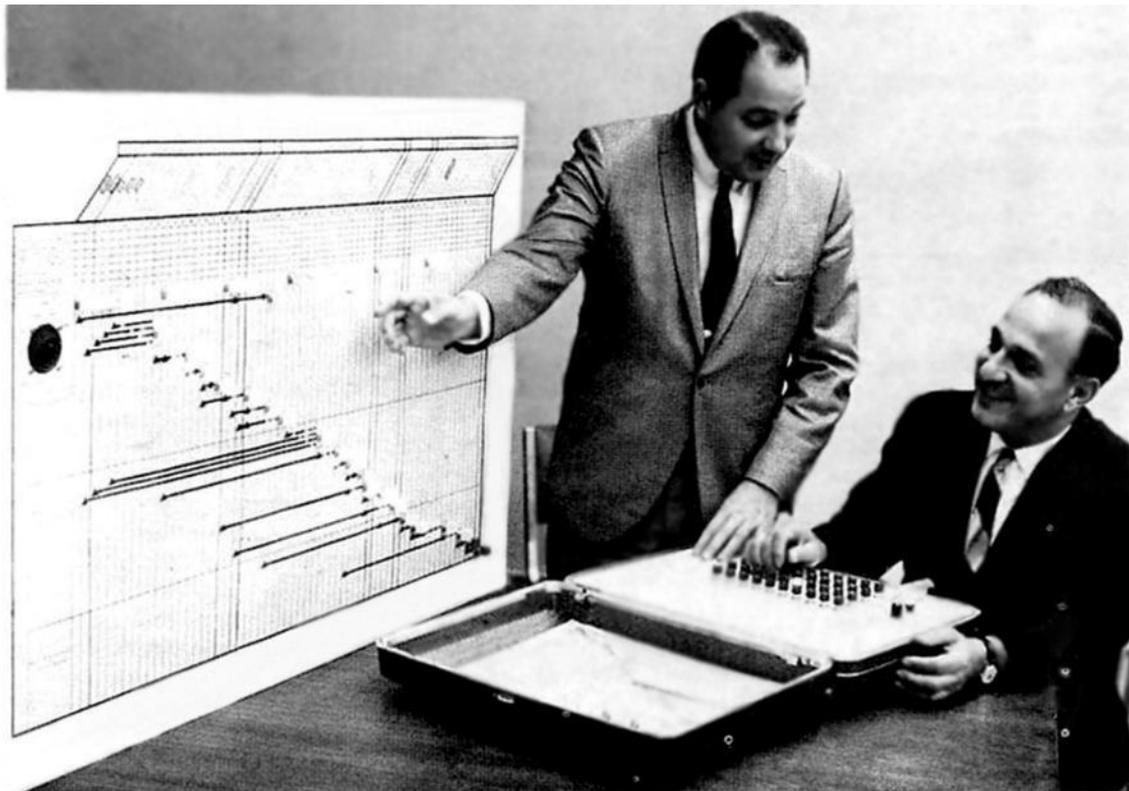


First Principle



Today -- Tomorrow

History

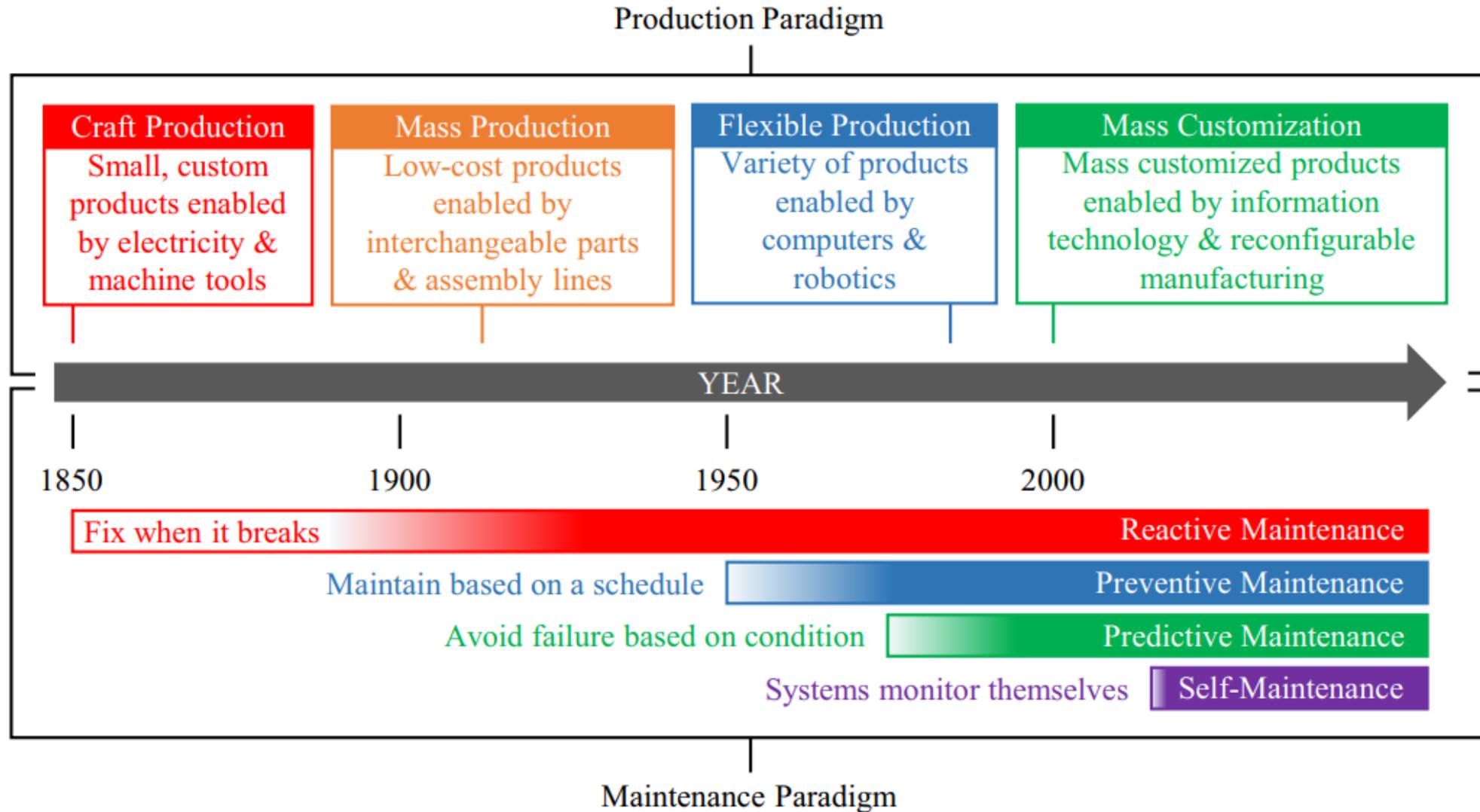


LOGIC MODEL — Ralph De Paul (standing) and Gus Daskalakis display logic model for the XM140 gun, which assists in equipment maintenance. A model also has been constructed for Chaparral weapon system.

April, 1969

Pathway Forward

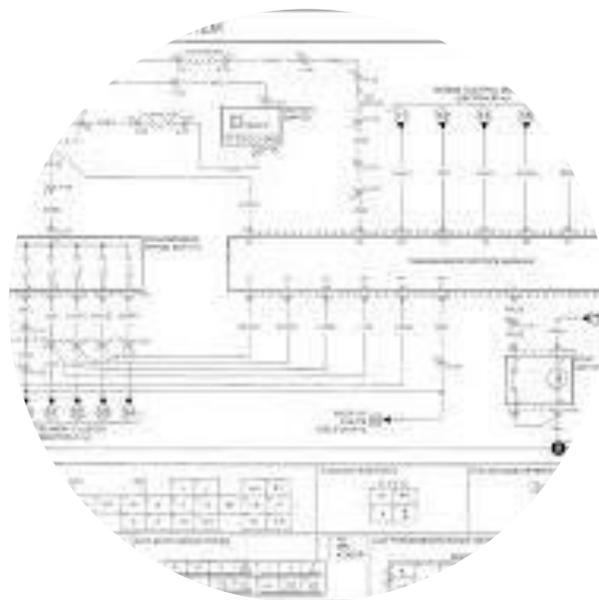
- Prognostics and Health Management (PHM)
- PHM DE3 Different viewpoints:
 - D^Esign
 - D^Evelopment
 - D^Ecision (DE³)



SERVICE
ENGINE
SOON



CHECK
ENGINE



Standard

ing
c Procedures (cont'd)

CODE	SYSTEM AFFECTED
000	CRUISE CONTROL (DODGE, CHRYSLER, PLYMOUTH)
MONITORING SYSTEMS (MIL FUNCTIONS)	
1300	EVAPORATIVE EMISSIONS (EVAP) SYSTEM
1301	EVAPORATIVE EMISSIONS (EVAP) SYSTEM - FUEL VAPOR
1302	EVAPORATIVE EMISSIONS (EVAP) SYSTEM - AIR FLOW
1303	EVAPORATIVE EMISSIONS (EVAP) SYSTEM - PURGE VALVE
1304	EVAPORATIVE EMISSIONS (EVAP) SYSTEM - PRESSURE
1305	EVAPORATIVE EMISSIONS (EVAP) SYSTEM - TEMPERATURE
1306	EVAPORATIVE EMISSIONS (EVAP) SYSTEM - VAPOR PRESSURE
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Three listed above are indicated, verify the code. If the code indicated is not set
might may come on, indicating a system problem when, in fact, there is a problem
and, check the electrical connections, clean or repair components if necessary
light does not come on when there is a malfunction in the Electric Load Detector
to when the Service Check Connector is jumped

DYNAMIC CODES/CHECK ENGINE LIGHT	
Code	Condition
1300	Open or short circuit in throttle position sensor
1301	Open or short circuit in water temperature sensor
1302	Open or short circuit in intake air temperature sensor
1303	Open or short circuit in barometric pressure sensor
1304	Failure in injector(s)
1305	Failure in sensor(s)
1306	Coolant Temperature Above 88° C (170° F)
1307	Coolant Temperature Above 93° C (170° F)

If the coolant temperature is at or above 88° C (170° F) the check engine light will flash a warning alert. If the coolant temperature is at or above 93° C (200° F), the check engine light will flash and will remain constantly illuminated.

*NOTE: At this point the operator should take precautionary measures such as changing to lower speed terrain and checking coolant level.

Diagnostic Digital Twin



The three elements of a digital twin



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.

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)



eXpress - [C:\ProgramData\DSI International\express\Designs\Examples\Braking System (New Hierarchical)\Braking System.exd:1]

File Edit Design Reports View Window Help

36%

Arial 30

All Errors in Local Model

Go to Error << >> Explain

Design

- COMPONENTS
- ASSEMBLIES
- I/O FLAGS
- ANNOTATIONS
- NETS
- SUBSETS
- OPERATING MODES
- TEST SETS
 - 1 - Prognostic Tests
 - TEST for Pad-Squeal from LF Disc Assy
 - TEST for Pad-Squeal from LR Disc Assy
 - TEST for Pad-Squeal from RF Disc Assy
 - TEST for Pad-Squeal from RR Disc Assy
 - 2 - Operator Detection
 - Automobile Start Test
 - Brake Fluid Low
 - Brake Overheated (Smell) from LF Disc Assy
 - Brake Overheated (Smell) from LR Disc Assy
 - Brake Overheated (Smell) from RF Disc Assy
 - Brake Overheated (Smell) from RR Disc Assy
 - Check Brake Linkage
 - Check for hydraulic leak
 - test at L Brake Light
 - test at R Brake Light
 - test at W Brake Light
 - 3 - ABS Light Indicates Problem
 - ABS Light Stays On Indicating problem
 - 4 - Maintainer Detection
 - Inspect Pads from LF Disc Assy
 - Inspect Pads from LR Disc Assy
 - Inspect Pads from RF Disc Assy
 - Inspect Pads from RR Disc Assy
 - 5 - ABS Warning Light Test at Power up
 - 6 - Mechanic Diagnostic ABM Light Code tests both sides
 - 7 - ABS Main Hydraulic elements tests
 - 8 - Electrical Elements tests
 - 9 - Replacement tests
 - 10 - Wheel Tests
 - 11 - Mechanic Brake Inspection Tests (Wear)

BRAKING SYSTEM

RF Wheel Torque, RF Wheel, RF Disc Assy, RF Pad Squealer, FR Line, Front Accumulator, CKV 1, Front Pump, CKV 2, LF Disc Assy, LF Pad Squealer, LF Wheel Torque, LF Wheel, LF Disc Assy, LF Pad Squealer, LF Wheel Torque, LF Wheel

RR Wheel Torque, RR Wheel, RR Disc Assy, RR Pad Squealer, RR Line, Rear Accumulator, CKV 3, Rear Pump, CKV 4, RR Disc Assy, RR Pad Squealer, RR Wheel Torque, RR Wheel

FS Line, RS Line, Reservoir, Master Cylinder, Brake Pedal, Foot Pressure, Brake Light SW, BF Level Sensor, Ignition Switch, Fuse, Driver Ignition, Auto Transaxle Module, Solenoid Relay contacts, Pump Relay Control, G Sensor, SENS CONN 2A, DIAG CONN, Mechanic L Test, Mechanic K Test, Brake Fluid LED, ABS LED, R Brake Bulb, RW Brake Bulb, L Brake Bulb, L Brake Light, R Brake Light, RW Brake Light, ABS LED Light, Brake Fluid LED Light

Details | Attributes | Failure Modes | States | Failure Effects

Failure Mode	Percent	Affected Functions
Master Cylinder Failure	5.0	<ul style="list-style-type: none"> Port Front Cylinder Fluid <input checked="" type="checkbox"/> Master Cylinder-Front Cylinder Fluid Port Front Cylinder Intake <input type="checkbox"/> Master Cylinder-Front Cylinder Intake
Hydraulic Leak	10.0	<ul style="list-style-type: none"> Port Pedal Pressure to MC <input type="checkbox"/> Master Cylinder-Pedal Pressure to MC
Air In Cylinder	85.0	<ul style="list-style-type: none"> Port Rear Cylinder Fluid <input checked="" type="checkbox"/> Master Cylinder-Rear Cylinder Fluid Port Rear Cylinder Intake
	[0.0]	

Adjust

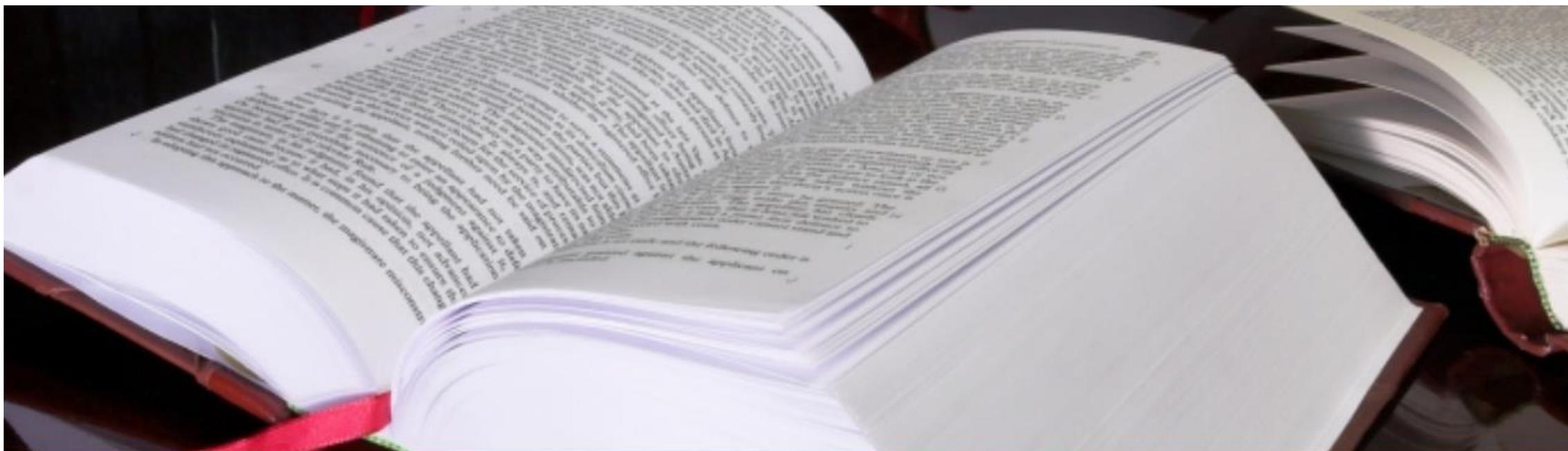
NUM

For Help, press F1

The “A” & The “I”



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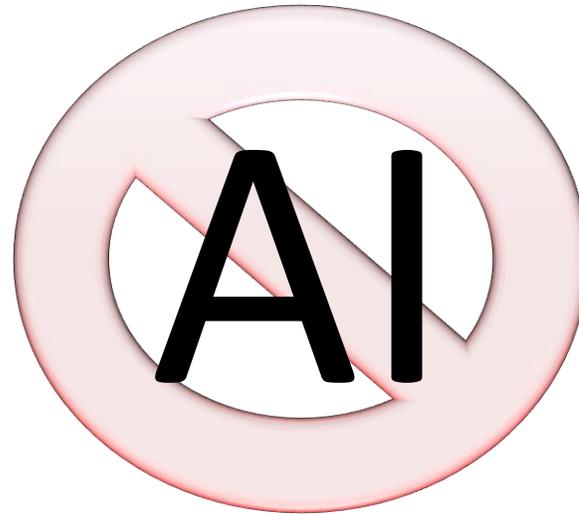


Knowledge Base

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

Diagnostics →
Knowledge

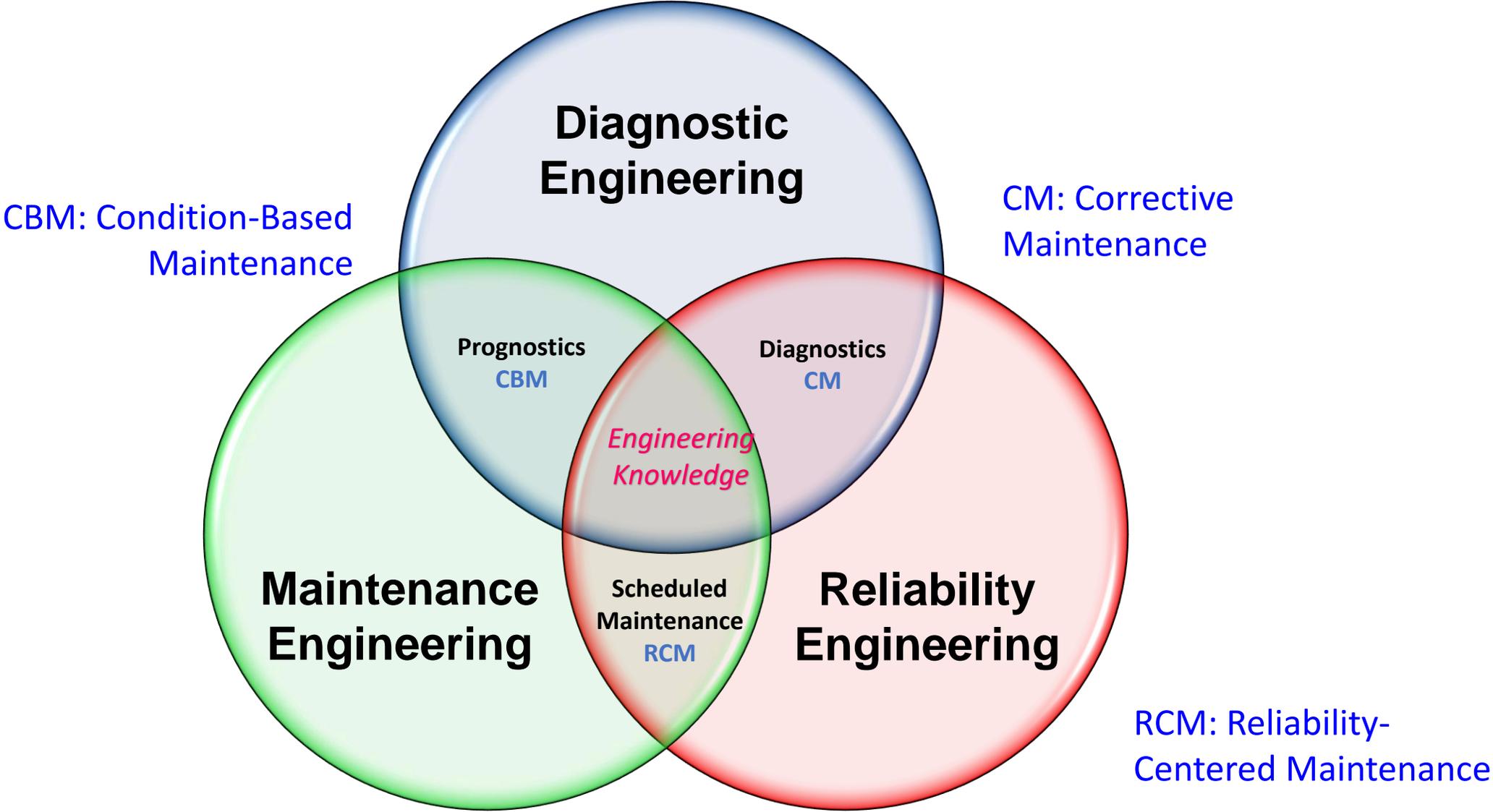
The screenshot displays the OSI Workbench software interface for a Braking System diagnostic. The interface is divided into several panels:

- Top Panel:** Includes a menu bar (File, View, Reports, Tools, Database, Help) and a toolbar with buttons for Guided Troubleshooting, Start Monitor, Monitor Control, Test Results, and Panel Layout.
- Left Panel:** Shows 'Isolating 3 Failures' with buttons for 'End', 'Save and Restart', 'Pass', 'Fail', 'Back', and 'Repair'. Below this is a 'Check Battery' section with an image of a battery and a warning: 'Wear safety goggles. A battery that contains sulfuric acid can be dangerous if it leaks or is shorted. If nothing reads, do not touch it.' A 'Test 1-1 Check BATTERY' button is also present.
- Center Panel:** Displays a 3D cutaway diagram of a car chassis showing the braking system components.
- Right Panel:** Shows a detailed electrical schematic of the braking system, including components like the BATTERY, F Pump, R Pump, CKV 2, CKV 4, Front Damper Chamber, Rear Damper Chamber, BF Level Sensor, Brake Light SW, Reservoir, and ECU.
- Bottom Left Panel:** 'Primary Suspects' table listing suspected failures and their probabilities.
- Bottom Center Panel:** 'Resolution History' table showing a list of actions taken to resolve the issue, such as 'Replaced Components', 'Replace Fuse', 'Repaired Components', 'Clean and Reconnect Battery Cables', 'Reconfigured Unit', 'Clean and Reconnect Battery Cables', 'Upgraded Unit', and 'Replace BATTERY', all dated 8/21/2013 9:30 AM.
- Bottom Right Panel:** A photograph of a physical fuse box with various fuses and components labeled, including a '40' amp fuse and a '5 20' amp fuse.

The overall interface is titled 'Diagnostic Status View' at the bottom.



Diagnostic Environments



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

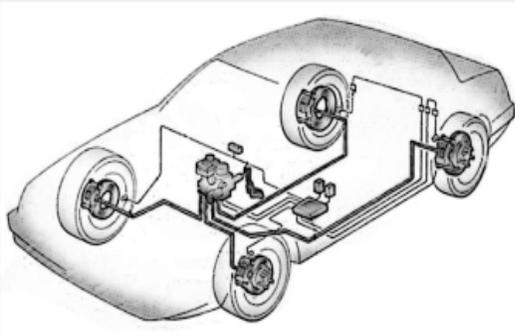
Test 1-1
Check BATTERY

Check Battery:

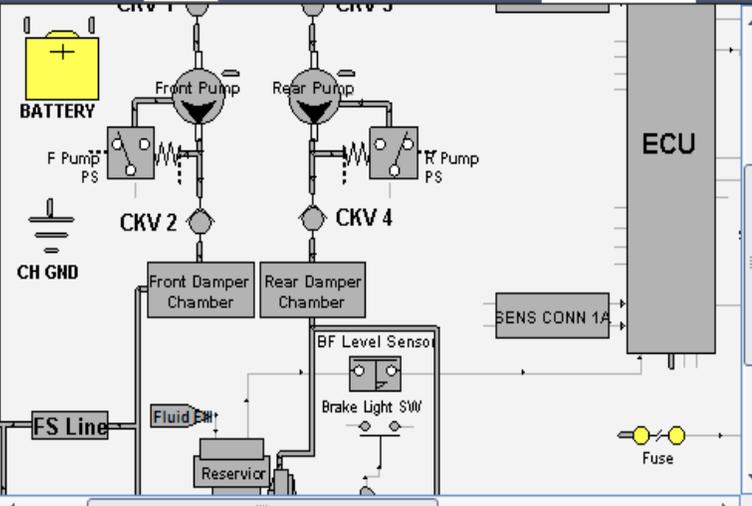


Wear safety glasses. Always wear eye protection when working with batteries. Sulfuric acid is highly corrosive. Wear safety glasses three most common. A battery that sulfates can be repaired. If nothing reads.

Braking System View



[Braking System]



Primary Suspects

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

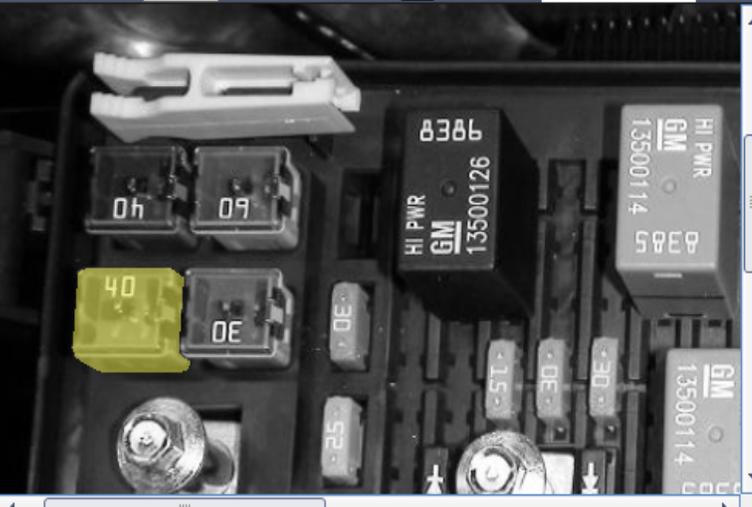
Primary Suspects Suspected Connections

Resolution History

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

Resolution	Resolution Date
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]



Diagnostic Status View

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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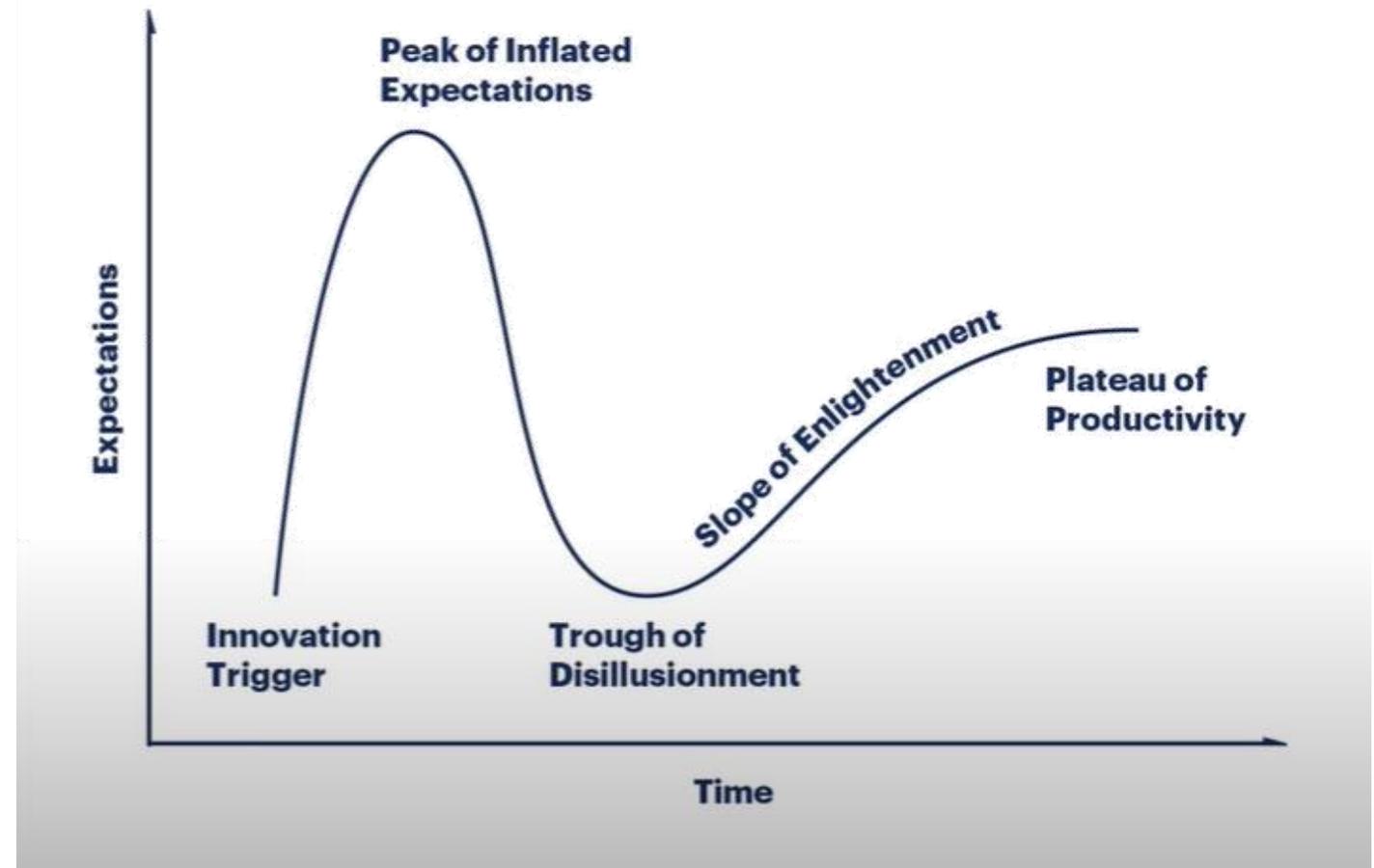
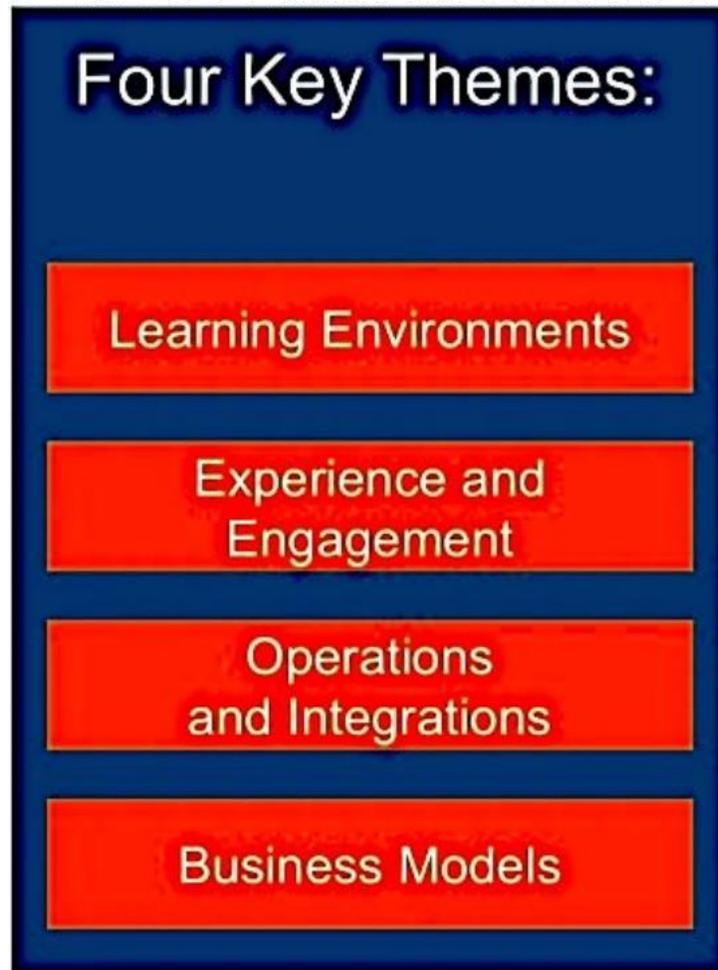
VR, AR, MR and XR Technologies

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.

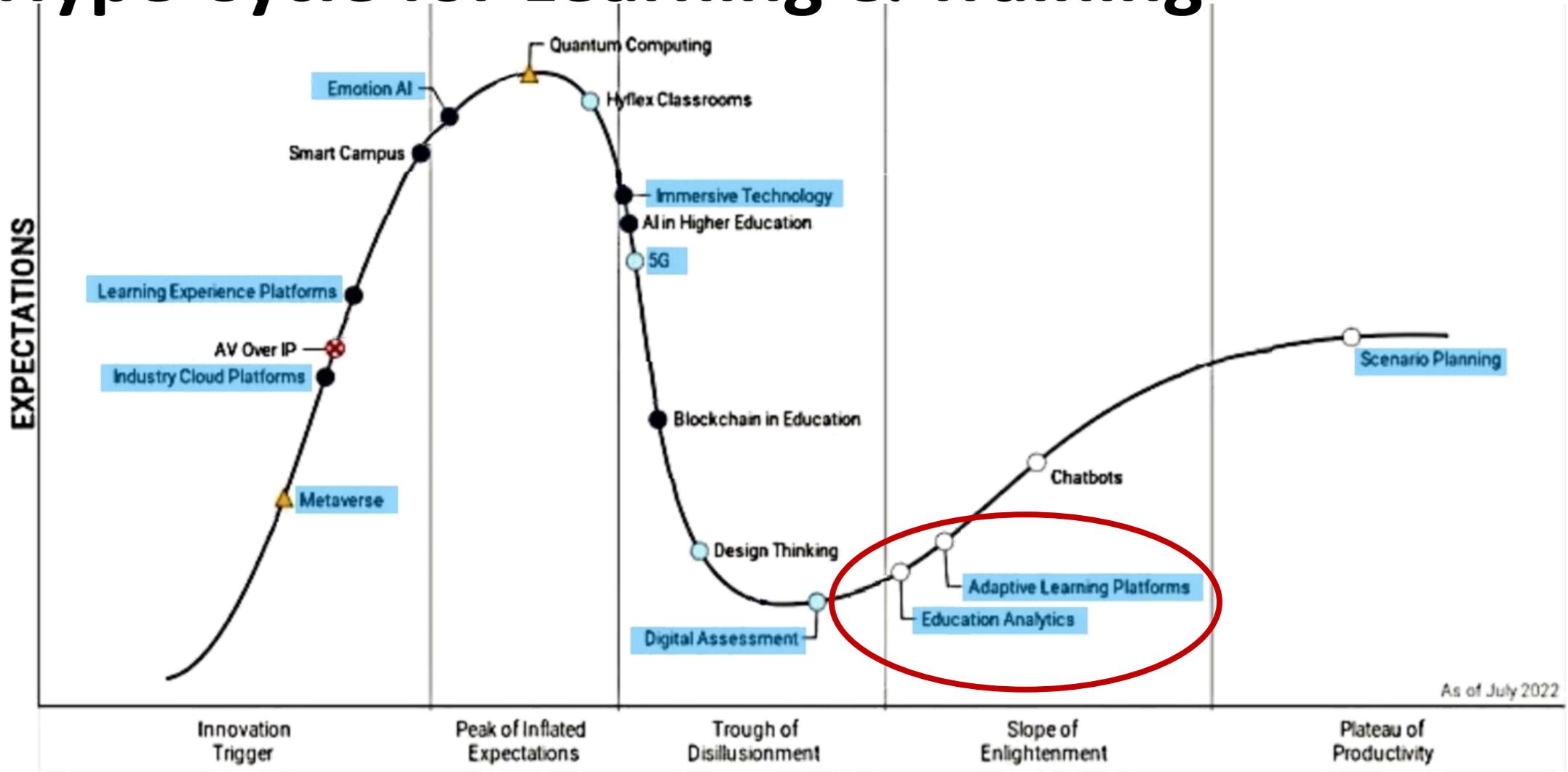


VR, AR, MR and XR Technologies

Gartner Hype Cycle



Hype Cycle for Learning & Training

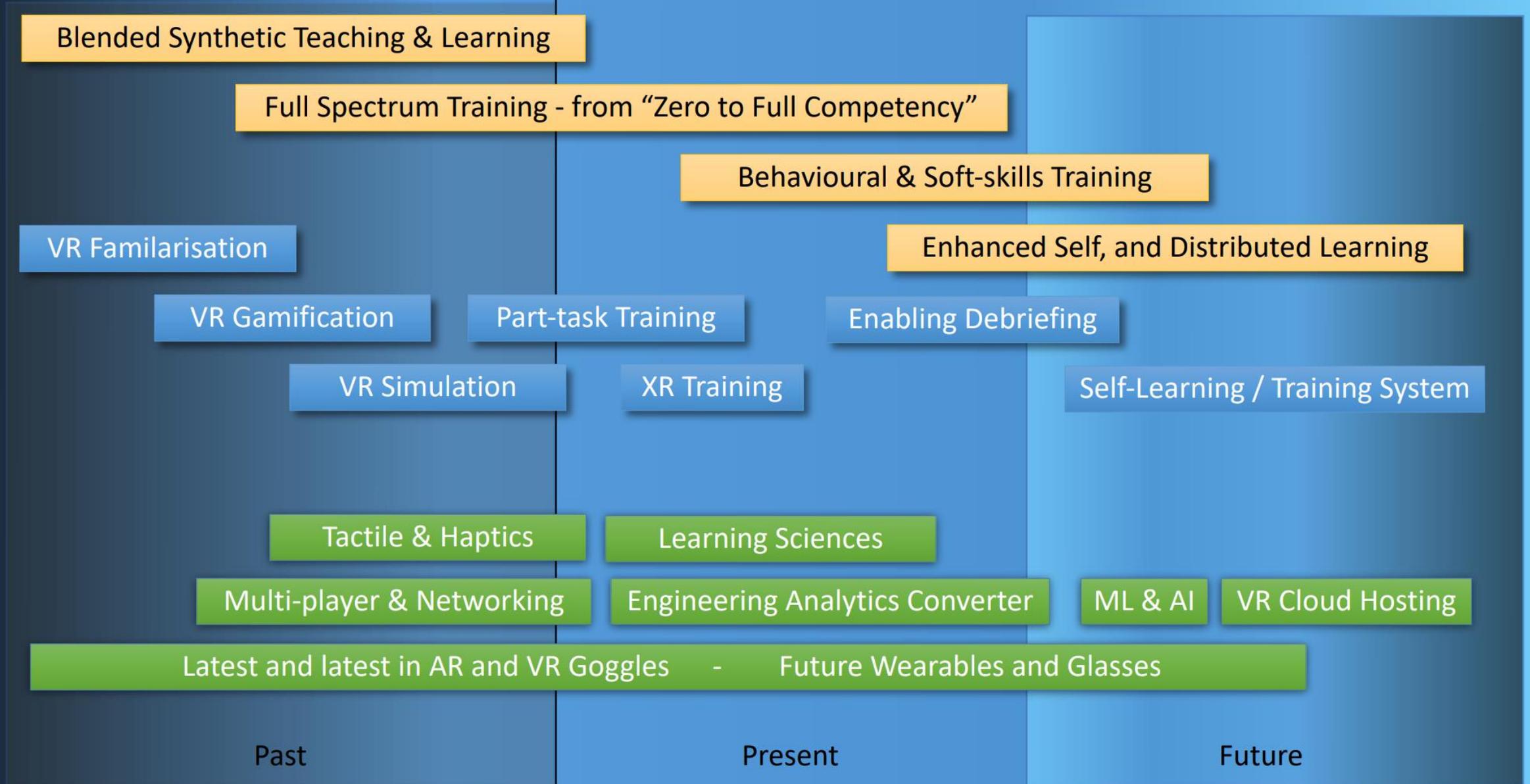


As of July 2022

Plateau will be reached: ○ <2 yrs. ● 2-5 yrs. ● 5-10 yrs. ▲ >10 yrs. ⊗ Obsolete before plateau

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

Technology Enablers | Learning and Training Spectrum



AR – VR – XR Application



The Blend



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Repair



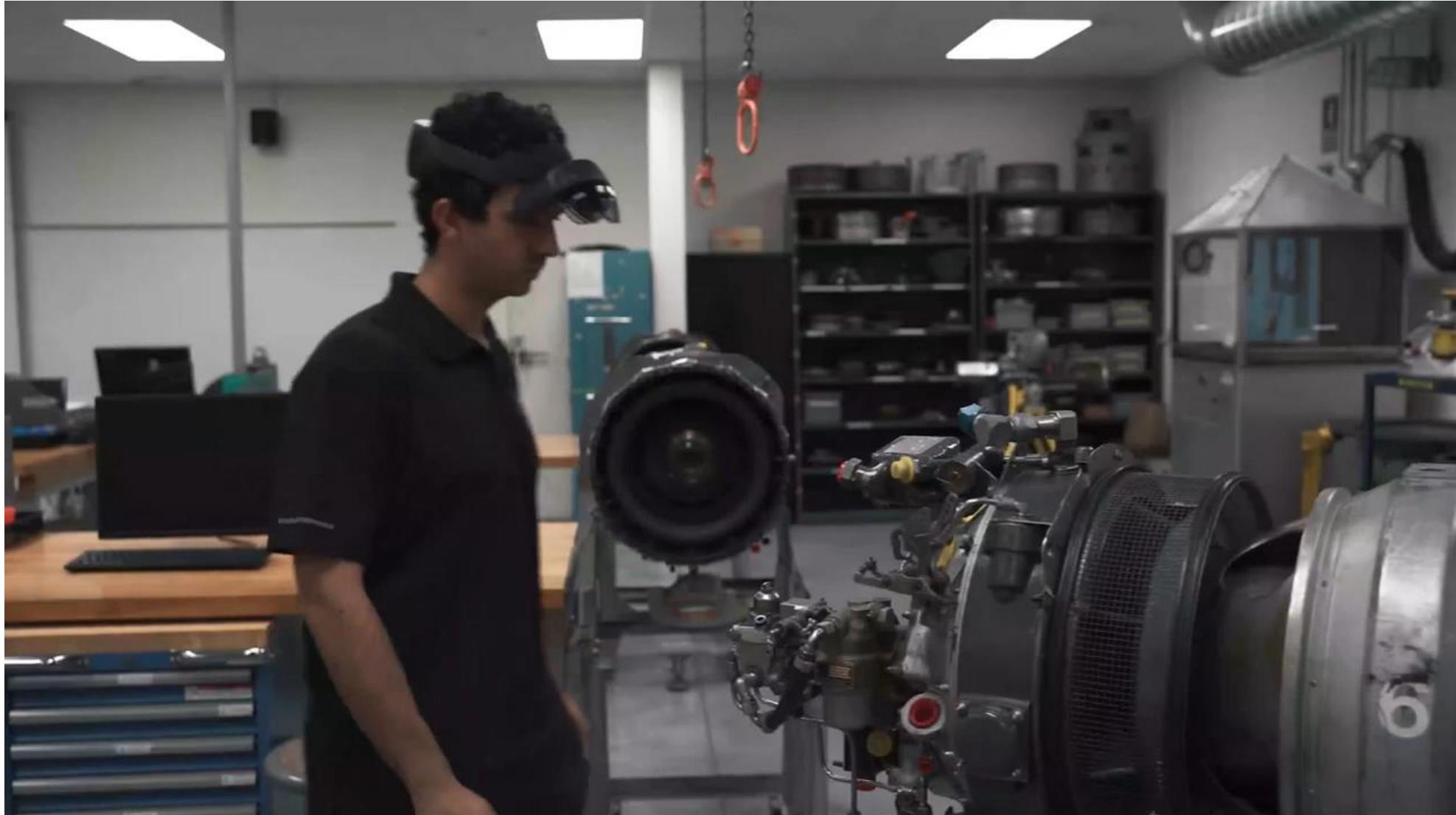
Opportunities

Training

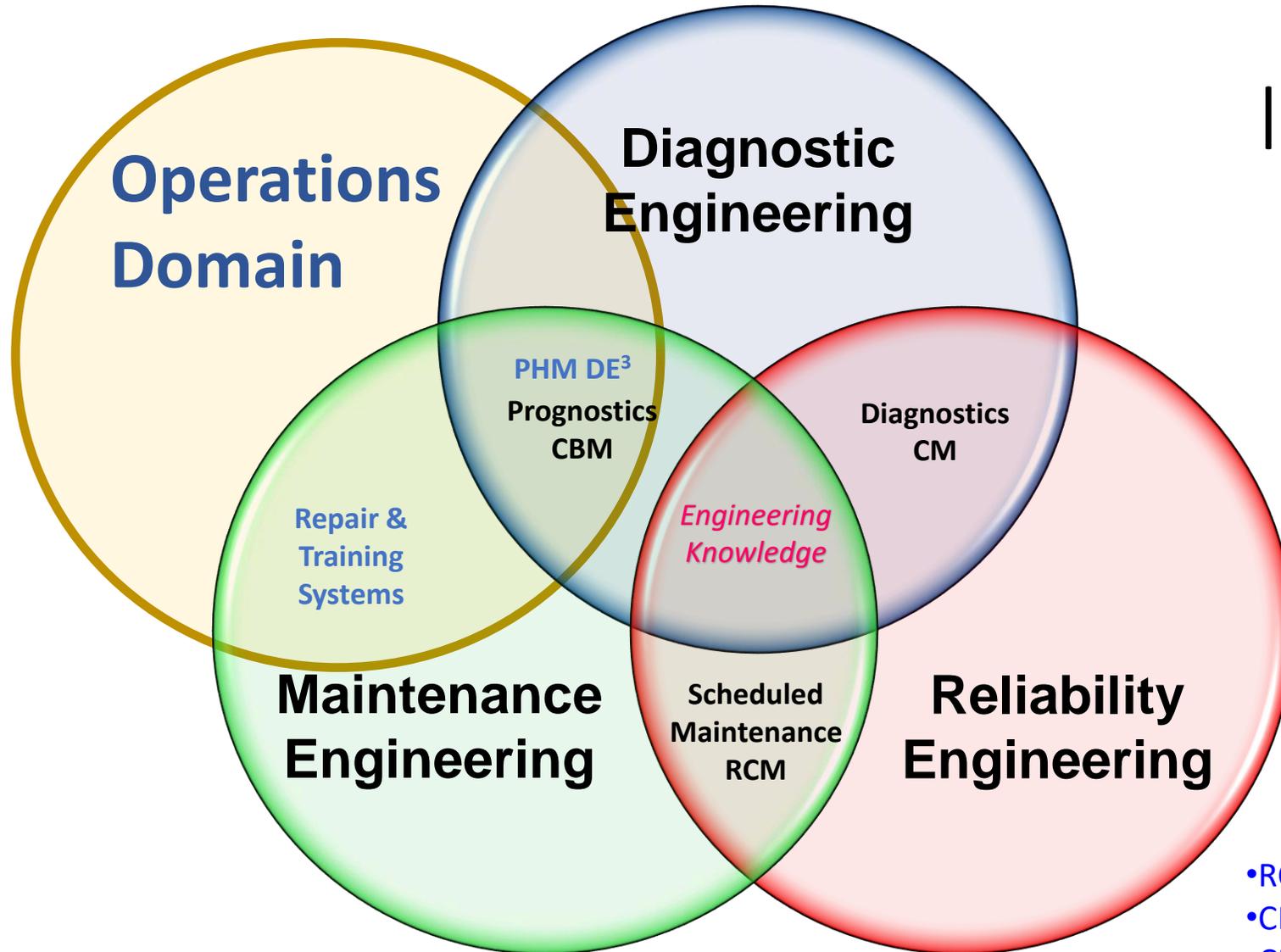


Opportunities

Repair



Intersecting Environments

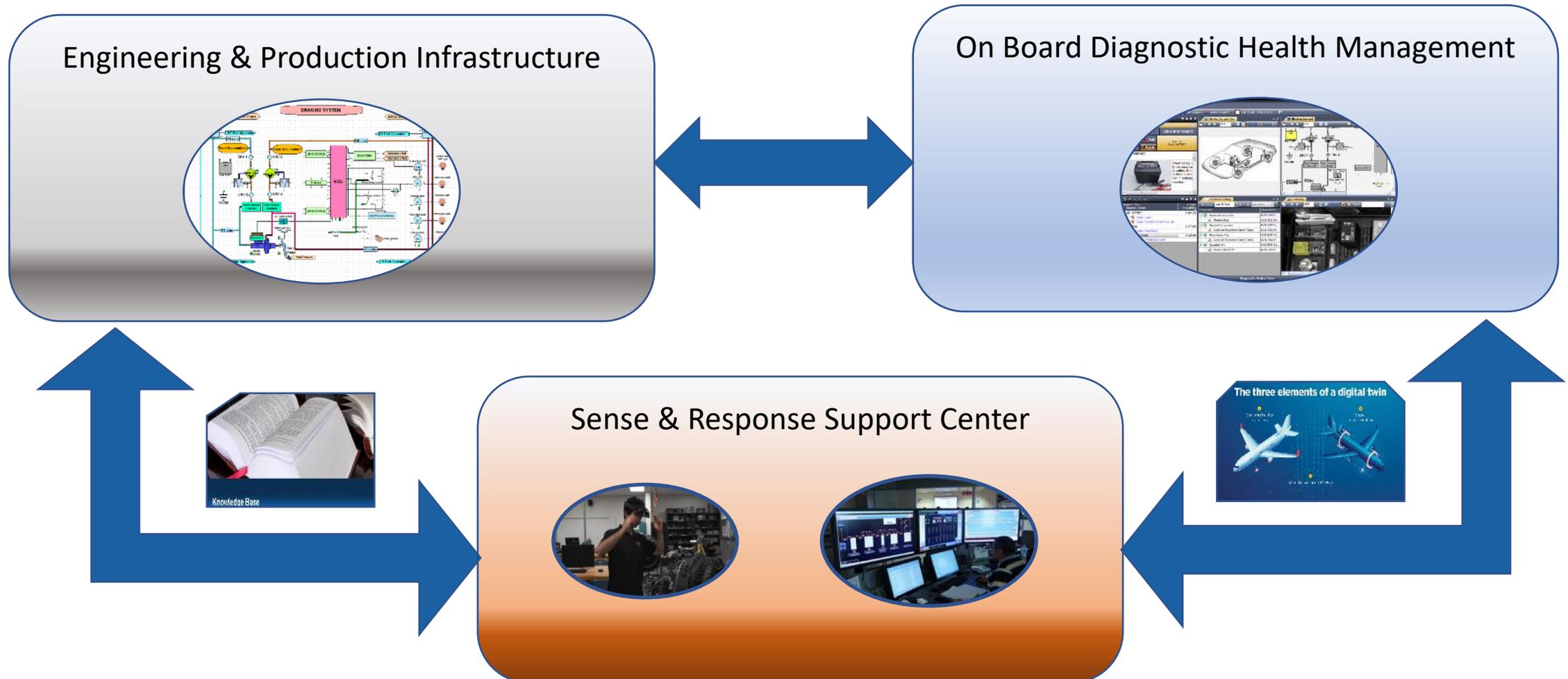


IOT New Frontiers

- Aircraft systems
- Mission and Personnel critical performance

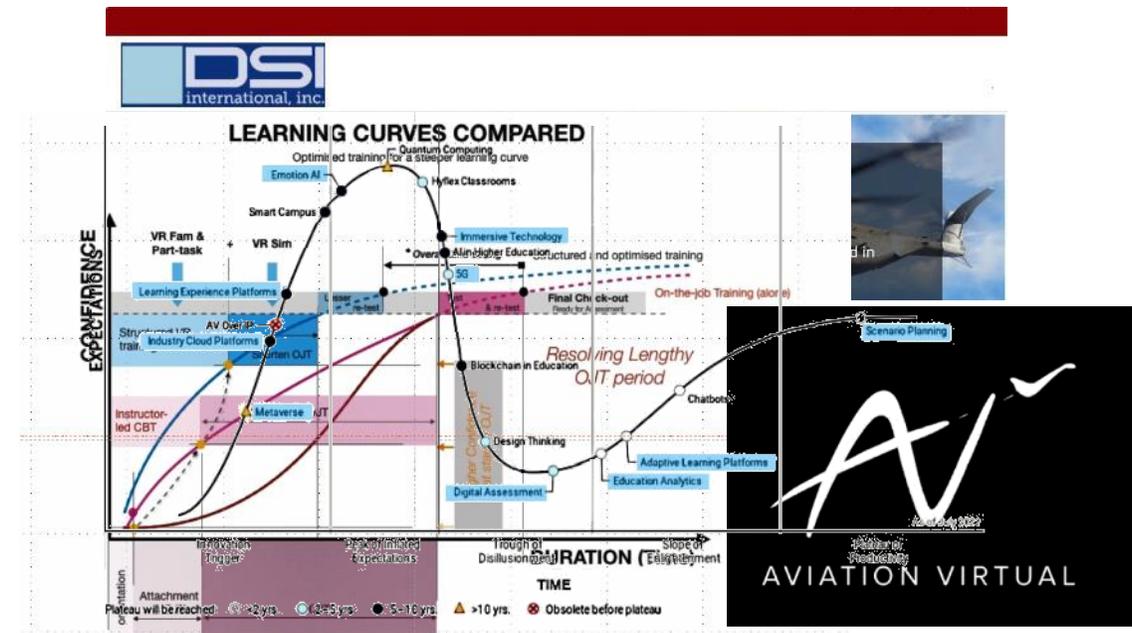
- RCM: Reliability-Centered Maintenance
- CBM: Condition-Based Maintenance
- CM: Corrective Maintenance
- PHM: Prognostics & Health Management

The Blend



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?

THANK YOU

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