RTX

COLLINS AEROSPACE | PRATT & WHITNEY | RAYTHEON

QUALITY THROUGH ADVANCED VISUALIZATION

James Cooper | Ryan Wheeler

March 2024

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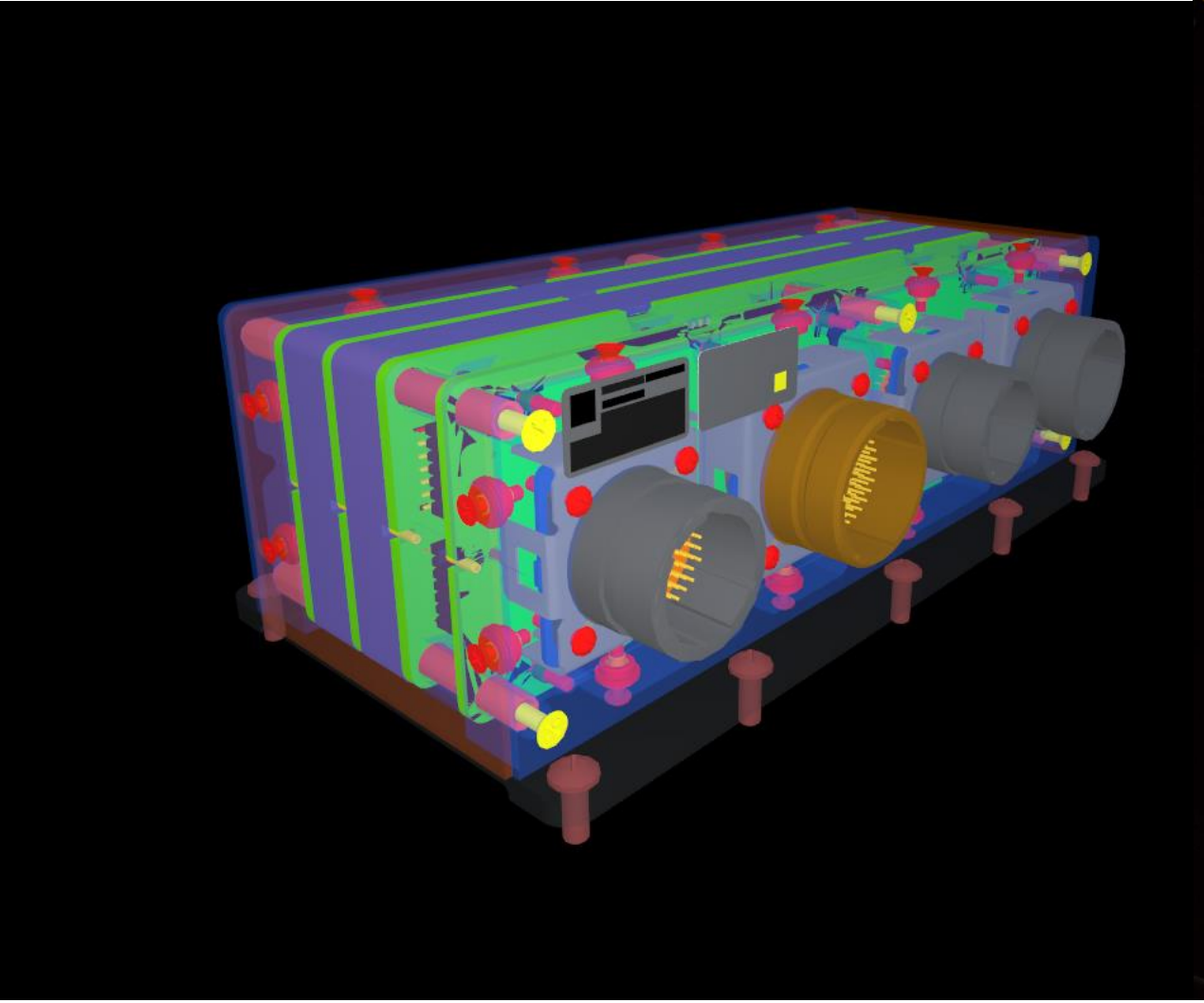

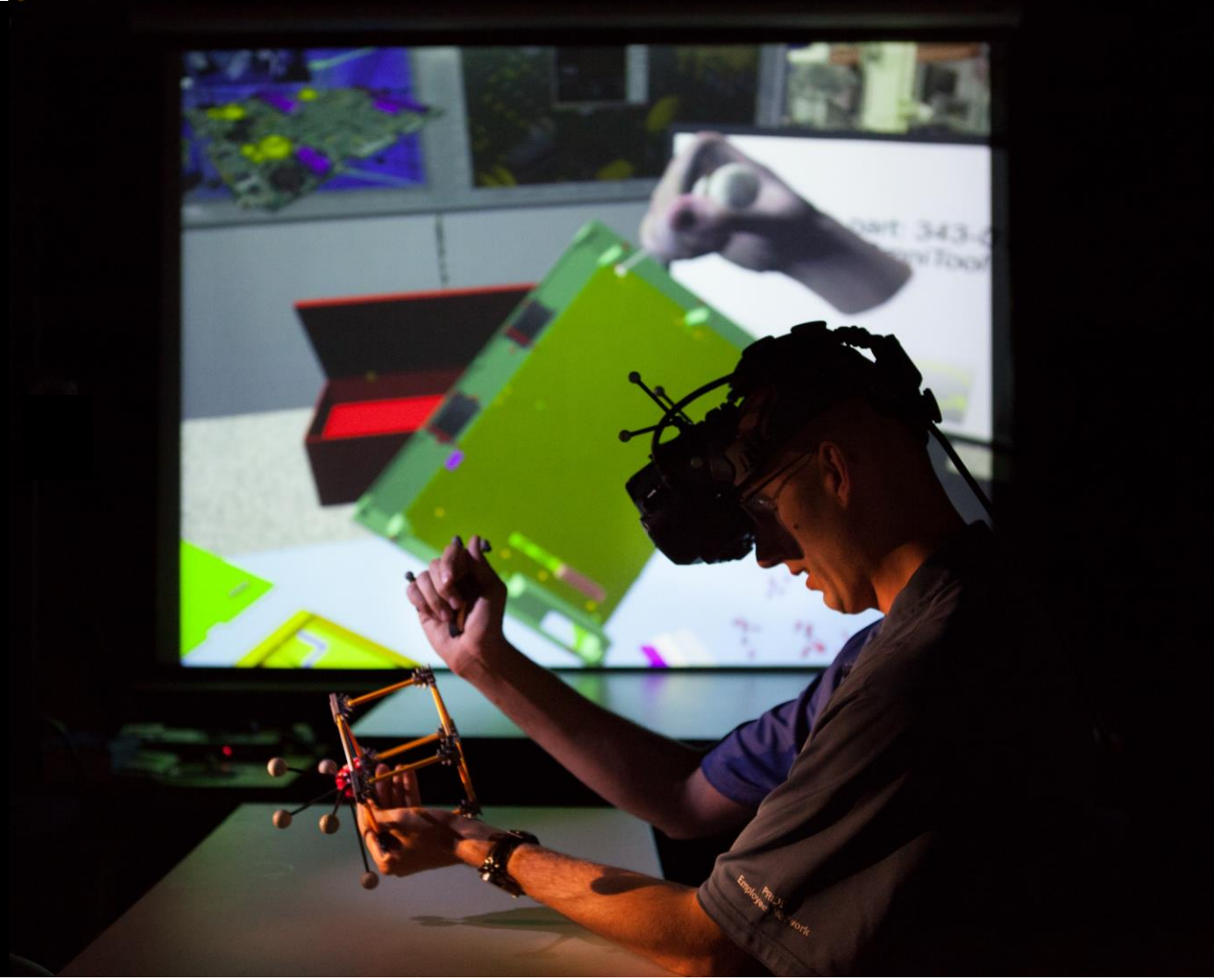

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VIRTUAL PROTOTYPE MODELING

Improved quality through virtual experience

STATE OF INDUSTRY

Mid 2000s sim-based DFA practitioners

- Ford
- John Deere
- Boeing
- Toyota
- Lockheed Martin
- Bell Helicopter
- Newport News Shipbuilding

Mid 2000s immersive visualization applications

- Teamcenter
- Eon Reality
- 3DVIA Virtools
- IC.IDO
- TechViz
- OpenSceneGraph
- VRJuggler
- Mechdyne Conduit

Years of trials & investigations found:

- Solutions were designed for OEMs
- Solutions priced for OEMs
- CAD-like, complex user experiences
- Extensive customizing to be effective
- Recurring cost-of-use was too high
- Time to use solutions was too long
- Each solution lacked an essential need that remains absent today

Mid-2000s Realization: There's reasons why competitors aren't yet doing this…

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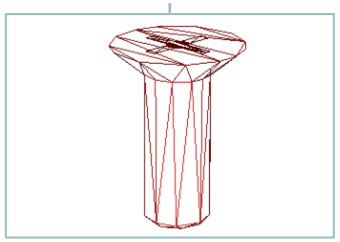
VIRTUAL PROTOTYPE MODELING

Analysis feedback

Any CAD → **Anark Workstation** → **Unity**

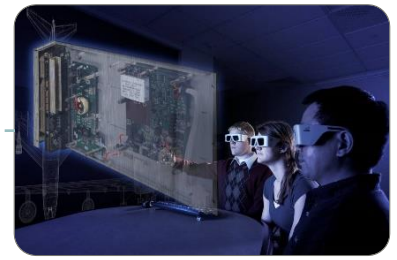
Design updates



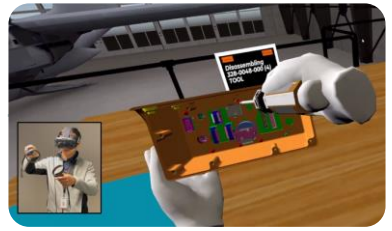
Model conditioning

One model.
Three interfaces.
Zero additional cost.

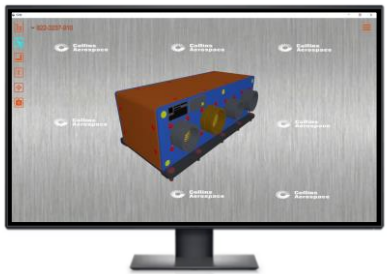
Collins proprietary solution



Powerwall
VR (3D)



Immersive
VR (VIPR)



Interactive
Desktop

2010: The market doesn't have what we need. Let's see if we can create it ourselves!

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FIRST USE

Collins Aerospace ARC-210 Gen 5

***Without mandate*, near-viral diffusion followed launch, fueled by Mech Engs & NPI orgs**

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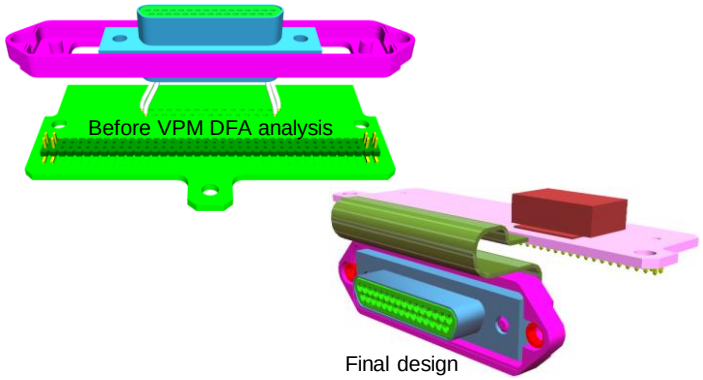
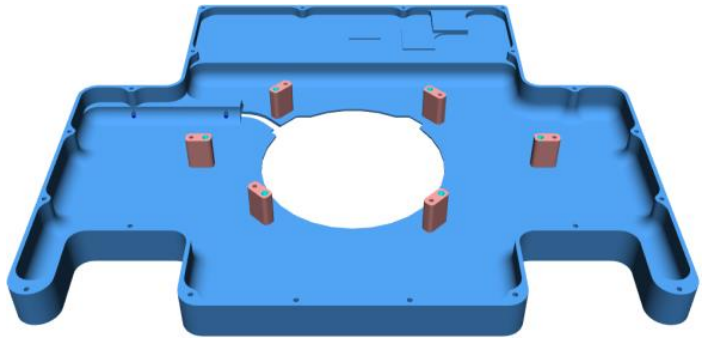
SOME EXAMPLES

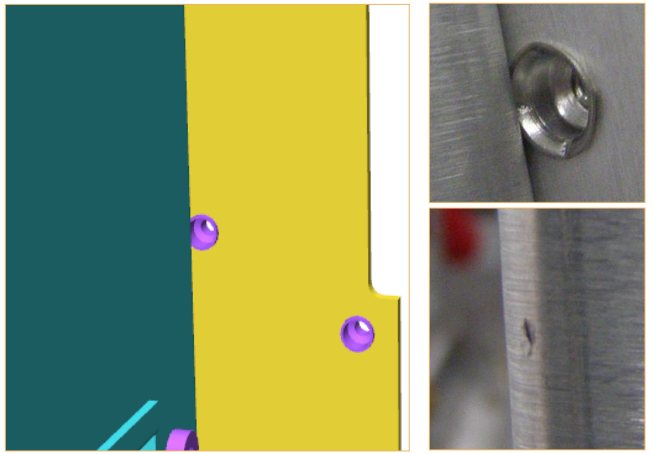
Improved quality & assembly



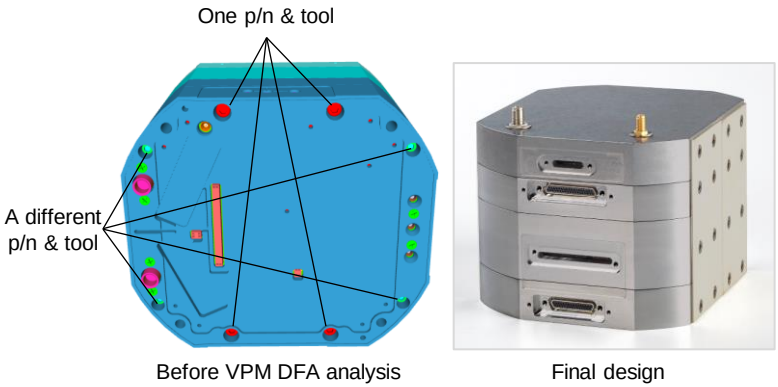
Part reductions & optimizations



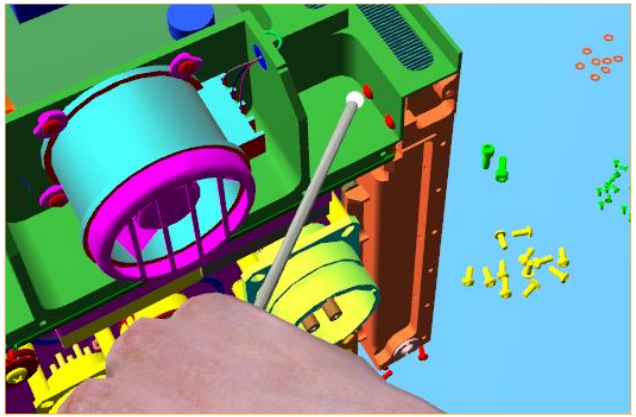
Adverse interferences & collisions



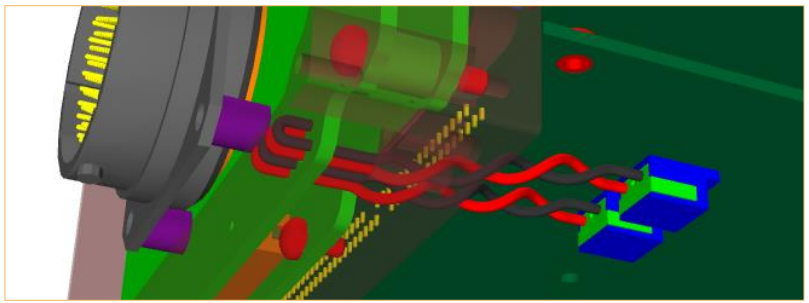
Improved assembly, service, & repair



Hand/tool access & common tools



Proactive mistake-proofing



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RESULTS

- **Per-use ROI of ~1,800%**
  - ~500 designs supported
  - >3,400 design issues detected, >2,300 further design optimizations
  - Faster-time-to-market with improved quality and reduced support staff
  - Near-perfect prevention of design flaws reaching factories *or customers*

- Unintended downstream uses
  - Earlier work instruction creation for improved New Product Introductions
  - Virtual training for hands-on assembly process familiarization

Virtual Prototype Modeling makes simulation-based producibility analysis a Collins Aerospace **competitive advantage**

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VirtualWorx™

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VirtualWorx™ system is an augmented reality (AR) collaboration system that uses secure voice, video and data transmission for real-time over-the-shoulder assistance, virtually.

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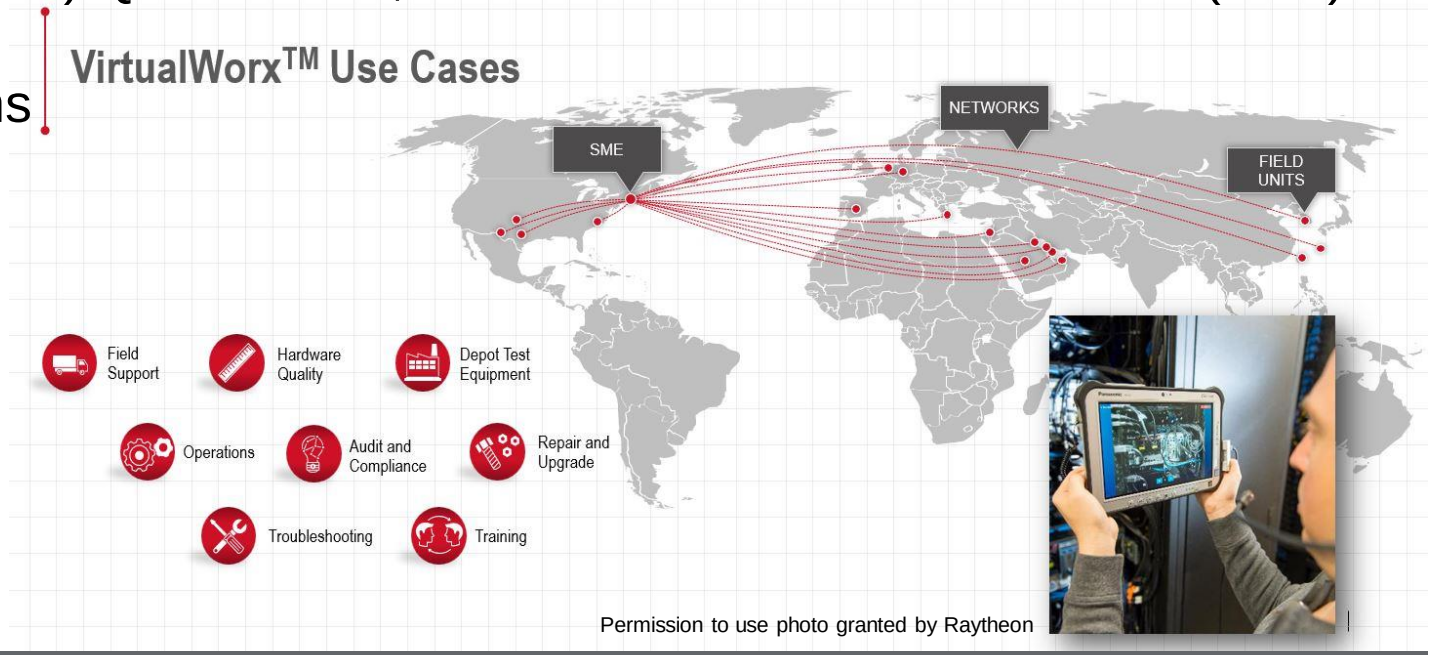
Highlights

- ✓ Originally used to connect field technicians to subject matter experts anywhere
- ✓ 11 weeks of third-party quality assessments with no travel required (huge during COVID)
- ✓ Defense Contract Management Agency (DCMA) approved DD250s for 100+ Lots of Hardware
- ✓ DCMA completed multiple DD250s in Closed Areas
- ✓ International Customer Inspections and Supplier Events
- ✓ Supplier Test Readiness Review (TRR)/Qualification, Product and Process Verification (PPV)
- ✓ DCMA “Process Review Audit”
- ✓ Remote hardware quality inspections



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VirtualWorx™ system enables improved supplier-customer relationships

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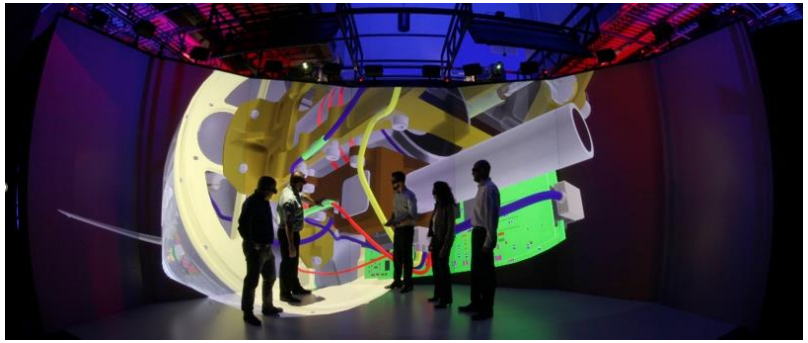
Cybersecurity
IoT
Business Intelligence
Artificial Intelligence

Immersive Design Centers

Machine Learning
Marketing
Project Management
Customer Relationship
Cloud Computing
Human Resources
Inventory Management
Supply Chain
Content Management
Networking



Arizona, USA

Massachusetts, USA

Texas, USA

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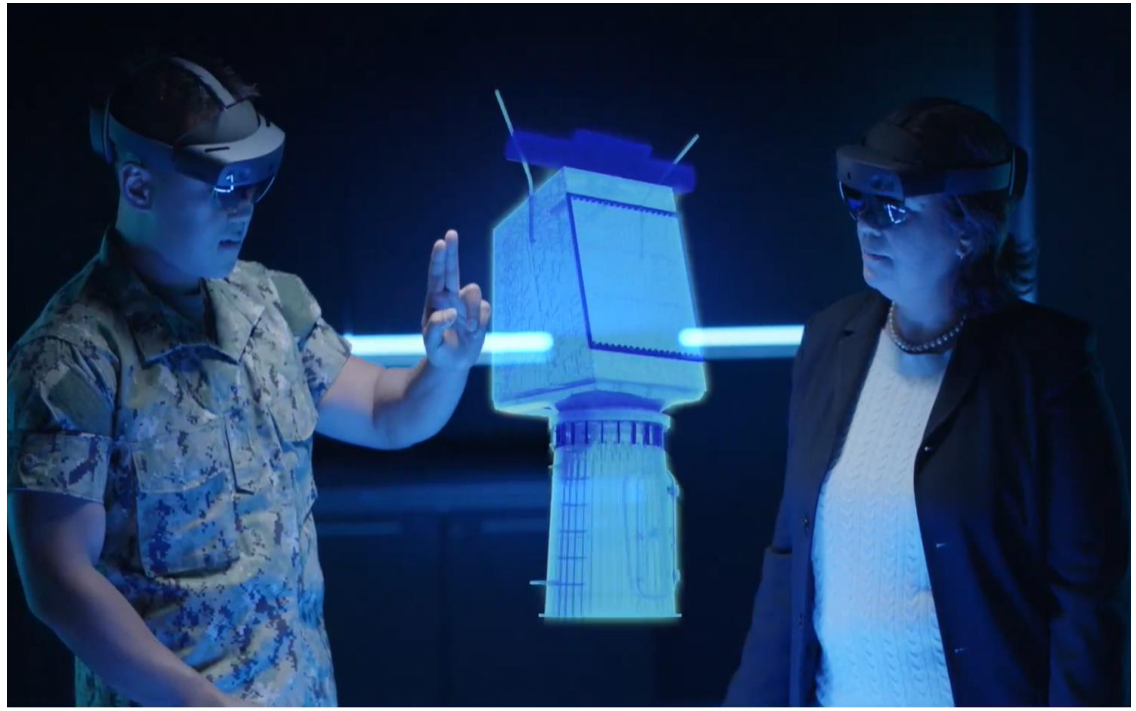
Design for Manufacturing and Assembly (DFMA)

Immersive Design Centers (IDCs) at Raytheon have been used for:

- Hundreds of DFMA reviews
- Generating over **20% efficiency improvement** for these activities
- All by increasing collaboration & understanding, preventing rework, improving meeting effectiveness, & mitigating travel



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Millions of dollars in cost prevention and savings

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“While everyone was theorizing and planning for Digital Thread, you did it… ***five years ago!***”

~ Ops Engineering Fellows Leader, Raytheon (2021)

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BETTER KNOWING
Smarter. Together.

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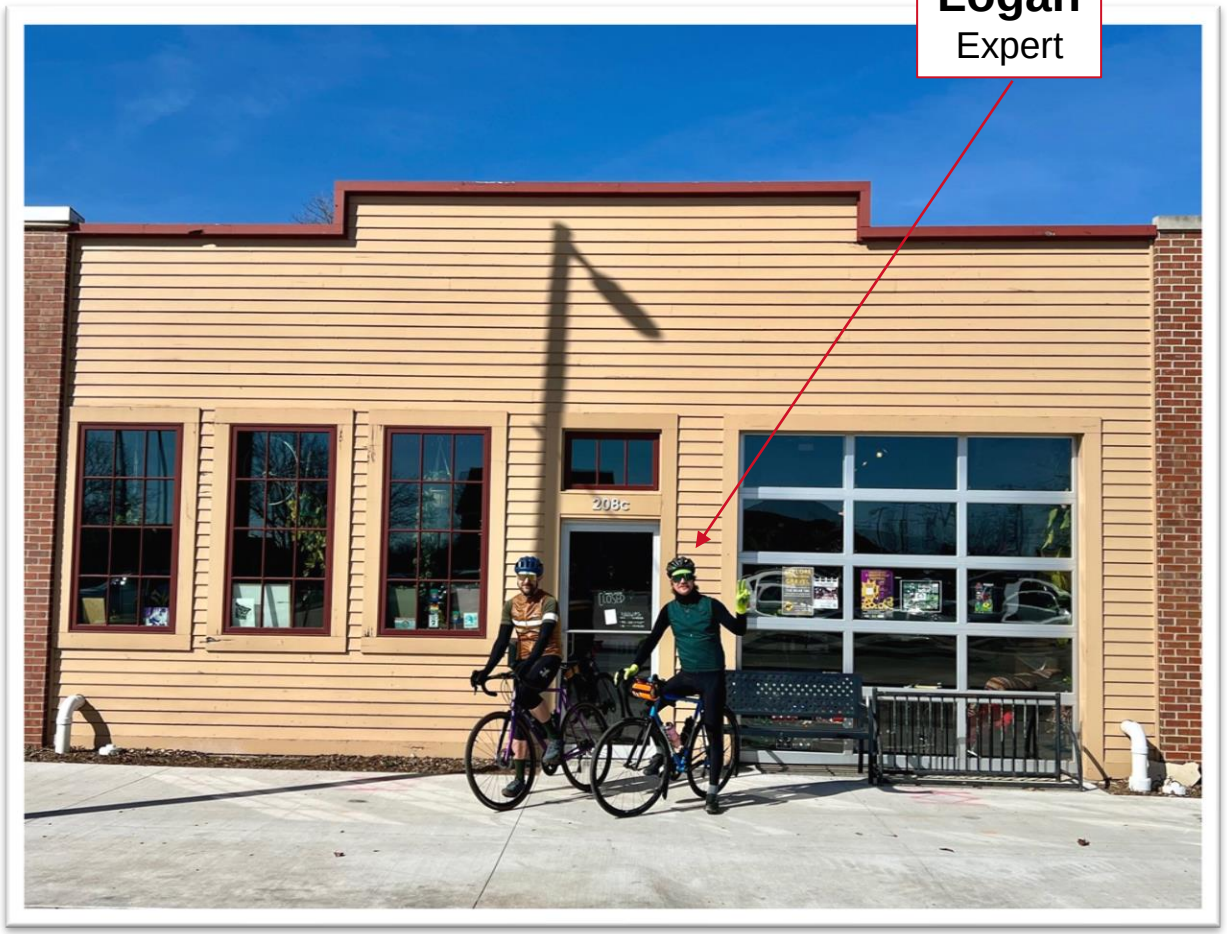
TRUE STORY OF EXPERTISE

2019 Kona Libre
2,835 miles



Goldfinch Cyclery
My local bike shop

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TRUE STORY ON EXPERTISE

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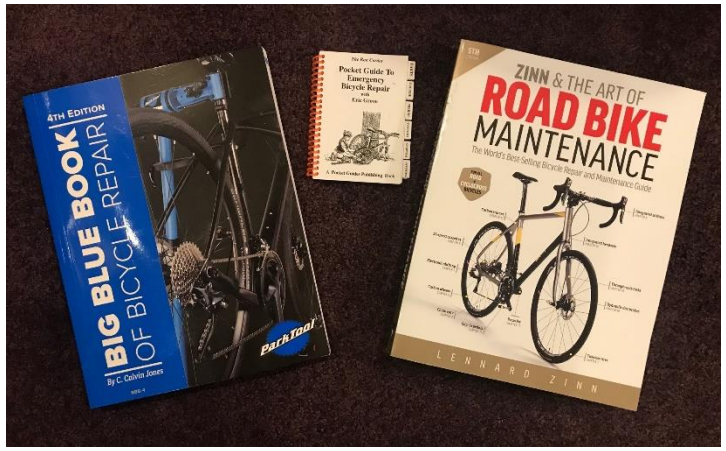
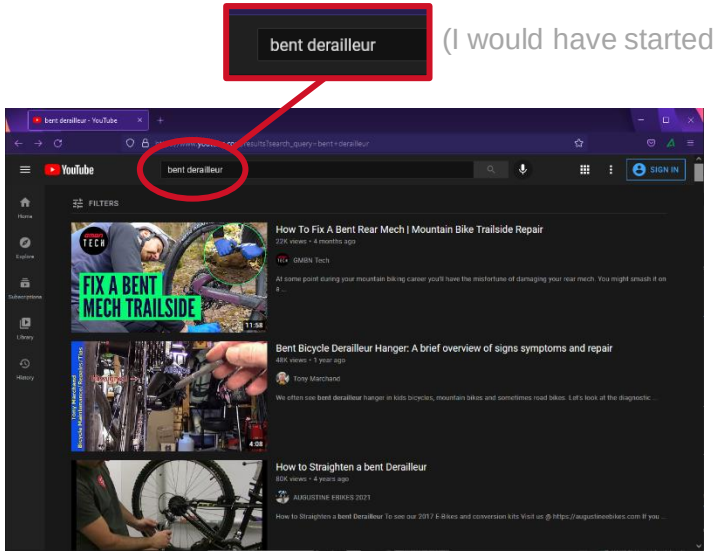
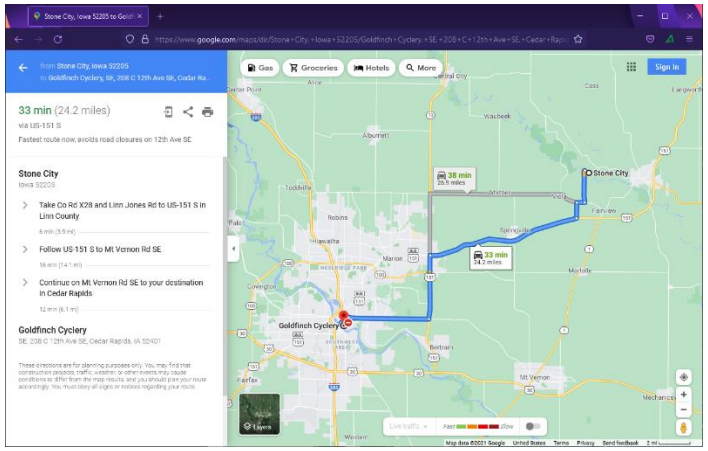
HISTORICAL KM







Guides, manuals, wikis

- Ease: Low
- Time: **Unknown**
- Cost: Parts
- Relevance: **Unknown**
- Outcome: **Unknown**

Effortful + Doubtful

Videos, training

- Ease: Low•ish
- Time: **Unknown**
- Cost: Parts
- Relevance: **Unknown**
- Outcome: **Unknown**

Effortful + Doubtful

Experts, community

- Ease: High
- Time: ~1 hour
- Cost: Parts, gas, labor?
- Relevance: High
- Outcome: Favorable

Easy + Certain

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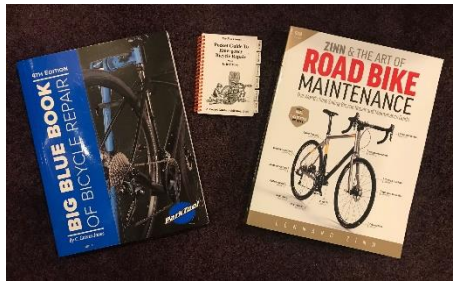
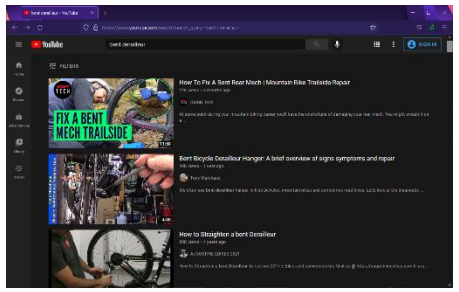
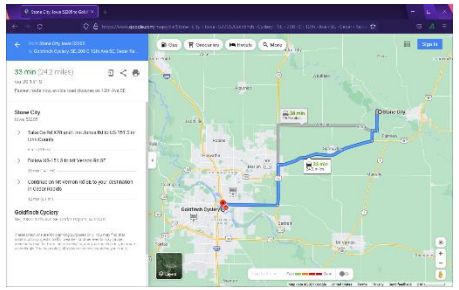


- Guides, manuals, wikis
  - Wordy. Lots of time to write, to read, to maintain.
  - “Is my answer even in this?”



- Videos, training
  - Still wordy. Lots of time to create & maintain. Faster to watch than read?
  - “Is my answer even in this?”



- Experts, community
  - Knowledge of who’s an “expert”.
  - “Will they want a charge number? *Will they even answer?*”

These are reasons why historical KM is little used in settings of urgency, e.g., Manufacturing

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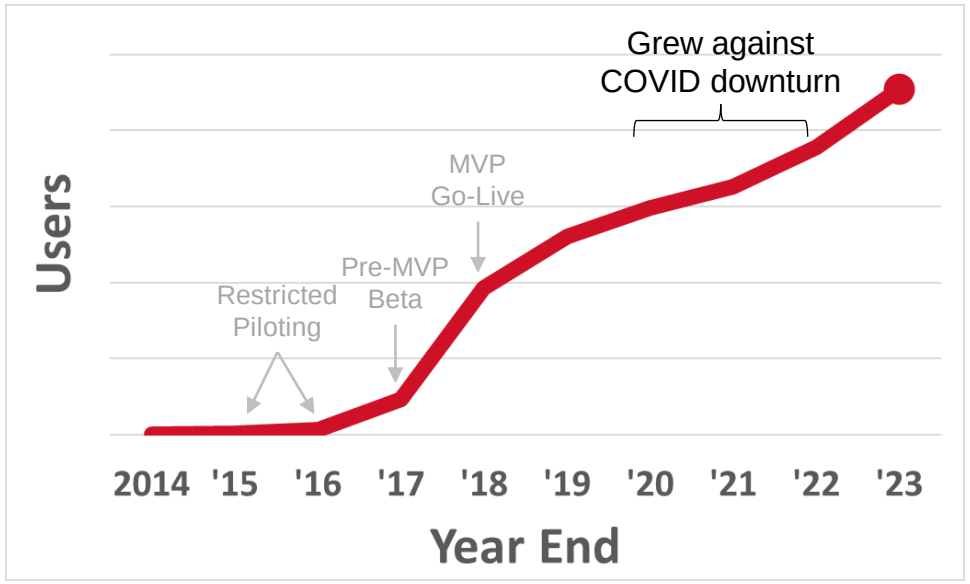
BETTER KNOWING

A digital thread solution



Real adoption data. Numbers withheld, proprietary.

100% organic uptake. Zero marketing, comms, or mandates.

Better Knowing improves:

- **Quality**
  "This was big in getting from 6% to 97% yield so fast." ~Manufacturing Engineer
- **Troubleshooting**
  "This lets me become an expert 20 times faster than anything else." ~Lab Technician
- **Autonomy**
  "It's been 6 months since a Tech has needed my help troubleshooting." ~Manufacturing Engineer
- **Engagement**
  "This has meant I don't need to be here 60 hours a week. *It's letting me see my daughter grow."*
  ~Test Technician

"This is the best thing I've seen in …… yeah, ever." ~US Navy Customer

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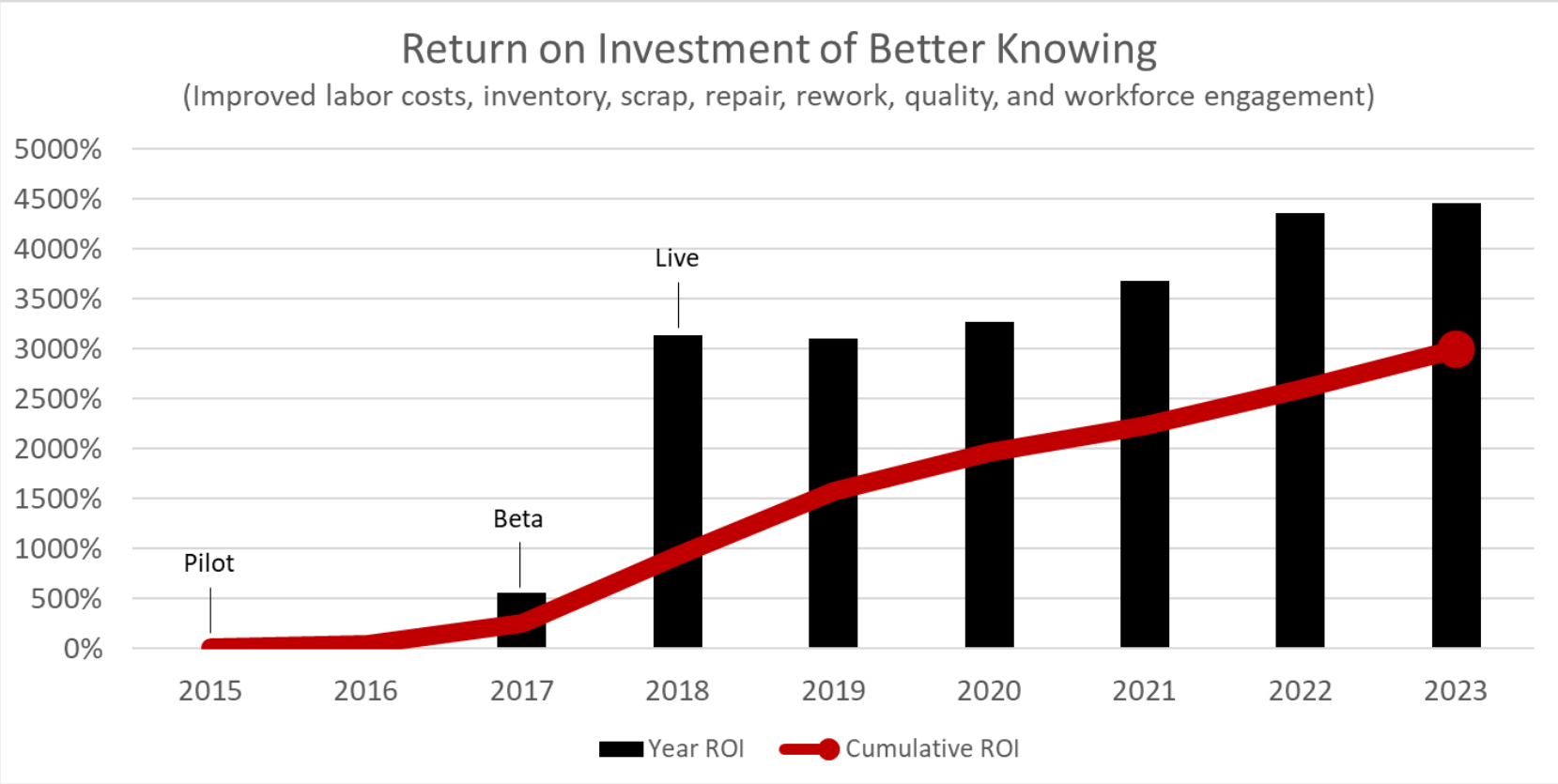

Delight in knowing is a quality & performance discriminator

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