



**Airlines for America™**  
We Connect the World

## **Use of Video Links in Procedures**

March 30, 2024

## Overview

---

- Approximately four years ago, A4A launched an initiative to identify safety improvement opportunities related to Human Factor errors in maintenance
    - The initiative intends to develop mitigations for Failure to Follow
    - Specification 127 (in development)
  - Over the recent 18 months A4A leadership has assigned increased priority, facilitated multiple routine meetings with a leadership team of Operators, Regulators (FAA), and OEMs (airframe and propulsion).
  - The initiative has branched into several sub-teams:
    - Simplification of Warnings, Cautions and Notes
    - Simplification of how procedures are presented
      - Focus on digital delivery w/nested and linked content
      - More intuitive navigation
    - Use of video links for point of use procedure, training and job aid
    - Benchmarking
-

## Overview

---

- The “Use of video links for point of use procedure, training and job aid” may interest IMRBPB for a couple reasons:
  1. Evolution to ICAs is anticipated. Initial use cases are accepted as “for reference only” under an operator's CAMP (training program).
  2. Advanced awareness may be helpful to harmonize forward looking NAA guidance and consider future guidance requirements
- Extensive Research has been performed by FAA’s Civil Aerospace Medical Institute (CAMI) (team member)
- Regulatory research has been done by Aircraft Maintenance Division Flight Standards, AFS-300 management (team member)

# Overview

---

- There are many initiatives underway by highly qualified persons / teams
- CAMI is one of the most longstanding
  - Advocating increased applied human factor principles for the maintenance domain while reflecting the extensive successes in flight ops
- The conclusion of two recent presentations are shared for your awareness:
  1. An FAA (Aircraft Maintenance Division AFS-300) regulatory assessment
  2. A Purdue presentation delivered at the December 2023 InfoShare
- The full presentations are in this file



**Federal Aviation  
Administration**

**PURDUE**  
POLYTECHNIC

SCHOOL OF AVIATION AND  
TRANSPORTATION TECHNOLOGY



**Airlines for America™**  
We Connect the World

# Conclusions



**Federal Aviation  
Administration**

Nothing in the paraphrased regulatory documentation (parts 43 and 121 only) provided in this presentation precludes the use of videos in maintenance instructions.

**PURDUE**  
POLYTECHNIC

SCHOOL OF AVIATION AND  
TRANSPORTATION TECHNOLOGY

- ~80% of maintenance mistakes involve human error
- Use of AR/VR/MR systems in parallel with procedure delivery and human decision-making may increase performance, improve safety and reduce errors.
- Errors and safety concerns could be reduced w/integration of contextual information provided to AMTs



**Airlines for America™**  
We Connect the World



**Airlines for America™**  
We Connect the World

Questions?

# Overview

- **Provide a review of US regulations and FAA guidance pertaining to the use of video or AR utilized as maintenance instructions, or as a supplement to maintenance instructions.**
- **ICA's verses Air Carrier Supplementation utilizing Videos (AIR, AED, AMD)**
- **Encourage discussion of conclusions and challenges.**
- **We applaud this effort and say thanks for giving the FAA a seat or two at the table. (CAMI and AFS-300)**



# 14 CFR 43.13c Performance Rules

## §43.13 Performance rules (general) (Paraphrased)

(a) Each person performing maintenance, shall use the methods, prescribed in the current manufacturer's maintenance manual or ICA, or other methods acceptable to the Administrator, except as noted in § 43.16.

NOTE: §43.16 Airworthiness limitations - Each person performing maintenance shall perform it IAW the operations specifications approved by the Administrator under part 121 or 135, or approved under § 91.409(e)

(b) Maintenance shall be at least equal to its original or properly altered

(c) Special provisions for holders of air carrier operating certificates and operating certificates issued under Pt 121, 135, or 129 operators holding operations specifications.

**The methods, techniques, and practices contained in the maintenance manual of an air carrier operating certificate or an operating certificate under Pt 121, 135 or 129 that is required to have a CAMP constitute acceptable means of compliance**



# 14 CFR 121.133 Preparation

## §121.133 Preparation

- (a) Each certificate holder shall prepare and keep current a manual for the use and guidance of flight, ground operations, and management personnel in conducting its operations.
  
- (b) For the purpose of this subpart, the certificate holder may prepare that part of the manual containing maintenance information and instructions, **in whole or in part, in printed form or other form acceptable to the Administrator**



# 14 CFR 121.135 Manual Content

## §121.135 Manual Contents (Paraphrased)

(a) Each manual required by § 121.133 must—

- (1) Include instructions and info necessary to allow personnel to perform their duties and responsibilities with a high degree of safety;
- (2) Be in a form that is easy to revise;
- (3) Have the date of last revision on each page concerned; and
- (4) Not be contrary to any regulations

(b) The manual must contain info appropriate for each group of personnel: Such as; maintainers, the training program, instructions for maintenance and inspections, other safety info

(c) Each certificate holder shall maintain at least one complete copy of the manual at its principal base of operations



# 14 CFR 121.367 Mx Programs.

## §121.367 Maintenance, Preventive Maintenance, and Alterations Programs

Each certificate holder shall have an inspection program and a program covering other maintenance, preventive maintenance, and alterations that ensures that—

(a) Maintenance, preventive maintenance, and alterations performed by it, or by other persons, are performed in accordance with the certificate holder's manual;

**(b) Competent personnel and adequate facilities and equipment are provided for the proper performance of maintenance, preventive maintenance, and alterations; and**

(c) Each aircraft released to service is airworthy and has been properly maintained for operation under this part



# 14 CFR 121.369 Manual Requirements

## §121.369 Manual requirements (Paraphrased)

(b) The certificate holder's manual must contain the programs required by § 121.367, and must include at least the following:

(1) The method of performing routine and nonroutine maintenance

(3) The method of performing required inspections

**(10) Policies, procedures, methods, instructions for the accomplishment of all maintenance. They must be acceptable to the FAA and are performed in accordance with their maintenance program and maintenance manual**

(c) The certificate holder must set forth in its manual a suitable system that provides for preservation and retrieval of info in a manner acceptable to the Administrator



# 14 CFR 121.375 Mx Training Program

## §121.375 Maintenance and preventive maintenance training program

Each certificate holder or person performing maintenance or preventive maintenance functions for it shall have a training program to ensure that each person (including inspection personnel) who determines the adequacy of work done is **fully informed** about procedures and techniques and new equipment in use and is competent to perform his duties



# Other Guidance for Consideration

- **AC 120-77A *Performance Rules: Provisions Contained in an Operators Manual Under §43.13(c)***
  - This AC describes a means of compliance for commercial operators, to meet the requirements of §43.13
- **FAA Order 8110.54A - Instructions for Continued Airworthiness Responsibilities, Requirements, and Contents**
- **FAA Order 8900.1 Vol 3 Chap 1 Sec 1 *The General Process for Approval or Acceptance of Operator Applications***
  - A process of approval or acceptance of programs, procedures, to ensure items meet regulatory standards



# What is FAA Order 8900.1

- It is a FAA order that directs the activities of Aviation Safety Inspectors (ASI) and other Flight Standards Service (FS) employees responsible for the certification, technical administration, and surveillance of air carriers, certain other air operators conducting operations in accordance with the appropriate part.
- Majority of content is available to the world!

<https://drs.faa.gov/browse>



# Additional Comments / FAA Concerns

- **Inexperience with Video Instruction**. In addition to obvious “training” for the technician, companies need a robust training program, tailored to their operations, fleet, CAMP, procedures, **and generational demographic, especially if “Video’s” are to be used for additional instruction.**
- **The overuse of warnings and caution notes becomes ineffective.** OEM’s should consider prioritizing them according to risk and likelihood of non-compliance. Many manufacturers instead, use notes and warnings to limit liability, just like the FDA warnings on medications. **(May require legal input)**
- **Generational issues** also need to be addressed. It is great for a new technician to have a mentor, to help them learn practical application of the training they have received, but a **company needs to be deliberate in who they want mentoring their new employees.** If they aren’t careful, the experienced technician will teach them “shortcuts” they have learned along the way, and then they have created **baby dinosaurs.** Generationally, the **younger generation is typically more accustomed to learning through video’s/YouTube, and are very comfortable with utilizing AR/VR!**



# Additional Comments Cont.

- Another example is organizational culture and organizational operations pace, applying pressure on the technician to get the aircraft back in service.
- Another factor to consider is environmental conditions, such as noise, working in high places, chemical fumes, poor lighting, snow, rain, wind, etc.
- Fatigue. CAMI has done extensive research in this area. There are a multitude of voluntary measures that individuals and corporations may employ, to assess a person's fatigue levels, and fitness for duty. In addition to voluntary measures, rulemaking may be necessary to move the safety needle in the area of fatigue risk management in aircraft maintenance (though unpopular with most of industry).
- Checklists, if a company provides and embraces the concepts of utilizing check lists, such as in the FAA Personal Minimums checklist, it can have an impact.



# Further Challenges and Concerns

- Challenges may exist with acceptance until additional FAA policy and guidance is written
- Should Video's have a caveat that mentions its purpose – (For information Only)?
- ICA's may be a challenge, at least at first.
- Maybe start with only perfecting Supplemental Videos (Beta Test).
- Where do the Videos get placed in the instructions?
- How would Videos stand out within maintenance instructions? (For example - Click Here For a Supplemental Video)
- When is it appropriate to use Videos – Continual areas where problems arise?
- Costs, will it be labor intensive to develop?
- Revisions – who does the revisions and how often?
- Possibly require a Proof of Concept?
- Avoid stacked and or duplicated warnings and cautions (Clutter)



# Further Challenges and Concerns

- What environment should / would they be used in? (Heavy Maintenance, Line Maintenance, Hangar Only, etc.)
- Will the organizations Culture support video use.
- Consistency – Should all operators and OEM's be doing it the same way?
- First - Consider the importance - Need to know vs Nice to know
- Should Video's be considered / incorporated based on a Comprehensive fix? (ASAP's, VDRP's, etc.)
- **What is EASA's, DGAC or TC's position?**



# Coordination within FAA

- Safety Assurance offices (CMO's, FSDO's, IFO's), along with AFS-300 (AMD), and AFS-100 (AED), will consider providing information and insight needed to develop effective guidance for inspectors, and certificate holders that want to use video technologies.
- FAA Safety Assurance offices typically will divulge any concerns and coordinate with the Aircraft Maintenance Division (AFS-300), and the Aircraft Evaluation Division (AFS-100) typically when new processes are established and initially implemented.
- AFS-300 would be the group that typically would develop any guidance, memos, info's etc. to support video use targeted around the workgroup's efforts associated with Video's.
- ❖ The Aircraft Evaluation Division (AED) assists and coordinates with aircraft manufacturers, operators, Aircraft Certification Offices, and other Flight Standards Offices with product-specific Continued Operational Safety (COS)



# Conclusions

- **Existing (FAA) Policy and Guidance**

- Although additional refining more than likely would be needed, current guidance provides a performance-based framework for accepting changes to a certificate holder's CAMP. Policy and guidance is not specific to new technologies such as the use of videos or AR in maintenance instructions.
- Nothing in the paraphrased regulatory documentation (parts 43 and 121 only) provided in this presentation precludes the use of videos in maintenance instructions.



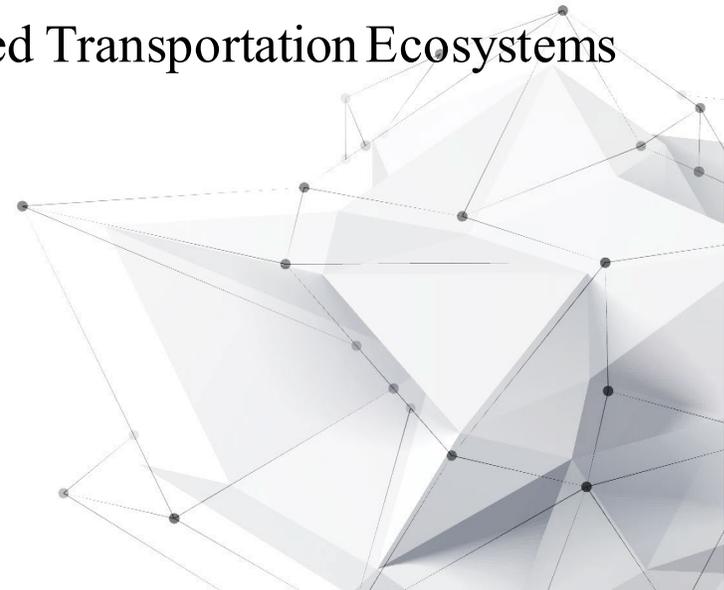
# The Future of Aviation Inspection: Artificial Intelligence (AI) and Mixed Reality (XR) as Agents of Transformation

**Damon Lercel, MBA, PhD.**

**Manoj S. Patankar, MBA, PhD., FRAeS**

Center for Research and Education in Advanced Transportation Ecosystems

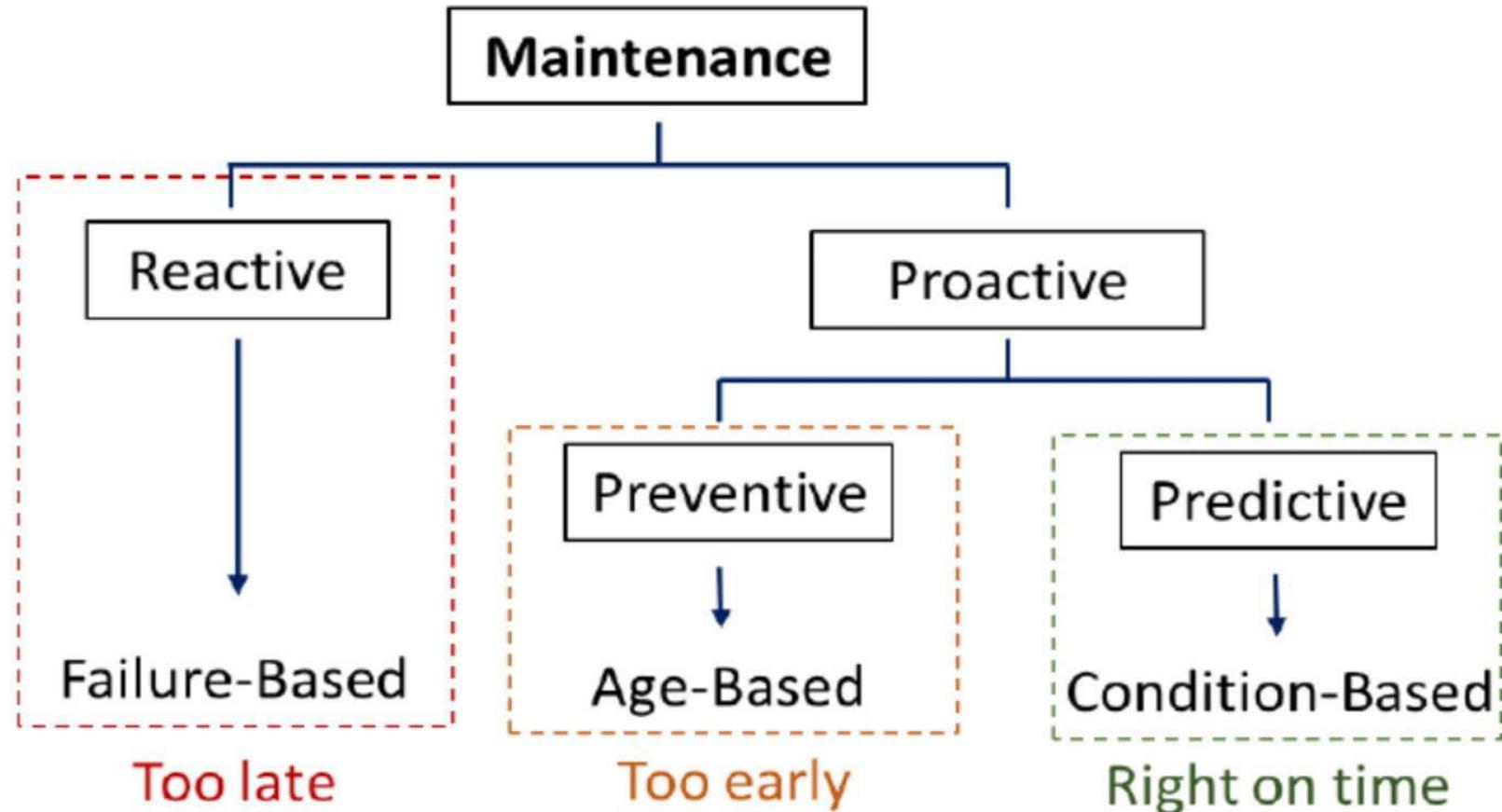
**Aviation Safety InfoShare December 2023**



# Background

- Nationally, 151,300 aviation technicians are tasked with safety work in hazardous environments that include heights, confined spaces, and extreme weather.
- Importantly, the work of these technicians is aided by collaborations with highly experienced inspectors who leverage their years of prior experience as technicians to inspect, identify, and certify necessary aircraft maintenance.
- Unfortunately, potential failures in these collaborations coupled with a high-stress environment and the potential to misunderstand maintenance manuals can directly lead to devastating air accidents.
- Human error accounts for 70% of aviation accidents, with technical/maintenance process failure being the leading cause of airline accidents and fatalities.
- Approximately 80% of maintenance mistakes involve human error.

# Background



# Introduction

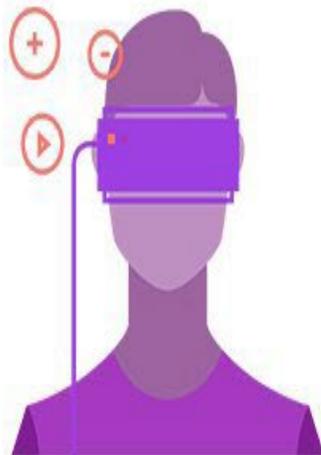
- Potential Impact Opportunity
  - The integration of Human-AI collaboration using AI and XR in inspection may reduce human error in aviation and other industries.
  - Errors and safety concerns could be remedied through the intelligent integration of contextual information that would provide AMTs with real-time data for aircraft inspections and repairs.
  - Utilizing AI and XR systems in parallel with human decision-making may provide AMTs access to more instantaneous information when needed and increase overall situational awareness, thus increasing performance and reducing the number of errors.
  - The incorporation of Human-AI teams via an AI and XR platform into inspection could reduce human error frequency in aviation maintenance, thereby enabling better human decision-making.

## VIRTUAL REALITY (VR)

Fully artificial environment



Full immersion in virtual environment

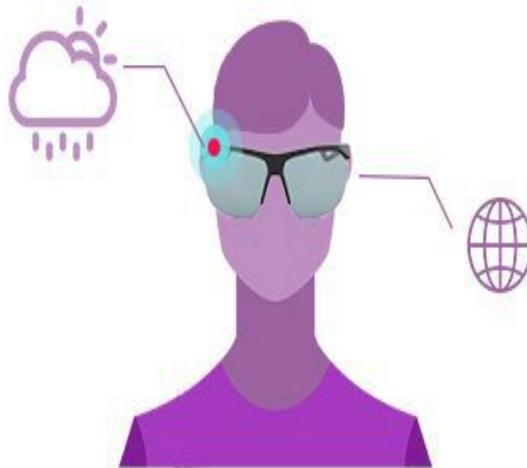


## AUGMENTED REALITY (AR)

virtual objects overlaid on real-world environment

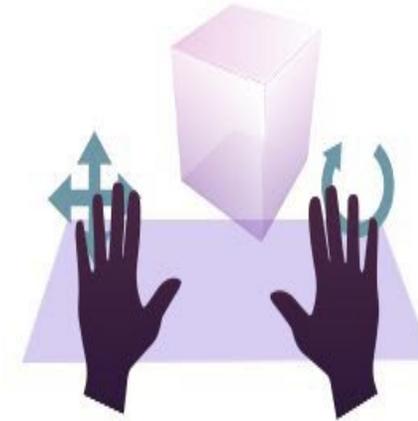


The real world enhanced with digital objects

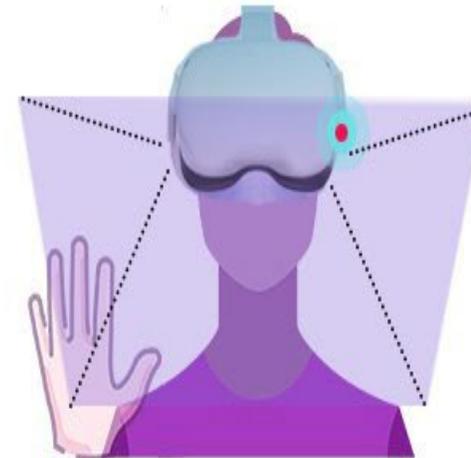


## MIXED REALITY (MR)

Virtual environment combined with real world



Interact with both the real world and the virtual environment



MARVEL  
**IRON MAN**  
VR



**RDUE**  
E C H N I C

AVIATION AND  
ION TECHNOLOGY



**PURDUE**  
POLYTECHNIC

SCHOOL OF AVIATION AND  
TRANSPORTATION TECHNOLOGY



**PURDUE**  
POLYTECHNIC

SCHOOL OF AVIATION AND  
TRANSPORTATION TECHNOLOGY

**1.**

Samuel enters the floor wearing HoloLens and launches the IoT MR Application

**3.**

The 3D machinery image with alert indicates open technical issues on the floor

**5.**

The hazard symbol can be seen at places and over people to indicate potential hazard spots or non-compliances

**6.**

The shortcut/contextual menus arising over the wrist for quick actions

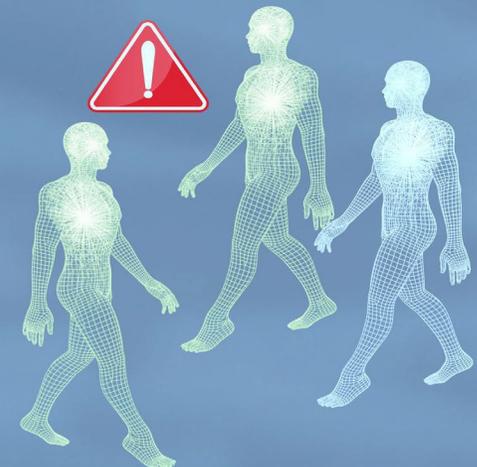
**4.**

The 3D image of people with alert indicates open compliance issues on the floor

**2.**

He is shown his profile card along with handles for viewing Messages and Job Logs

Samuel Sanders  
(Foreman)  
ID# XL-324432  
Unit# 344-774



# The Research Team

## COLLABORATIVE RESEARCH TEAM

### CLEMSON UNIVERSITY

Anand K. Gramopadhye, PI  
Kapil C. Madathil, Co-PI  
Nathan McNeese, Co-PI  
Carlos Toxtli-Hernández, Co-PI  
Christopher Flathmann  
Katie Shakour, Social Science

### PURDUE UNIVERSITY

Manoj Patankar, Aviation Safety  
Gaurav Nanda, AI & Human Factors  
Damon Lercel, Unmanned Aerial Sys.

### SOUTHERN ILLINOIS UNIV.

Karen Johnson, Aviation Tech

### GREENVILLE TECH

Carl Washburn  
Aviation Maintenance

## SMEs, ADVISORY BOARD AND EVALUATION TEAM

**Crystal Maguire**  
Strategic Initiatives  
ATEC

**Jon Beck**  
Unmanned Aerial Systems  
NCAT

**Mica Endsley**  
Situational Awareness  
SA Technologies

**Jeff Bertrand**  
Mixed Reality Design  
Clemson University

**Clemson  
Evaluation  
Group**

**Ryan Goertzen**  
Workforce Development  
ChooseAerospace

**Devon Gorry | Yichen Zhou | Jon Leganza**  
Economic Impact  
Clemson University

## PARTNERS

LOCKHEED MARTIN

FRONTIER  
AIRLINES



AMFA  
Aircraft Mechanics  
Fraternal Association

STEVENS AEROSPACE AND  
DEFENSE SYSTEMS  
EST. 1950

ATLAS AIR



AAR



VERICOR

RDUE  
TECHNIC

OF AVIATION AND  
ATION TECHNOLOGY

# The Research Project

Thrust 1. Convergent research on the study of AI and XR in inspection and exploring risk mitigation methods

Thrust 2. Breakthrough integration of AI and XR into intelligent work systems to achieve technological transformation

Thrust 3. Improve human performance through the evidence-based Human-AI system paradigm

Thrust 4. Economic evaluation and workforce impact of integrating AI and XR technology in inspection

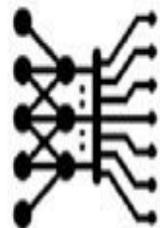


1



Output 1:  
Mental Models

2



Output 2:  
Novel Machine  
Learning Tools

3



Output 3:  
Human-AI  
Systems

4



Output 4:  
Workforce  
Impacts

**ADUE**  
E C H N I C

AVIATION AND  
ION TECHNOLOGY

# The Research Project

## *Research Goal and Questions:*

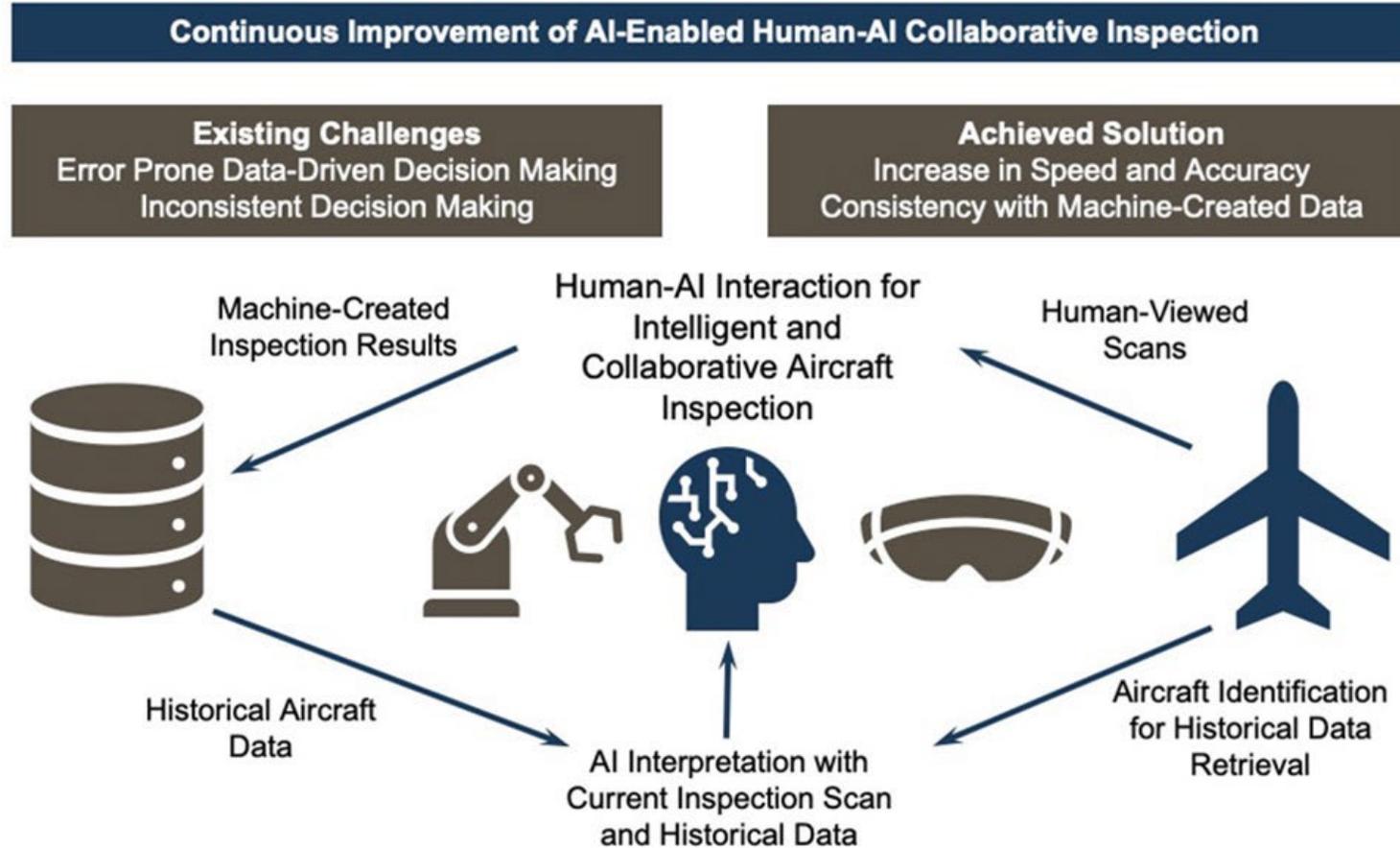
- What are the potential risks and the ways to mitigate them when integrating AI and XR in aviation maintenance settings?
- How can we effectively integrate AI and XR into intelligent work systems to achieve breakthroughs in aviation inspection for diverse populations?
- How can we design, develop, and evaluate evidence-based interaction paradigms to combine the capabilities of humans and AI to enhance Human-AI team performance?
- What are the economic and workforce impacts of integrating AI and XR technology in this domain?

# The Research Project



Prototype XR Simulator Currently Used by AMT Students for Training

# The Research Project



# Questions?



Dr. Damon Lercel  
Purdue University  
Email: [dlercel@purdue.edu](mailto:dlercel@purdue.edu)

Dr. Manoj Patankar  
Purdue University  
Email: [m spatankar@purdue.edu](mailto:m spatankar@purdue.edu)



**Airlines for America™**  
We Connect the World

Questions?