# Cutting Edge: Digital Twinning Installation Operations

Moderator: Lance Marrano, USACE

Speakers:

- Munjeet Singh, Senior Vice President, Booz Allen
- Scott McClure, Enterprise Architect, Image Matters LLC
- Lowell Usrey, Chief, Arc Branch, US Air Force AFWERX

May 14, 2024, 3:00 p.m.

Joint Engineer Training
JETC
Conference & Expo

MAY 14-16, 2024
ORLANDO, FL

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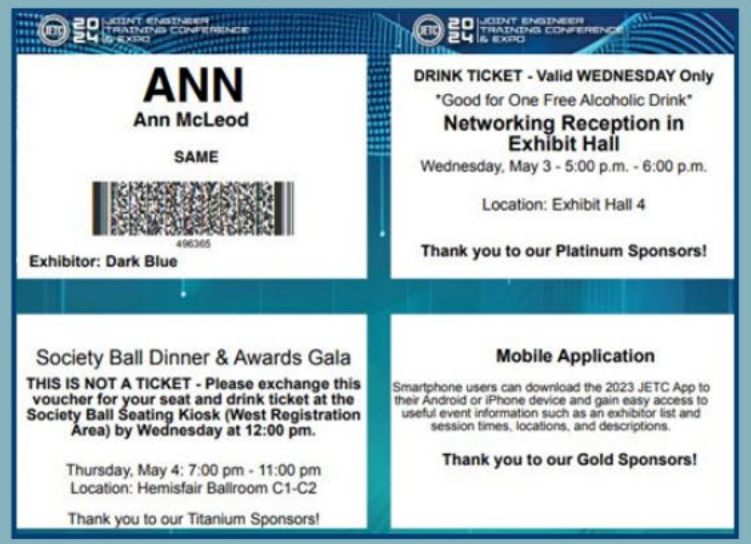
# Opening Reception at Universal CityWalk

## (Minimum age 18 - No Children)

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# MODERATOR

## Lance Marrano

USACE Engineering Research and Development Center

Science and Technology Advisor, Tyndall AFB

## Fun Facts

- Call sign “Q”
- Changed college major three times **in Grad School**
- Serves on local school board

*Live Content Slide*

**Poll: What digital twin technologies and/or applications have you used in the past 2 years (multiple choice)?**

# Unlocking the Potential of Digital Twins in a Rapidly Evolving Technological Landscape

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# SPEAKER

# Munjeet Singh

## Booz Allen Hamilton

Senior Vice President

## Fun Facts

- Proud Denver Broncos Fan
- Avid mountain biker

# The Tyndall AFB Digital Twin

## The Largest Digital Twin in the DoD


Visualized Entire Installation

14,000 Acres of Terrain and Topography

77 Existing Facilities; 105 New Facilities

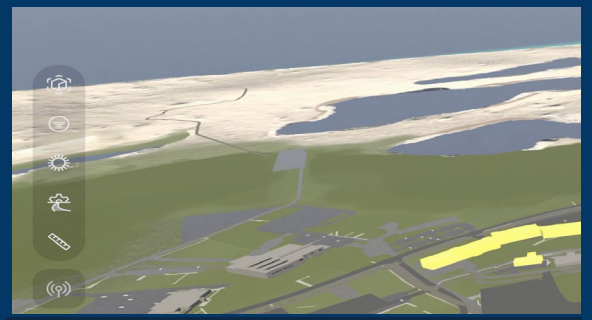
2,406,311 Feet of Utility Assets
(Water, Gas, Fuel, Electric Lines)

46 Miles of Pavement

Building Information Models

Detailed Utility Infrastructure

Advanced Technologies Across Multiple Platforms
for Efficient Data Collection Workstream



GIS Environmental Layers

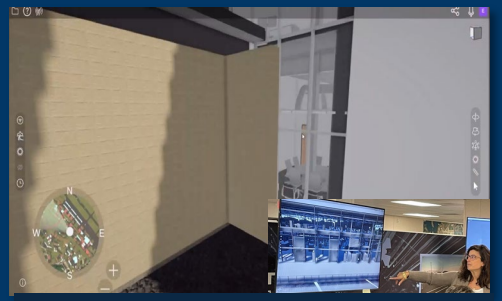
# Maturing Capabilities

## Planning

Base Master Planning

4D Analytics

## Design



Immersive Design Reviews

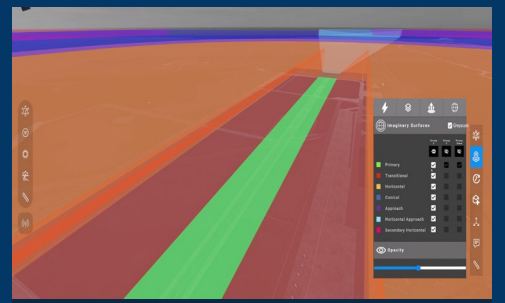
3D Space Planning

## Sustainment

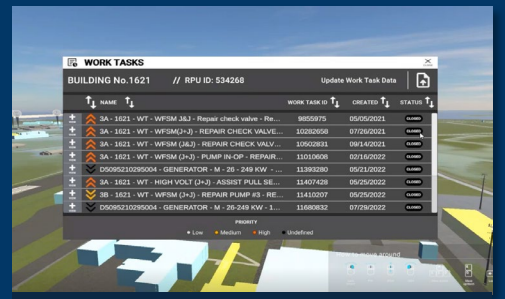

Condition Assessment Data

Critical Component Data

## Operations



Imaginary Surfaces

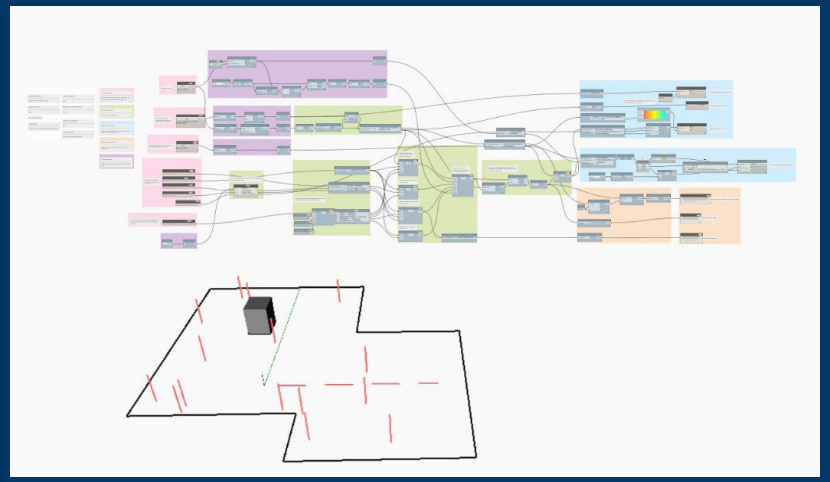



Facility Work Task Dashboard

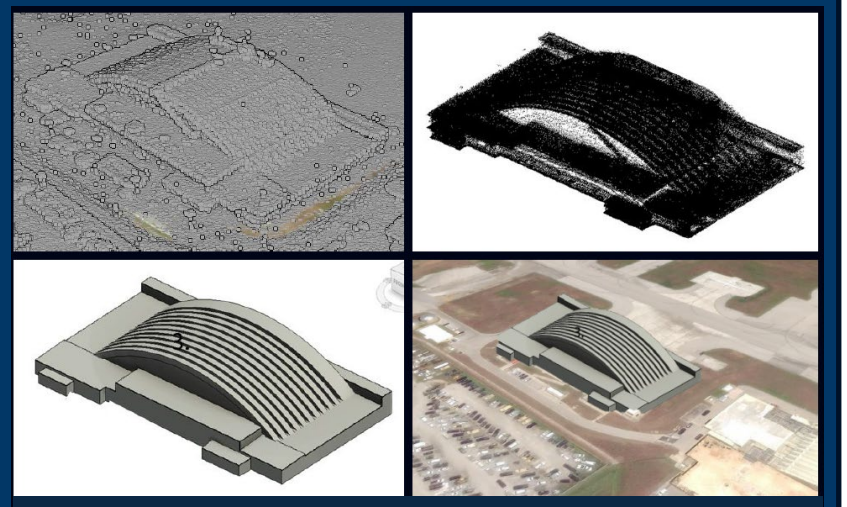
# Building Digitization with LiDAR Technology

## Utilizing Technologies and Automation to Make Digital Twin Development Cost-effective at Scale

The Air Force is Digitizing 230M Sq Ft of Facility Space using Handheld LiDAR Capture at 78 AFBs



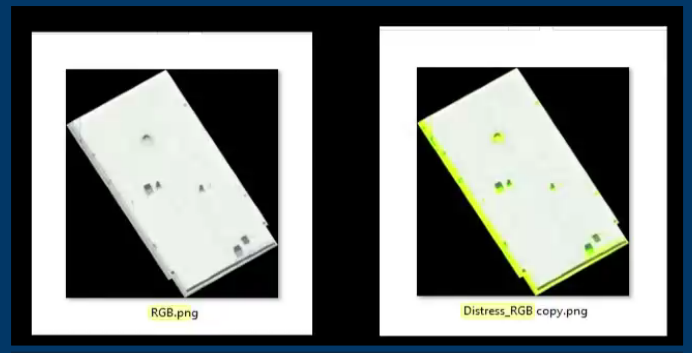
Leveraging RPA and Computer Vision AI, we have built algorithms that reduce the time required to convert imagery to CAD and Revit files by 40%



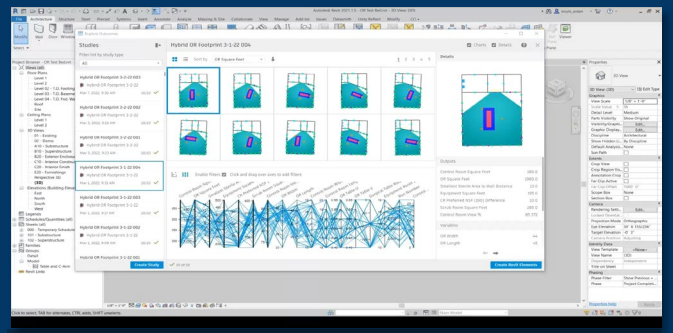
The use of these advanced techniques enables the rapid development of large-scale digital twins with accurate Building Information Models.

# The Future of Digital Twins in the DoD

## Artificial Intelligence




AI-Enhanced Sustainment



Generative Design

## Simulations


Complex Data Visualization Modeling


Powerful Simulations

## Connectivity

5G for Digital Twins around the Globe

Edge Computing and IoT

# Bridging to Digital Twin with Reality Capture

## - The Air Force "*Source3D*" Project –

*Project Manager: Bill Valenti AFCEC/CXAA, william.valenti.2@us.af.mil*

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# SPEAKER

# Scott McClure

## Image Matters, LLC

Enterprise Architect

## Fun Facts

- Lives and loves living in Alaska
- Has hosted Japanese teachers 5 times for 3-4 months at a time
- Loves dad'ing, mountain biking, woodworking, board gaming, and EHK
- Discovered undiagnosed autism at 41 (2 years ago)

(EHK = Embarrassing His Kids 😎)

# The Problem…(s)

- Facility Interiors: Failing Domain Awareness
  - And yet… Exterior Imagery is in Oversupply.
- Floorplans and Photographs are Unmanageable
- BIM Implementation = Supply-side Economics
- Digital Twin meets “Blue Collar” Culture…?

# Background – A Basis for Objectivity

- USAF Palace Acquire Intern
- USAF Operations & Engineering for 10+ years
  - Orchestrated Facility Condition Assessments (FCA)
- USAF *Squadron Wide* Asset Mgmt Program Manager

**Directly Experienced**

---

- BUILDER Data Analysis Tiger Team
- Chair: Digital Twin Integration Subcommittee (NIBS)
  - Paper to be Published: *Digital Twin in the Built Environment*
- Co-lead: SAME Digital Twin Work Group

**Policy Applied**

# Source3D: Testing Reality Capture in CE

- 2019 Local Testing ⟶ AFIMSC Rodeo ⟶ Six Pilots
- Experimental Phasing: Reduced 10+ people down to 2
- 6 Installations with 1 Full Remote Base in the Pacific
- Creating Interoperable 3D Dataset and 360° Photography

**Use What You Got.**

# The Solution: Reality Capture

## Hard Value

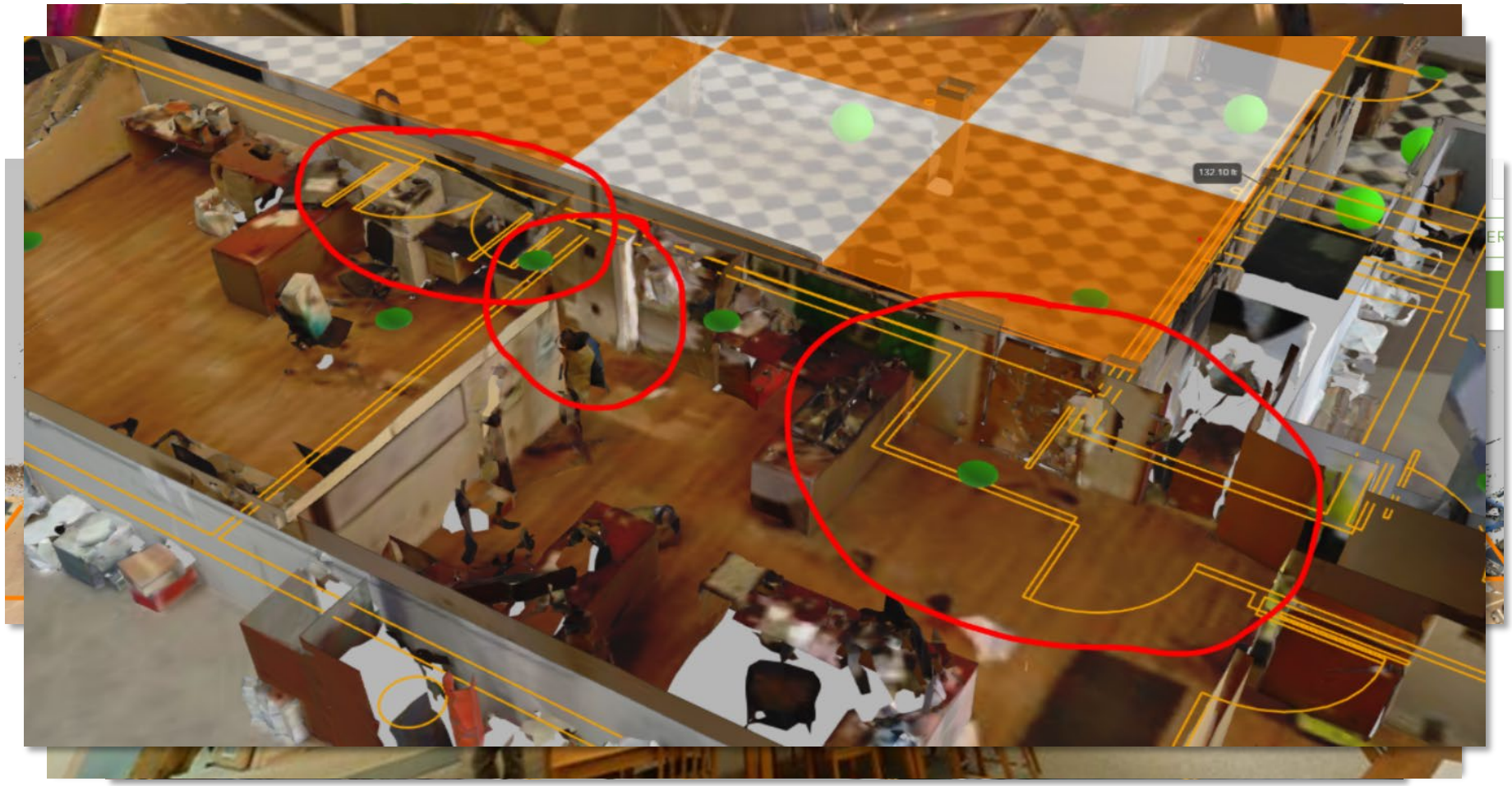
- Mature Technology (TRL 7-9)
- Automated Processes
- Right-Sized Delivery

## Soft Value

- Innovative Appeal
- Forces Interoperability
- Transforms Culture

**Source3D Sets The Stage.**

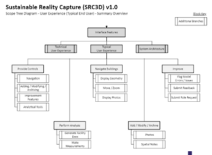
# Lesson Learned: Understand.



# Lesson Learned: Deliver.

System Context

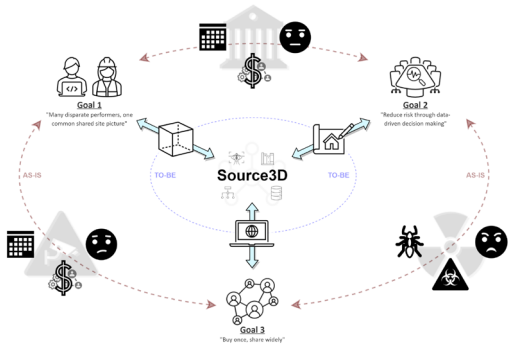
Business Use Case



Interface Scope

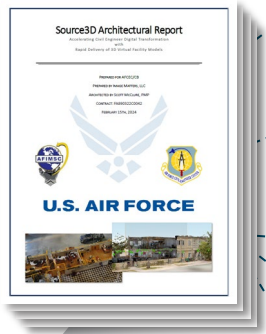
Stakeholder Use Case

AFNET Published Data

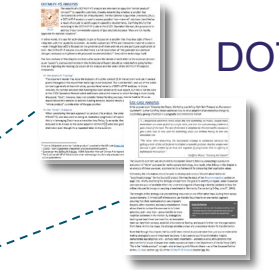



CV-1 Capabilities Vision

166 Pages




Architectural Report



DOTmLPF-P$ Analysis



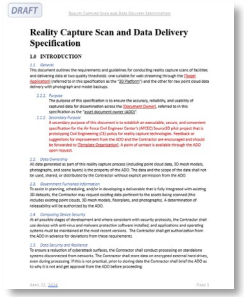
Use Case Analysis

Architecture

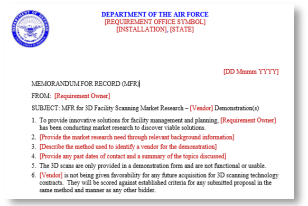
Phased Schedules

Estimates


BOS/BMC Contract TTP




RC Guide Specification




Template Demonstration Letter

# The Future

- Vast VAULTIS 3D Facility Data, Operationally Relevant
- Digitally Primed Workforce
- Data and Metrics Supporting
  - Artificial Intelligence
  - Facility Simulation
  - Contingency Response
  - Digital Twin

**Calling in the Big Players.**

AFWERX

# SAME JETC
# Digital Twinning Installation Operations

Mr. Lowell Usrey
**Arc Branch Chief**

Installations are looking to leverage increasingly advanced reality capture, modeling, and information display technologies to help them understand, simulate, and plan how to operate their facilities. Digital facility information remains locked behind tools with highly technical training requirements and only comprises a very small portion of the facility portfolio, thus limiting its utility; until now.

AFWERX | SPACEWERX

## MISSION

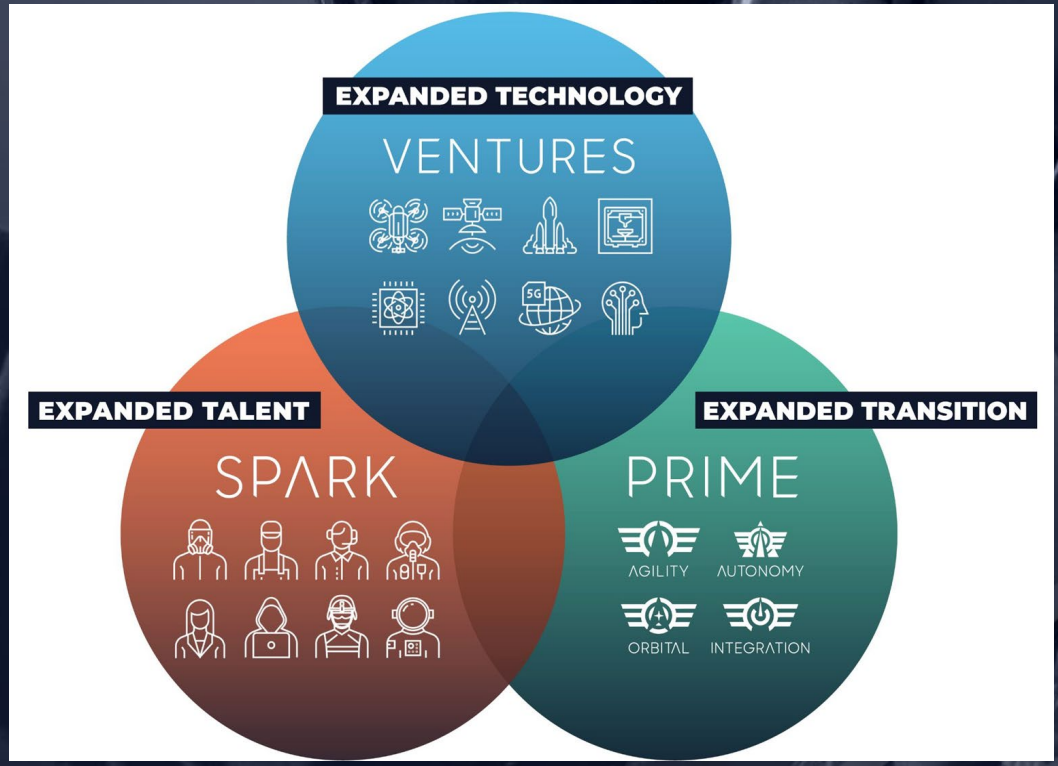
AFWERX accelerates agile and affordable capability transitions by teaming leaders in innovative technology with Airman and Guardian talent.

## VISION

Forge an innovation ecosystem that delivers disruptive Air & Space capabilities.

## MANTRA

Unleashing American Ingenuity




**178** Civilians

**18** Military

**176** Contractors

**100** Fellows

**10** Reservists

# Rebuild TAFB as the "Air Force Installation of the Future"

$4.9B Program

44 Projects = ~120 New

~260 FSRM Projects

# AFWERX <-> AFIMSC Partnership

FLoF Summit Held

FLoF Scoping Sessions

*Challenge Workshops*

Concept Submissions (1100+)

Evaluations (627)

Showcase Selection (107)

AFWERX Showcase (85)

**Awards (9)** ~$3M through CSO

Project Kickoffs

Project Demos and Milestones

| FY20 Q1 | FY20 Q2 | FY20 Q3 | FY20 Q4 | FY21 Q1 | FY21 Q2 | FY21 Q3 | FY21 Q4 | FY22 Q1 | FY22 Q2 |
|---|---|---|---|---|---|---|---|---|---|

AFWERX CHALLENGE

PMO and AFWERX issue 4 BoTF Challenges

Concept Submissions (1300+)

Finalists Selected (66)

**Awards (7)** ~ $16M through CSO

Developed two Other Transaction Agreements (OTA's)

Digital Twin and IROC

**FLoF Summit Focus Areas**

**Airfield Maintenance and Repair**
(Lt Col Rob Bouffard and Maj Kayley Squire)

**Flightline Security**
(Maj Jordan Criss)

**Aircraft Sortie Generation**
(Lt Col Yogi Lebby)

*Bridging the Valley of Death!*

# Tyndall Digital Twin: How we built it

## Ingested Existing Data

***28,966 acres of GIS*** *layers*

***32,000 sq. ft. of pavement*** *(roads and airfield)*

***2,406,311 feet of utility assets*** *(water, gas, fuel, electric lines)*

*Digital Elevation Model:* ***14,000 acres of terrain*** *and topography*

***Automated BUILDER Integration*** *via API*

## Integrated 112 BIM Models

*Including 77 models (1,775,891 sf) developed using existing facility as-builts supplemented by on-site data capture*

*The Digital Twin overall includes:*

- *75* ***Medium Fidelity*** [1] ***Existing*** *Facilities*
- *2* ***High Fidelity*** [2] ***Existing*** *Facilities*
- *35* ***High Fidelity Future Construction*** *Facilities*

## Filled Gaps through On-site Capture of Selected Facilities & Security Assets

***Ground Capture****:*
*LiDAR and imagery of 1.64M sq. ft. of facility interior and exteriors and over 200 security assets*

***Aerial Capture****:*
*LiDAR and imagery of 1.58M sq. ft. of facility exteriors and roofs*

***Vehicle Capture****:*
*LiDAR of 46 miles of Tyndall roads*

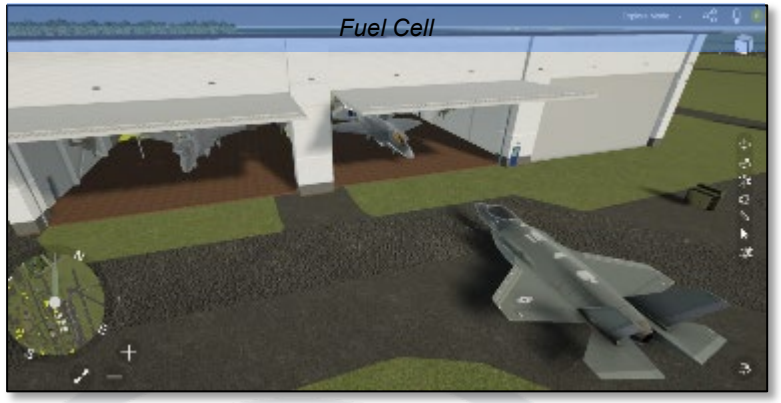
**Accessible, Centralized Source of Truth Across the Installation Inventory & Lifecycle…**

**…instantly deployable across multiple devices.**

# Use Cases for the Installation of the Future

AFWERX SPARK | ARC

## INSTALLATION PLANNING & BEDDOWN




- **Visualize and test mission beddown** for F-22 or F-35
- Virtually Plan with **Library of 3D BIM, utilities, aircraft, etc**.
- Analyze and compare cost build-up of design options

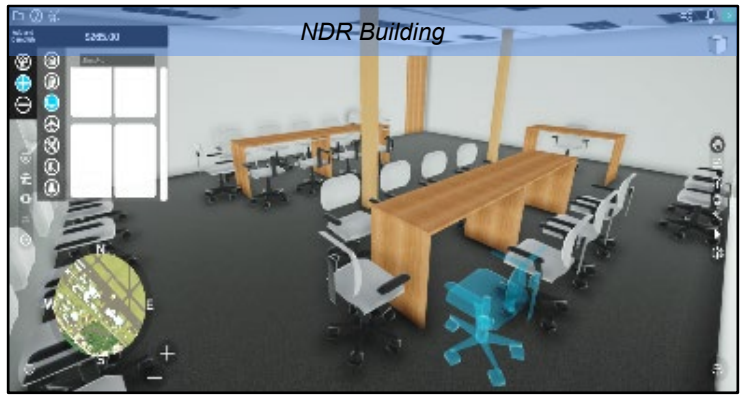
## RESILIENCE

- **Simulate scenarios** and their impact on resilience, stakeholders, and operational effectiveness
- Identify **vulnerabilities** and explore **mitigation** strategies
- Stress test facilities, processes and systems in a risk-free environment

## 4D VISUAL ANALYTICS


- **Visualize Installation Investment Strategy** (I2S) over time
- Reflect the past landscape of the installation
- **Visualize the future planned installation landscape**, projects and infrastructure

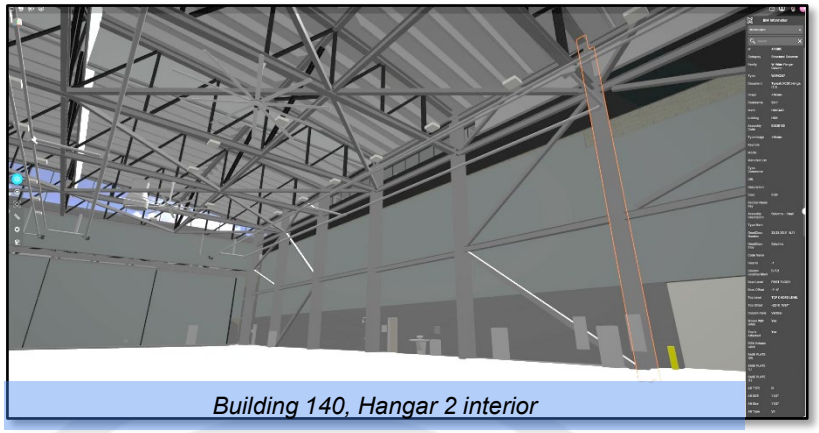
## DESIGN OPTIMIZATION




- **Test configurations** of furniture, fixtures & equipment (FF&E)
- **Accelerate design** cycle times
- Increase designs' **cost fidelity**
- **Achieve greater stakeholder and mission owner buy-in** before building hand-off

# Use Cases for the Installation of the Future

## ASSET DATA VISUALIZATION



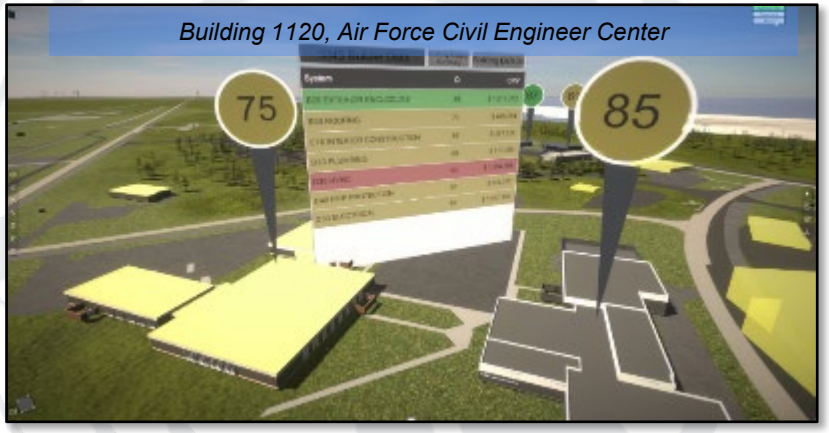
*Building 140, Hangar 2 interior*

- Enable **Virtual Site Surveys** for maintainers and facility managers
- **Increase Asset Visibility**—condition, location, engineering data, cost, imagery all in one place
- **Reduce inspection and maintenance time** and cost

## IoT AND SENSOR MONITORING

- Monitor **installation operations in real-time** through the Internet-of-Things (IoT)
- Ensure **mission-critical assets** remain functional
- **Address alerts & anomalies** more quickly

## AI-DRIVEN CONDITION ANALYSIS




*Building 1120, Air Force Civil Engineer Center*

- Reduce bias, error, and level of effort of asset inspections with **advanced imagery and AI**
- **Identify and quantify roof defects** and distresses from imagery

## AR FACILITY INSIGHT

- Overlay real-world infrastructure with **digital information via Augmented Reality**
- Quickly **find and inspect** facility components

# Orlando Economic Partnership

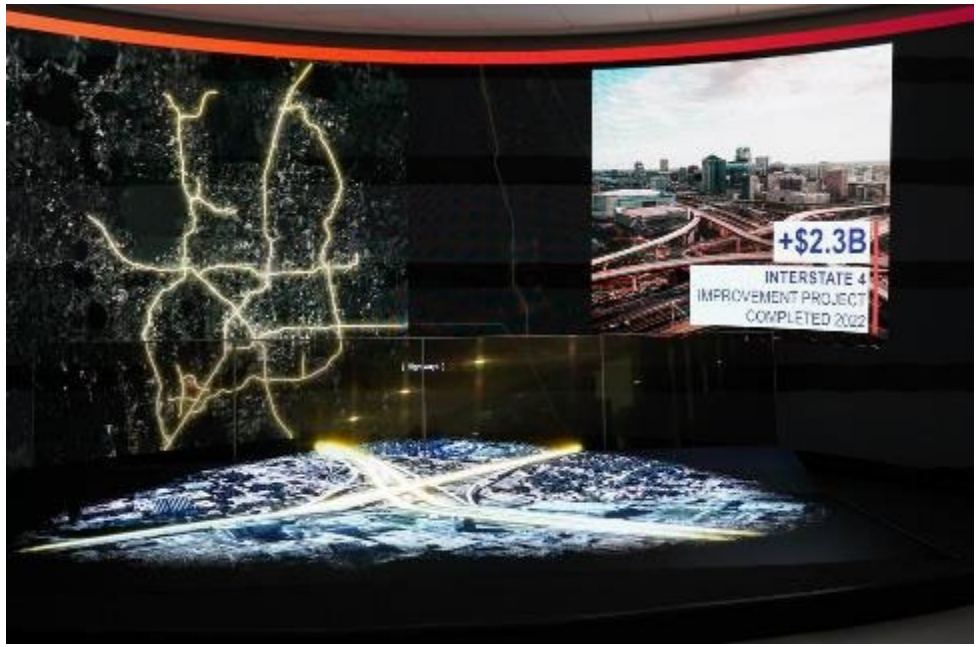
AFWERX SPARK | ARC

### Overview

OEP and Unity worked together to build a foundational Digital Twin of an 800 sq mile area of the Central Florida area to assist with economic development initiatives.

### Challenge

- Visualization of large geographic areas for large group tours
- Lack of data in 3D format
- Disparate data sets
- Non technical staff needed to use the Digital Twin for presentations




### Solution

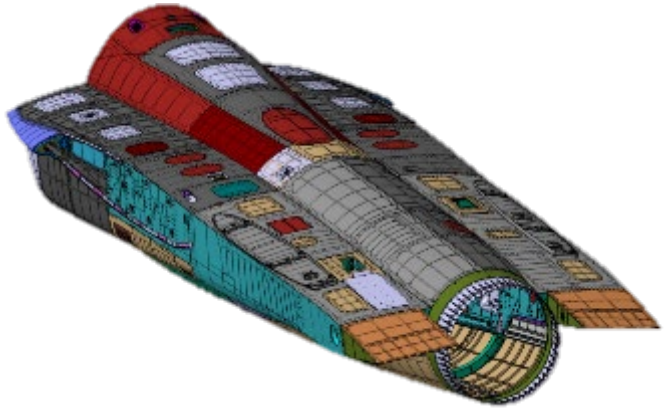
- 180 degree LED panel wall coupled with OLED panels on the floor to create an immersive experience
- Presentations driven by staff members using a normal tablet with a user configurable interface

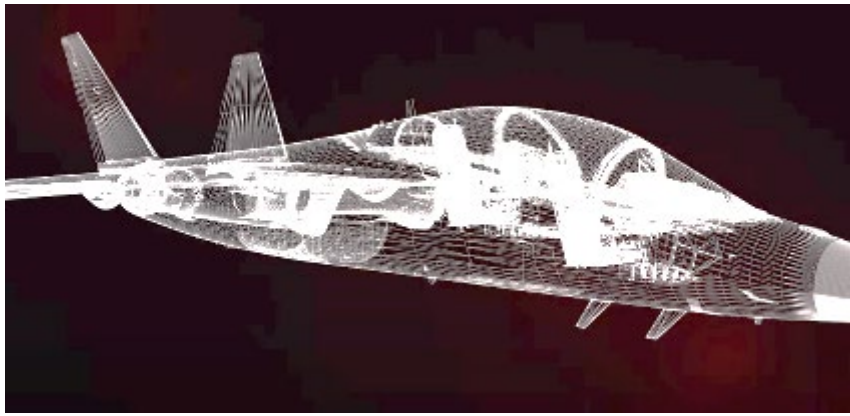
### Results and Value

- Phase 1 development complete and is undergoing user testing to continue to collect feedback for further feature development
- This is the first RT3D digital twin in the world used for Regional Economic Development purposes

# Production of the T-7A Fuselage

- Saab responsible for assembly of T-7A aft fuselage, system installation and delivery to Boeing in St. Louis.
- First USAF aircraft designated as the “e-series” embraced model-based engineering, development of electronic product models (digital twin), and 3D design tools which reduced assembly hours by 80% and cut software development time in half.
- Digital twin serves to facilitate analysis, simulation and testing of aircraft throughout its life cycle.
- Saab is applying Digital Engineering capabilities used for T-7A aircraft to other programs and technology initiatives.





# SAAB Manufacturing Facility

- Saab Advanced Manufacturing facility established in West Lafayette, IN, adjacent to Purdue University and the Purdue Airport.
- Broke ground in 2019, official opening in Nov 2021 on time and on budget.
- Saab “Smart Factory” capabilities include:
  - Digital Twin of facility
  - Automation of key Supply Chain/Intralogistics capabilities (use of autonomous mobile robots, etc.)
  - Connected Quality through the use of networked, laser-based measurement systems
  - Smart Operations using digital work instructions, shared digital data, etc.
  - Development of **Virtual Reality** applications to increase efficiency of technician training

# Digital Twin Maturity Model

LEVEL 1

## Virtual Twin

**The Level 1 twin** is a physically accurate realistic digital representation of an asset, facility, or product that emulates its real-world counterpart

**Keywords**

- Spatial awareness
- Interaction
- Experience
- Collaboration

LEVEL 2

## Connected Twin

**The Level 2 twin** integrates real-time and right-time data to provide insights into the performance of an asset at specific points in time.

**Keywords**

- Real-time data
- Monitoring and reporting
- IoT

LEVEL 3

## Predictive Twin

**The Level 3 twin** leverages data to predict the outcomes and problems for the operations of complex facilities and equipment.

**Keywords**

- Analytics
- Decision-assist
- Predictive maintenance

LEVEL 4

## Prescriptive Twin

**The Level 4 twin** leverages advanced modeling and real-time simulation for potential future scenarios as well as prescriptive analytics and recommendations.

**Keywords**

- What-if simulation
- Machine learning
- Intelligent recommendations
- Process optimization

LEVEL 5

## Autonomous Twin

**The Level 5 twin** uses multiple real-time data feeds to learn and make decisions to correct issues automatically and enable predictive and prescriptive analytics.

**Keywords**

- Autonomous action
- Artificial Intelligence

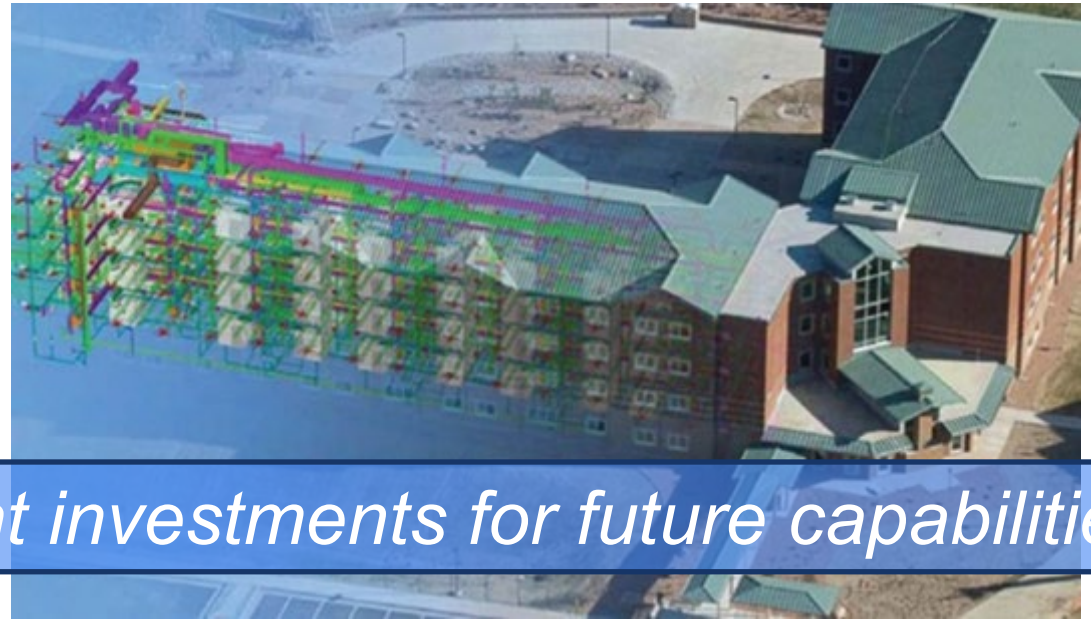
# Way Ahead

## Other Services

- Navy - Naval Support Activity Annapolis/US Naval Academy
- Marine Corps
- USA
- USSF

## Standards

- Data Standards – capture and models
- [Behavior] Model interoperability
- Roadmap to greater maturity levels…focus on low maturity/low cost/high ROI now

*Steward current investments for future capabilities*

*Live Content Slide*

**Poll: Are you looking at implementing any of these technologies?**

# THANK YOU

Please take a few minutes to complete a short survey about this session. Your feedback will help us improve future programming for JETC.

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