



Advancing Aircraft Maintenance Smart Mechanic Glasses (SMG)

2026 GATEWAYS TO BLUE SKIES RepAir Advancing Aircraft Maintenance



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Cecil College



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Agenda

Situational Assessment

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2

Solution Overview & User Case

Concept of Operations

3

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Technical Development

Deployment, ROI, & Regulatory

5

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Conclusions



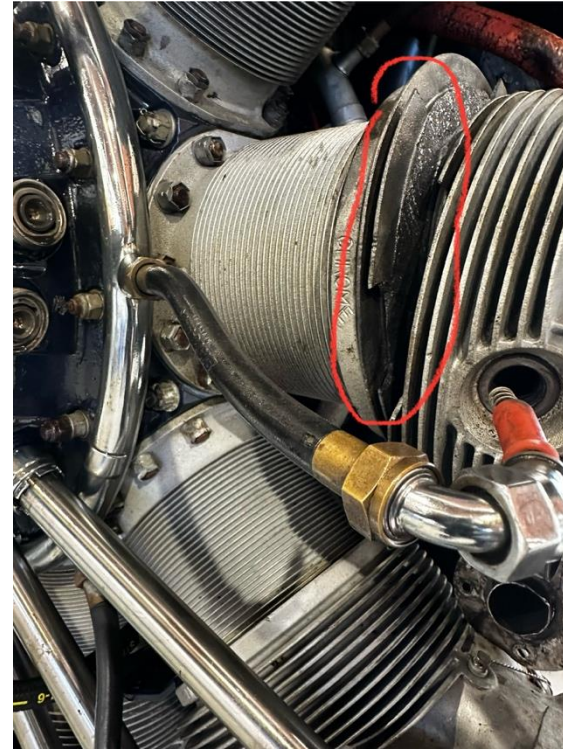
Situation Assessment



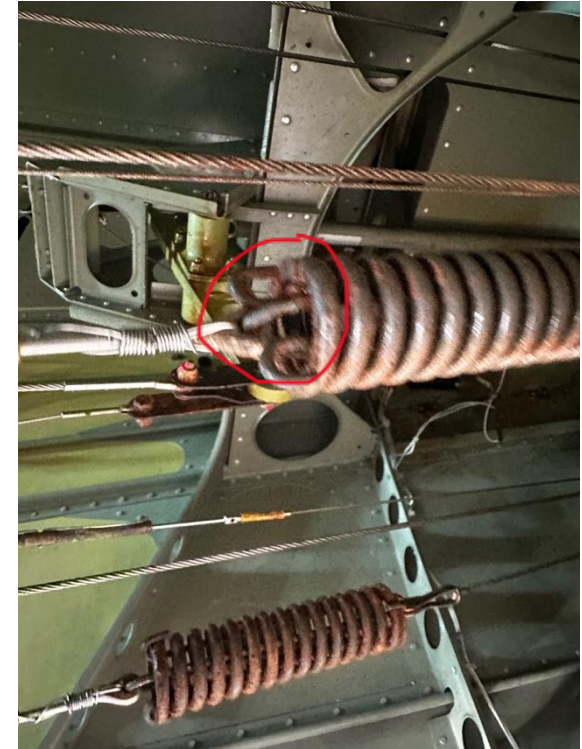
1. C208 Wipaire 8000 float overlooked
Crack under float skin



2. C-208 PT6engine -Starter Generator carbon brush abnormal wear



3. R-985 Cylinder head crack causes power reduce in flight



4. Water rudder spring hook not secured



Situation Assessment



Where is it?

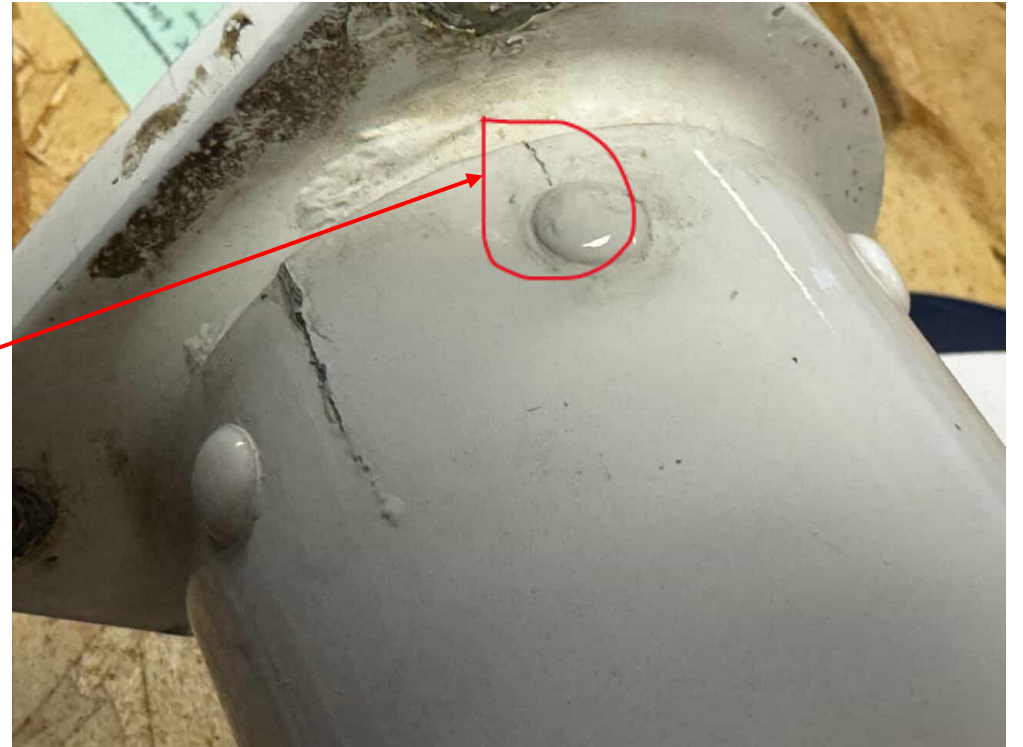
Cessna 208 –
Elevator Torque tube crack



Situation Assessment



Where is it?



Cessna 208-
Elevator Torque tube crack



Situation Assessment



Transport Canada Service Difficulty Report SDR 20161215010

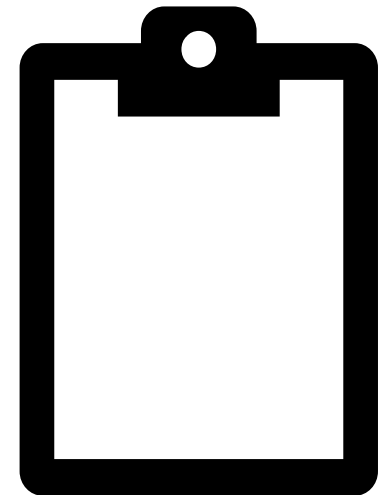
- Aluminum corrosion (Eats through the skin)
- Poor accessibility: Elevator lightning hole
- Inspection technique: Borescope, visual inspection
- Lack of knowledge: never noticed before



Human Factors: Survey Results

Survey Questions:

- Attentional Capture:
 - Has there been a time where a sudden noise, light, or person made you lose focus on a task you were performing. Per workday.
- Memory Uncertainty:
 - Has there been a time where you had to perform a task where you were uncertain of a specific aspect and caused a time extension of the task.
- Poor-Human System Interface:
 - Per workday, how often do you experience technology with poor user interface's (UI) that you feel are unnecessarily difficult or not intuitive.

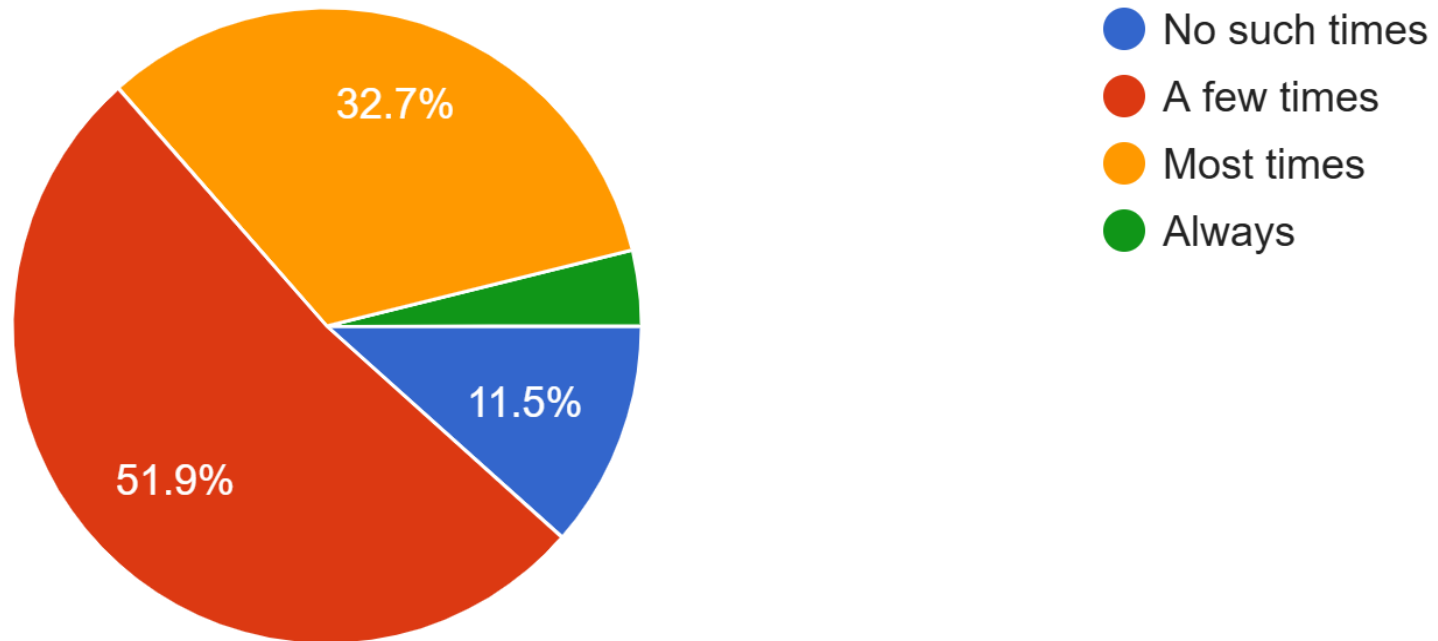




Human Factors: Survey Results

Attentional Capture: Has there been a time where a sudden noise, light, or person made you lose focus on a task you were performing. Per work day

52 responses

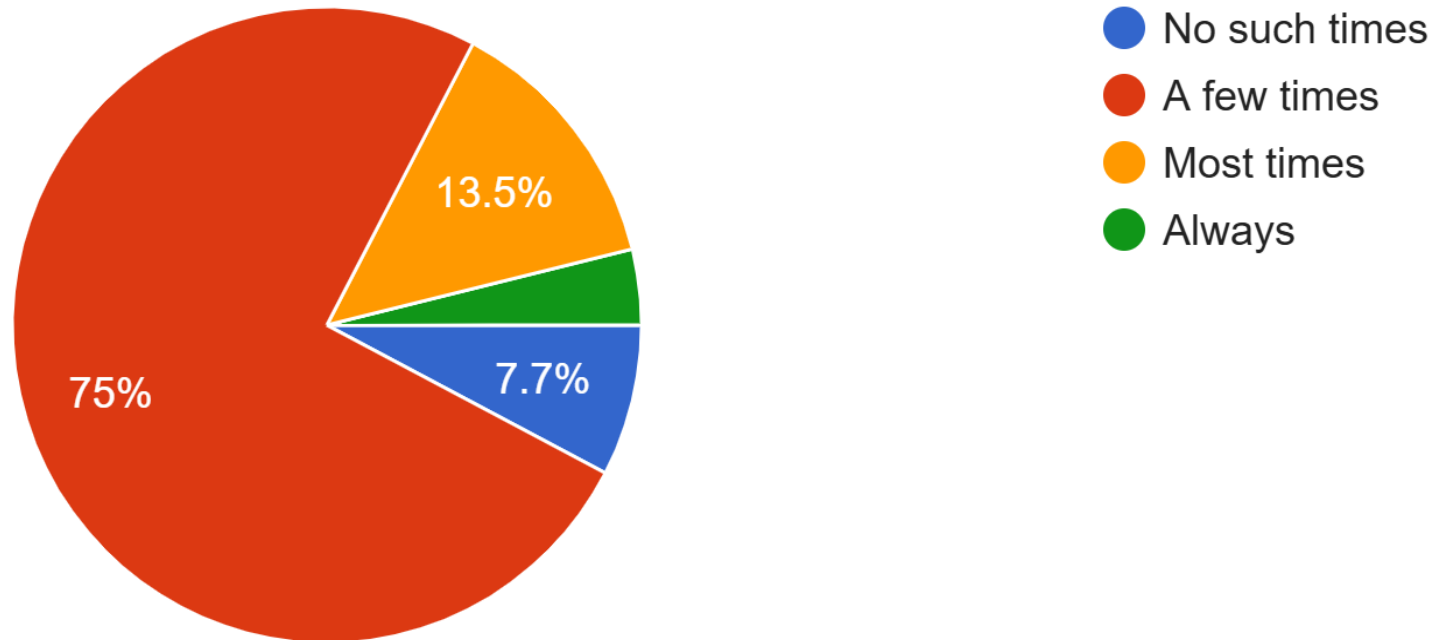




Human Factors: Survey Results

Memory Uncertainty: Has there been a time where you were required to perform a task where you were uncertain of a specific aspect and caused a time extension of the task.

52 responses

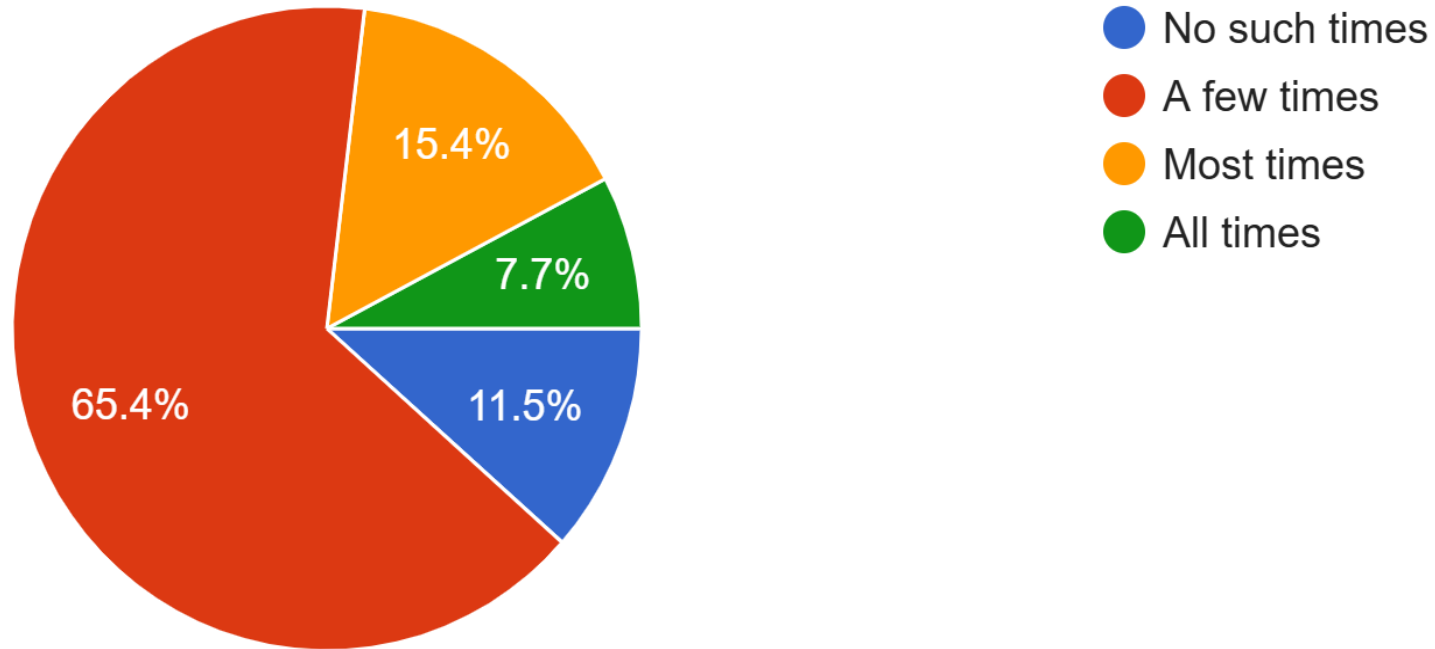




Human Factors: Survey Results

Poor human-system interface: Per work day, how often do you experience technology with poor user interface's (UI) that you feel are unnecessarily difficult or not intuitive.



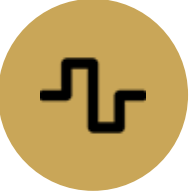


52 responses





The Solution: The Smart Mechanics Glasses System

The combination and integration of the technologies below creating a system that simplifies and assists with the heavy workloads in the industry.

 <p>AR Glasses</p> <p>Hands-free voice + gesture control. CAD-aligned procedural overlays.</p>	 <p>Inspection Drone</p> <p>Semi-autonomous fuselage scan using aircraft CAD as flight reference.</p>	 <p>THz NDT</p> <p>Subsurface scanning that detects corrosion delamination, etc.</p>	 <p>Digital Twin + SHM</p> <p>Closed-loop predictive maintenance from live structural health data.</p>	 <p>RFID Tool Tracking</p> <p>Auto check-in/out, FOD prevention, work-order traceability.</p>
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User	Who	Impact
Primary	Maintenance Technicians	Hands-free procedural guidance, pre-flagged defects before walk-up, auto-logged documentation
Secondary	Inspectors, QA personnel, Engineers	Remote live monitoring, audit-ready traceability, real-time fault disposition



Concept of Operations: Setting the Scene

WHAT IS AN A-CHECK?

Routine line maintenance inspection

Frequency: performed every 400 to 600 flight hours

Duration: 10 to 50 hours of work, depending on aircraft type

Scope: visual inspection of fuselage, wings, control surfaces, landing gear

Tasks: fluid checks, system tests, and AMM-specified items

Pressure: aircraft must return to revenue service quickly

CURRENT PAIN POINTS

Where the workflow breaks

- Toggling between paper checklists and tablets
- Walking back to office for AMM references
- Radio coordination with supervisors mid-task
- Documentation completed after-the-fact, not in flow
- No real-time visibility into hidden subsurface defects



A-Check Walkthrough: AR Login to Drone Scan

STAGES 1 AND 2 OF 4

1 Pre-Inspection

2 Drone Pre-Scan

3 AR-Guided Inspection

4 Documentation

STAGE 1: PRE-INSPECTION (0 TO 10 MIN)

0:00

Authentication

Technician logs in via biometric + PIN. System validates Part 145 work authorization.

0:02

System Sync

AMM, active SBs, ADs, and Digital Twin record auto-pull.

0:04

Checklist Display

Task-specific checklist appears in field of view.

0:06

RFID Tool Init

Tool tracking initializes; checked-out tools auto-link to work order.

0:08

Supervisor Mode

QA and engineering log in for live monitoring.

STAGE 2: DRONE PRE-SCAN (10 TO 25 MIN)

00:10

Drone Launch

Programmed flight path using aircraft CAD. Visual SLAM for indoor nav.

00:12

Multi-Modal Scan

Visual imagery + Terahertz subsurface across fuselage and primary structure.

00:23

AI Classification

Onboard processor reconstructs depth profiles. Severity classification.

00:25

AR Overlay Ready

Defects spatially registered onto aircraft geometry.

Result: by walk-up, problem zones already highlighted in technician view.



A-Check Walkthrough: AR Login to Drone Scan

STAGES 1 AND 2 OF 4

1 Pre-Inspection

2 Drone Pre-Scan

3 AR-Guided Inspection

4 Documentation

STAGE 3: AR-GUIDED INSPECTION (25 TO 90 MINUTES)

0:25

Inspection / Defect Walk-Up

AR overlay highlights drone-flagged defect locations before the technician reaches the aircraft.

0:30

Checklist Execution

PTC Vulforia overlays AMM steps on various aircraft pieces. Tasks marked as complete or flagged in AR.

1:00

Physical Verification

Technician performs standard tactile and visual checks. Suspicious areas flagged all annotation spatially registered to aircraft geometry.

1:15

Remote Expert Support (Conditional)

Engineers annotate directly in the AR field of view.

1:25

Supervisor Review

Supervisor confirms flagged zones via master node before the technician closes each finding.

Result: full inspection execution with continuous AR guidance and live supervisor oversight.

STAGE 4: DOCUMENTATION (90 TO 120 MINUTES)

1:30

Defect Logging

AR captures defect location, photos, and measurements. Auto-linked to the active work order in real time.

1:45

QA Remote Verification

QA personnel monitor progress remotely and verify findings before technician sign-off. Additional checks requested through AR interface.

2:00

Digital Twin Sync

Inspection results uploaded to aircraft Digital Twin. Defect location, severity, and corrective action stored for predictive maintenance.

2:00

Part 145 Sign-Off

Completed inspection synchronized to manufacturer and operator records. Open items flagged with warning for next interval.

Result: audit-ready record synced to Digital Twin with little to no paper documentation.



Software Integration

System consists of four core software components: two commercial platforms we outsource & integrate and two modules our team develops.

TRL 7 to 8

COMMERCIAL

PTC Vuforia

CAD-based AR procedural guidance

- Recognizes aircraft structures from manufacturer-approved CAD datasets
- Overlays inspection zones, fastener locations, torque sequences, and warnings on components
- Auto-aligns captured images to structural coordinates for traceable condition tracking

TRL 8

COMMERCIAL

TeamViewer Frontline

Live remote expert support

- Live video, voice, and virtual annotations placed in the technician's field of view
- Engineers guide fault isolation without interrupting workflow
- Built for non-routine findings, troubleshooting, and engineering disposition

TRL 5 to 6

TEAM-DEVELOPED

Training Module

Built on Unity and Meta platform

- Immersive virtual environment replicating aircraft systems and maintenance scenarios
- Supports onboarding, recurrent training, and high-risk procedure rehearsal
- Technicians adapt to AR before entering the hangar

TRL 6

TEAM-DEVELOPED

Custom Backend

Integration layer

- Integrates all of the subprograms into one seamless program.
- Authentication, document sync, and Part 145 work authorization
- Mode switching between procedural and troubleshooting workflows
- Offline cache keeps the system operational when connectivity drops



Software Integration

PTC Vuforia

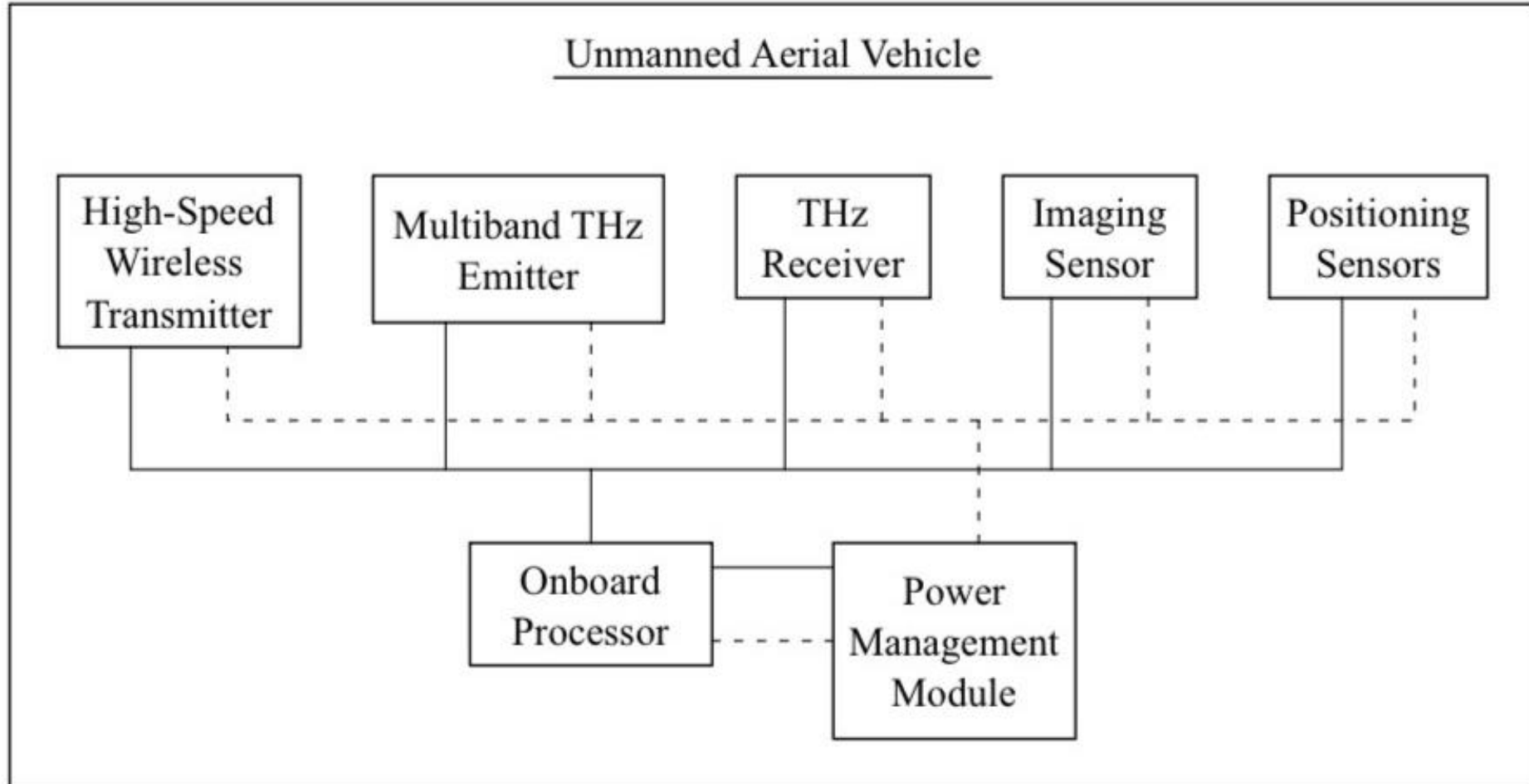


TeamViewer Frontline





Inspection Drone: Software System



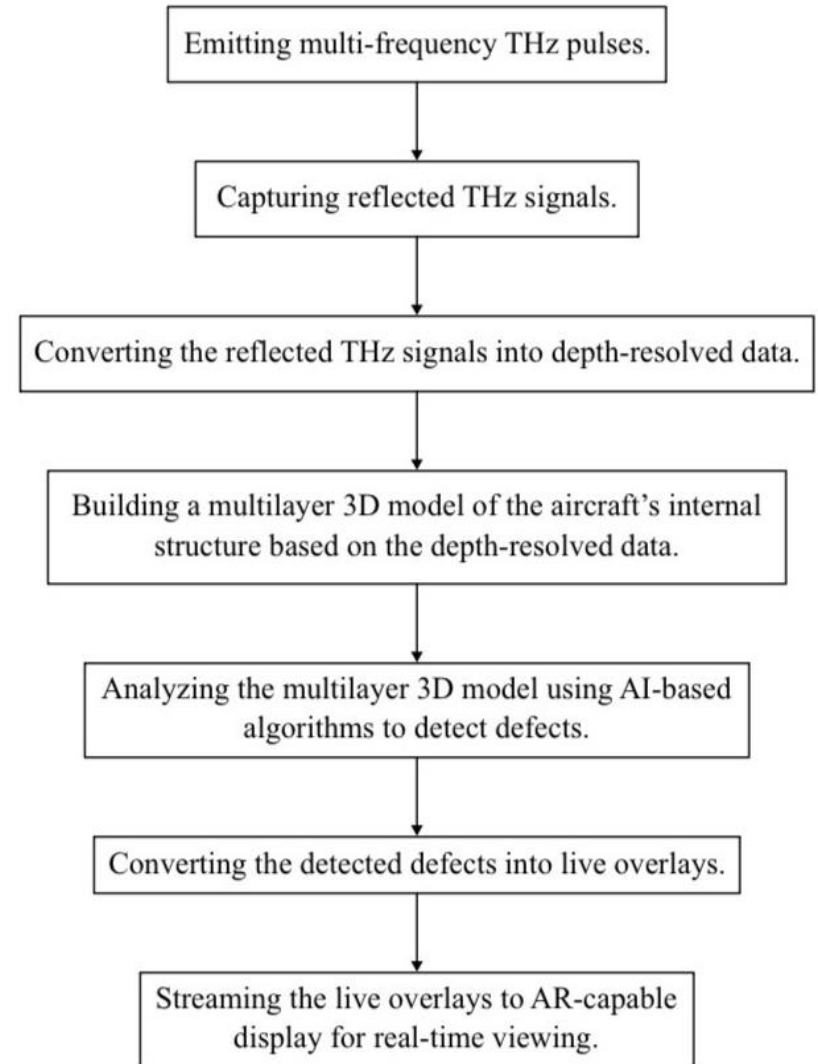
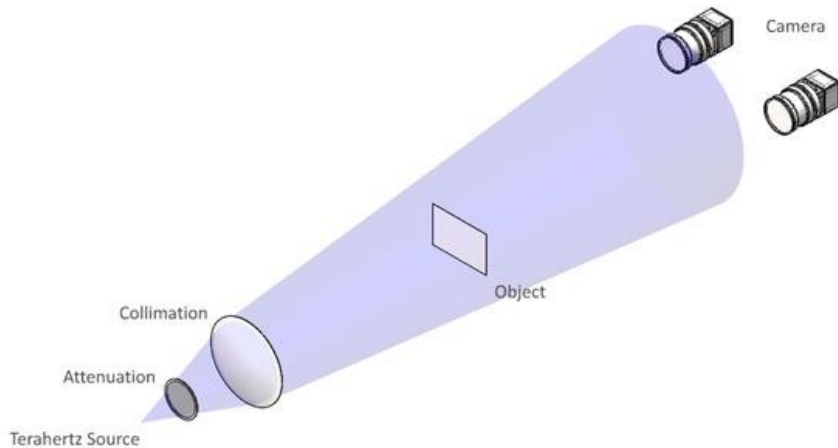


Terahertz Imaging System

Terahertz Imaging uses **electromagnetic frequencies** to detect imperfections hidden from plain view.

Defect Detection:

- Corrosion
- Delamination
- Deformation
- Liquid contaminants
- Voids and Gaps





Onsite Computer

The onsite computer is used to identify and reconstruct potential defects into multiple layers using AI software.

Also allows:

- Enabling fault identification
- Reduced inspection ambiguity
- Predictive maintenance

3D Reconstruction



Overlays are created using time domains



The time domains are compared to the predicted CAD model



Each layer is the designed into a color-coded multilayer reconstruction



Structural Health Monitoring & Digital Twin

4 INPUT STREAMS

Drone Scans

Visual + THz subsurface

RFID Tracking

Tool usage records

AR Checklists

Completed work + TeamViewer logs

SHM Sensors

Live structural state

Digital Twin Persistent Aircraft Replica

Predictive analytics on fatigue trends

Color-coded severity mapping

Historical maintenance correlation

Failure-period forecasting

AR OVERLAY OUTPUTS

Severity Markers

Spatially registered defects

Predictive Hot Spots

Areas trending toward failure

Stress Visualizations

Live SHM signal overlays

Inspection Priorities

Risk-ranked task ordering



Collaborative Maintenance

- The collaborative AR system enables real-time communication between:

Technicians

Supervisors

**Quality Assurance
Personnel**

- Supervisors use a **master node** to monitor inspection progress, analyze SHM data, and send annotated guidance directly to technicians' AR displays.
- Technicians can instantly document:

Critical Findings

Highlighted Defects

Synchronized Instructions



Cybersecurity and Constraints

STANDARDS

Frameworks aligned to

DO-326A / DO-356A

Airworthiness security standards

ISO/IEC 27001

Ground systems information security

NIST 800-53

Federal compliance baseline

MITIGATIONS

Security controls applied

- End-to-end encryption
- Multi-factor authentication
- Cryptographic data validation
- Redundant cross-referencing
- Controlled network access
- Anomaly detection on AR overlays

OPERATIONAL CONSTRAINTS

What we know going in

Connectivity: Wi-Fi for sync; offline cache for AMM

Privacy: video/voice recording requires consent and labor agreement compliance

Environment: THz inspection limited to controlled hangar in early phases

Surface prep: aircraft skin must be clean for accurate THz scan



Smart Mechanic Glasses: Human Fitment

Weight + Size

HUMAN FACTORS

Head Borne Equipment Adds Additional Weight

Concerns of weight to head and spine when AR glasses in use.

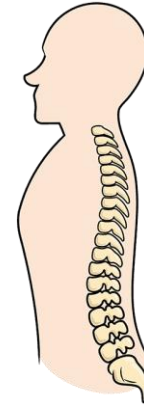
- AR glasses weight should average: 200-300 grams
- No more than 500 grams
- No larger than normal sized eyewear

Position

HUMAN FACTORS

Location of AR Glasses on Head

Position glasses so the device's center of mass aligns with the midpoint of the cervical spine.



AR Visual Latency

HUMAN FACTORS

AR Glasses Frame Rate

To prevent dizziness/ cybersickness. The SMG must provide:

- Legible text
- High frame rate
 - 20 to 90+ frames per second
- Latency no higher than 20 milliseconds

Personalized Use

HUMAN FACTORS

Users with Corrected Vision Via Eyeglasses

Universal fit and compatibility

- Designed for maximum comfort across all users
- **Prescription Users:** Custom clip-on lenses attach externally for seamless integration



Deployment Roadmap and TRL Timeline

2026

2026-2027

2028-2029

2030-2031

2032

TRL 3

Concept and Feasibility

- Human-factors evaluation using existing AR hardware
 - Trade studies for AR software, backend, and drone-based THz inspection
 - Define system architecture and offline data needs.

TRL 4 to 5

Prototype Development

- Develop functional AR maintenance prototype with procedure guidance, documentation sync, and remote expert support
- Integrate backend services
- Validate workflow testing.

TRL 6

Operational Testing

- Conduct technician field trials to assess efficiency, accuracy, and workflow.
 - Introduce THz drone inspection and spatial mapping
- Refine ergonomics and User Interface.

TRL 7

Certification and Refinement

- Integrate advanced inspection capabilities
 - Evaluate system in controlled environments
- Develop acceptable use cases, training requirements, and tool qualification plans with regulatory authorities.

TRL 8

Production and Deployment

- Integrate system with airline and MRO maintenance databases to enable digital tool tracking, fleet-wide analytics, and predictive maintenance
- Scale deployment.



Cost, ROI, and Regulatory Pathway

COST AND RETURN ON INVESTMENT

Order-of-magnitude estimates

AR glasses	~\$1,000	Per technician
Drone with THz payload	\$50K to \$100K	Per inspection station
Software license	~\$2,500/yr	Per seat, recurring

PROJECTED ROI

**3 to 5 years payback
(100-aircraft fleet)**

VALUE DRIVERS

\$10K-\$150K/hr AOG cost range (Boeing estimate)

25 to 30% AR task-time reduction (Boeing AR wiring, Davies 2018)

90% First-time quality improvement (same Boeing study)

REGULATORY PATHWAY

How the system gets certified

AR SYSTEM

14 CFR 43.13(a): AR is a new interface using approved inspection techniques

14 CFR 145.223: FAA inspector approval required for repair station workflow

Adaptation pathway: system effectiveness must be approved before full implementation

THz NDT

14 CFR 25.571: must meet structural fatigue evaluation requirements

MIL-HDBK-1823 §4: probability of detection validation

AC 25-29: NDT development guidance for personnel and procedures

OEM approval and operator validation required prior to operational deployment.



Conclusions and Key Findings

1

The technology fills a real gap

Drone-mounted THz subsurface scanning, integrated with AR procedural guidance, addresses defects that current visual and traditional NDT methods may require significant inspection time.

2

It is buildable on a phased schedule

AR and software components are at TRL 7 to 8 today and can deploy in early phases with the technology stack maturing incrementally.

3

The economics work at conservative assumptions

Even with moderate inspection-time reductions and conservative downtime-avoidance assumptions, modeled savings exceed annualized operating costs by approximately 4×. Fleet-scale deployment and certification are expected over a 3–5 years.



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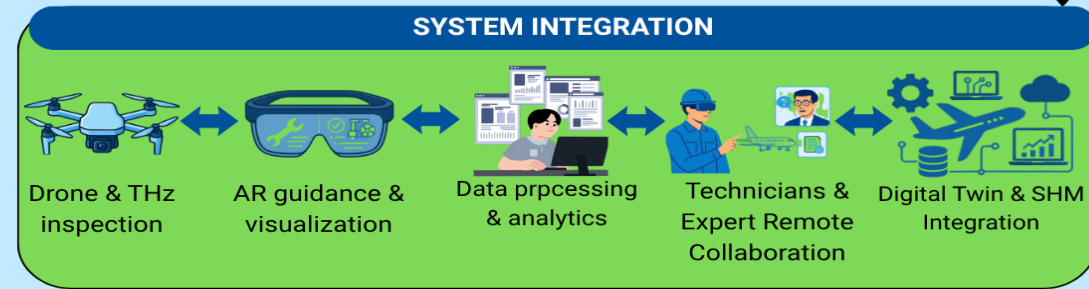
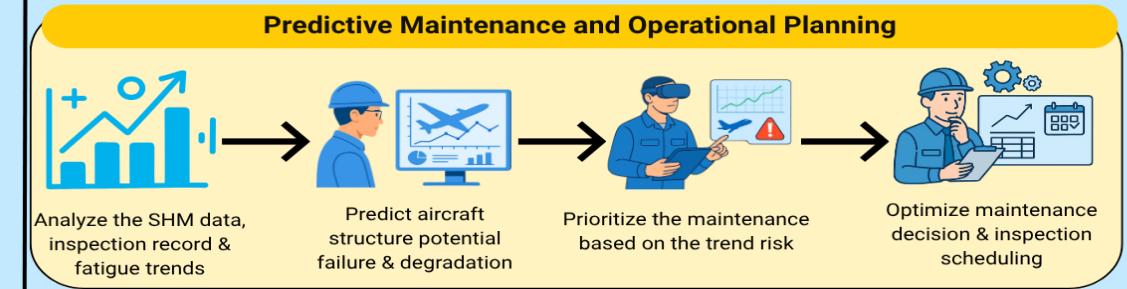
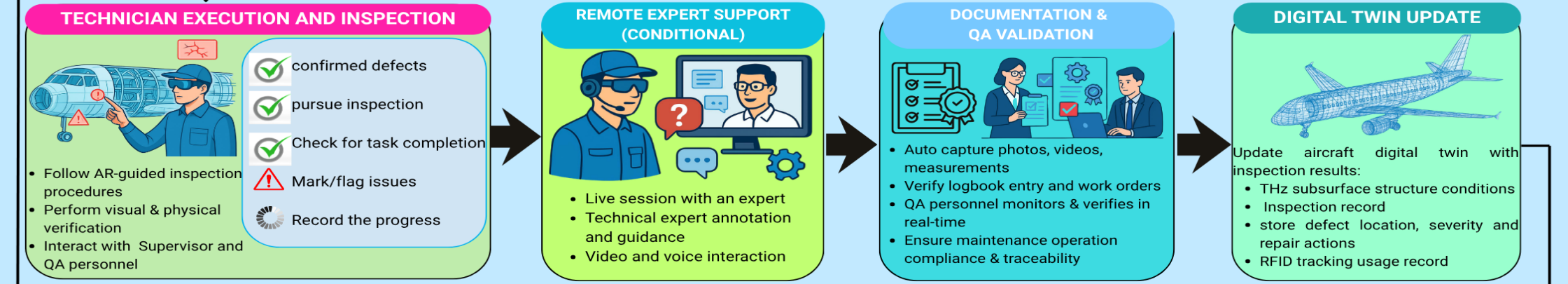
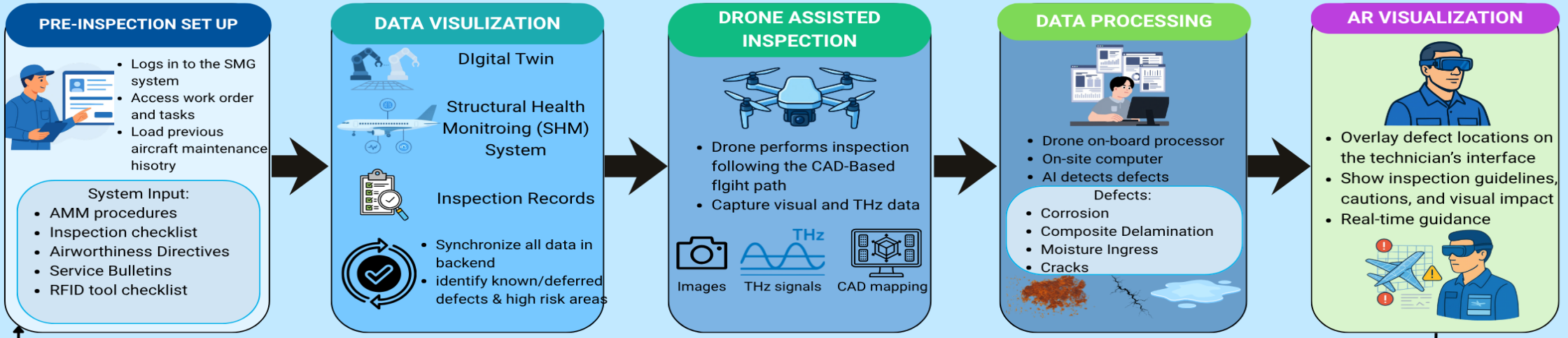
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SMART MECHANIC GLASSES (SMG) SYSTEM WORKFLOW



Closed loop maintenance architecture

PRE-INSPECTION SET UP

- Logs in to the SMG system
- Access work order and tasks
- Load previous aircraft maintenance history

System Input:

- AMM procedures
- Inspection checklist
- Airworthiness Directives
- Service Bulletins
- RFID tool checklist

DATA VISUALIZATION

Digital Twin

Structural Health Monitoring (SHM) System

Inspection Records

- Synchronize all data in backend
- Identify known/deferred defects & high risk areas

DRONE ASSISTED INSPECTION

- Drone performs inspection following the CAD-Based flight path
- Capture visual and THz data

Images THz signals CAD mapping

DATA PROCESSING

- Drone on-board processor
- On-site computer
- AI detects defects

Defects:

- Corrosion
- Composite Delamination
- Moisture Ingress
- Cracks

AR VISUALIZATION

- Overlay defect locations on the technician's interface
- Show inspection guidelines, cautions, and visual impact
- Real-time guidance

TECHNICIAN EXECUTION AND INSPECTION

- Follow AR-guided inspection procedures
- Perform visual & physical verification
- Interact with Supervisor and QA personnel

- Confirmed defects
- Pursue inspection
- Check for task completion
- Mark/flag issues
- Record the progress

REMOTE EXPERT SUPPORT (CONDITIONAL)

- Live session with an expert
- Technical expert annotation and guidance
- Video and voice interaction

DOCUMENTATION & QA VALIDATION

- Auto capture photos, videos, measurements
- Verify logbook entry and work orders
- QA personnel monitors & verifies in real-time
- Ensure maintenance operation compliance & traceability

DIGITAL TWIN UPDATE

Update aircraft digital twin with inspection results:

- THz subsurface structure conditions
- Inspection record
- Store defect location, severity and repair actions
- RFID tracking usage record

Predictive Maintenance and Operational Planning

Analyze the SHM data, inspection record & fatigue trends

Predict aircraft structure potential failure & degradation

Prioritize the maintenance based on the trend risk

Optimize maintenance decision & inspection scheduling

SYSTEM INTEGRATION

Drone & THz inspection

AR guidance & visualization

Data processing & analytics

Techinicians & Expert Remote Collaboration

Digital Twin & SHM Integration



ROI Model: Cost vs. Savings per Aircraft

WHAT IT COSTS (per aircraft, annualized)

AR Glasses 3 techs × \$1,000 = \$3,000 hardware → **\$600/yr**

Drone + THz \$100K ÷ 10 aircraft = \$10K hardware → **\$2,000/yr**

Software + Training 3 seats × \$2,500/yr ÷ 10 aircraft → **\$750/yr**

TOTAL ANNUALIZED COST **\$3,350 / aircraft / year**

Hardware amortized over 5 years

AR Glasses: \$3,000 ÷ 5 = \$600/yr

Drone: \$10,000 ÷ 5 = \$2,000/yr

Software: \$750/yr recurring

Total: \$600 + \$2,000 + \$750 = \$3,350/yr

100-aircraft fleet: **\$335K annualized cost** vs. **\$1.34M/yr savings**

100-aircraft fleet: **\$1.1M upfront deployment cost**

All figures are order-of-magnitude estimates. See sources in footnote.

WHAT IT SAVES (per aircraft, per year)

Inspection Labor Savings

40 man-hrs × \$85/hr × 25% reduction × 4 A-checks/yr

= \$3,400 / year

Source: Davies 2018 (Boeing AR wiring); BLS 2024 shop rate \$85/hr

AOG Deterrence / Avoidance (U.S. avg: 14 AOG events/aircraft/yr)

Reduced troubleshooting and unscheduled downtime exposure.

Estimated Savings = \$10,000 / year

Source: Boeing est. \$10K-\$150K/hr; avg 14 AOG/aircraft/yr (Boeing/SkyThread)

TOTAL SAVINGS **\$13,400 / aircraft / year**

Saves **\$13,400** for every **\$3,350** spent

≈ 4× return

3-5 yr headline = TRL ramp + station-by-station FAA approval + fleet rollout

Drone cost: Boeing/industry est. \$80K-\$150K. Shop rate: \$85/hr fully-loaded (BLS 2024: \$38-58/hr wage). A-check: 40 man-hrs, 4/yr at 500-hr intervals.

Labor reduction: Davies 2018, Boeing AR wiring study. AOG: Boeing est. \$10K-\$150K/hr; avg 14 events/aircraft/yr.