A WHITE PAPER FROM TAQTILE

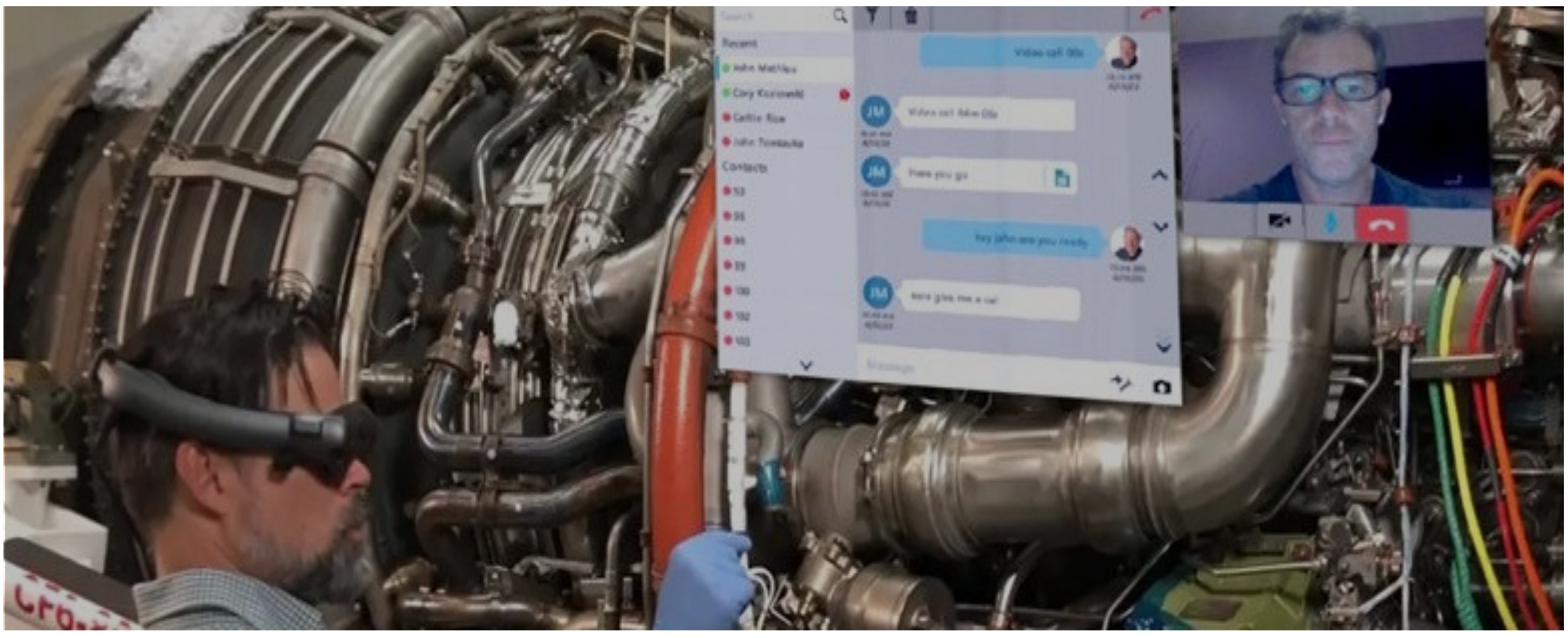
Digitally Transforming the Maintenance, Repair and Overhaul Deskless Workforce

EXECUTIVE SUMMARY

Enterprises within the maintenance, repair and overhaul (MRO) sector of the aerospace industry have been slow to digitally transform. Traditionally, paper and manual-based processes have dominated MRO operations for commercial and military aircraft. However, the need for virtual work, the adoption of emerging technologies such as artificial intelligence (AI), machine learning (ML), and augmented reality (AR) within aviation manufacturing, supply chain evolution, and fleet conversions are accelerating transformation. Increasingly, MRO service providers are focusing on IT and technological developments to increase their efficiency and reduce the time consumed on MRO activities.

However, the growing complexity of maintaining and overhauling hardware is increasing dramatically while the availability of experienced technicians who understand both the technology and the hardware is decreasing. An aging workforce and an exodus from the aerospace industry due to the recent disruptions have increased the skills gap within the workforce, creating challenges with operating, training, and adopting the new technologies that will drive the operational efficiency required to be competitive.

Taqtile's Manifest is an enterprise software-as-a-service (SaaS) platform that that empowers deskless workers through digitally augmented workstreams, collaboration tools and connectivity to IT systems. Manifest harnesses, distributes, and applies what your experts know and gives deskless workers instant virtual access to step-by-step guidance and remote support anywhere, anytime. MRO jobs get done more efficiently and operations, productivity and throughput is improved.



If a technician on the shop floor should encounter a problem, they can reach out to an engineer via video chats for remote assistance, reducing time to resolution

CHALLENGES FOR THE DESKLESS MRO WORKFORCE

The MRO sector remains highly competitive with market pricing exerting constant downward pressure on profit margins for operators, OEM, and independent MRO organizations. Add the pressures from increasingly squeezed supply chains, labor and technician shortages, and consider the fact that aircraft maintenance is overwhelmingly human dependent, it is not surprising that many organizations – commercial, cargo and military alike - are looking at new technologies to increase operational efficiencies. Digital Twins, powered by real-time sensor data and AI algorithms are optimizing preventive maintenance and decreasing aircraft on grounds (AOGs). And experiments with inspections done by drones look promising. While these are two illustrative examples how technology will improve MRO operations, when it comes to performing actual scheduled or unscheduled work for engine overhauls, airframe and component maintenance, line maintenance and modifications, there are many challenges for technicians and engineers. New technology solutions specifically for the deskless MRO workforce will be required to remain competitive. Some of these challenges include:

1. **Lack of significant digital transformation.** Compare a hanger today with one decades ago and a lot looks quite similar. There are still paper manuals on shelves, people running back and forth to stores, illustrates parts catalogs (IPCs) being used to understand a machine or component.
2. **Growing complexity of work environment.** In commercial sectors, older planes are being replaced with newer, more complicated aircraft with more sophisticated hardware and components. In the defense sectors, fleet complexity and diversity is increasing with new planes being introduced and useful life of others being extended.
3. **Growing skills gap.** Recently, there has been a huge loss in talent with many leaving the industry during the downturn. This accelerated and widened an already existing skills gap as the experienced workforce aged and institutional knowledge began disappearing with every retiring technician and engineer. Younger workers are less experienced with less exposure to trades and industrial operations. Yet, as digital natives, many have expectations and desires to work with digital tools and the latest technology in their workplace. Turnover and attrition rates have never been higher as the new generation trade lifetime employment for flexibility and advancement. But traditional training methods can still take years to bring an apprentice up to the high level skills necessary to maintain the safety and reliability required in the industry.
4. **Disrupting forces.** Disruption from COVID continues to wreak havoc in many locations. Physical distancing, vaccination and testing requirements are still limiting expert availability and travel and often dictating skeleton crews. Economic counter actions have further exacerbated workforce shortages and availability of new employees. This disruption will likely linger for years and new disruptive forces will, no doubt, introduce new challenges that require more continuity solutions in the future.
5. **Silos of operations and expertise.** Despite the advances in technology, connectivity, and integration, silos of expertise and operations continue to persist – especially within the deskless workforce. Digital transformation has been slow and limited for the majority of these workers due to the lack of suitable devices, data connectivity, and solutions. So, job performance can vary widely due to variations of people, places, procedures, and hardware.

Manifest utilizes spatial markers associated with instructions to show technicians where to perform a procedure.

TRANSFORMATION OF THE DESKLESS MRO WORKFORCE

While AI predictive maintenance solutions, inventory management systems, and integrated supply chains and back-end systems will drive significant change and efficiencies within the industry, the most significant and revolutionary transformation opportunity rests with maintenance and technicians. Workforces focused on performing the heavy maintenance, component repairs, line maintenance, and other maintenance operations cannot be left behind and need new technology and tools. Some of what is needed include:

- **Digitized documentation and tools.** Physical manuals, paper-based procedures, clipboards, and the like need to be replaced with modern tools and solutions. Creating, updating, locating, and using paper documents is outdated and fraught with issues. Often written instructions are misinterpreted. So, procedures that leverage video and other media, 3D models, AR augmentation improve and expedite overall comprehension and decrease misunderstanding.
- **Standardized and digitized procedures.** Easy to comprehend and follow, standardized procedures are key to precision, accuracy, consistency and safety across different personnel, locations, hardware, and directives. Standardized procedures are nothing new to the MRO space but digitizing and providing access to them from a hands-free wearable computer will be game changing.
- **Efficient knowledge transfer.** Coordination, collaboration, and machine interaction will be more complex yet needed more than ever. Efficient and effective training, on-boarding, skills refreshing, and guidance and assistance will be required to transfer skills and expertise quickly and efficiently to less skilled workers.
- **Device and platform flexibility.** Operational and maintenance procedures need to be digitized and accessible from devices that are suitable for the array of different environments and conditions. Suitable devices have long been a limiting factor for digital transforming components of many different operations. What might work in the hanger, might not work as well at the gate. With the emergence of mobile and wearable devices viable for many different uses, solutions and tools need to provide broad device support to provide the right tool for each job and environment.
- **Remote solutions.** With FAA's announcement of policy PS-AIR-21-1901, video links and other remote technology to help conduct inspections and validate regulatory compliance was enabled. This policy supports the use of remote technology to perform prototype conformity inspections, engineering and ground tests, engineering compliance inspections, production conformity inspections, and inspections for the issuance of an Authorized Release Certificate, FAA Form 8130-3, and Airworthiness Approval Tag. Remote work and collaboration is sure to be here to stay given the potential for huge amounts of cost and time savings as well as the ability to enable more comprehensive inspections of parts and components.
- **On-demand and offline content.** Technicians need access to knowledge when and where they need it. High-speed wireless connectivity, such as 5G, enables instant access to content and assistance. But for many locations, work instructions and guidance need to be accessible while disconnected and offline.
- **Integration**. As more components and systems become connected, more data than ever is becoming available. But that data needs to be accessible in solutions that help people use it. Often deskless workers will need real-time access to this data to make better decisions. And operational data related to job history and performance; fault reporting and resolution; or inspections and auditing needs to be integrated with business systems for archiving and compliance or to automatically trigger downstream workstreams.

Mobile phones, tablets, rugged headsets like RealWear and augmented reality heads up displays like Hololens 2/Magic Leap makes Manifest the right tool for any job.

MANIFEST ENABLES OPERATIONAL EXCELLENCE

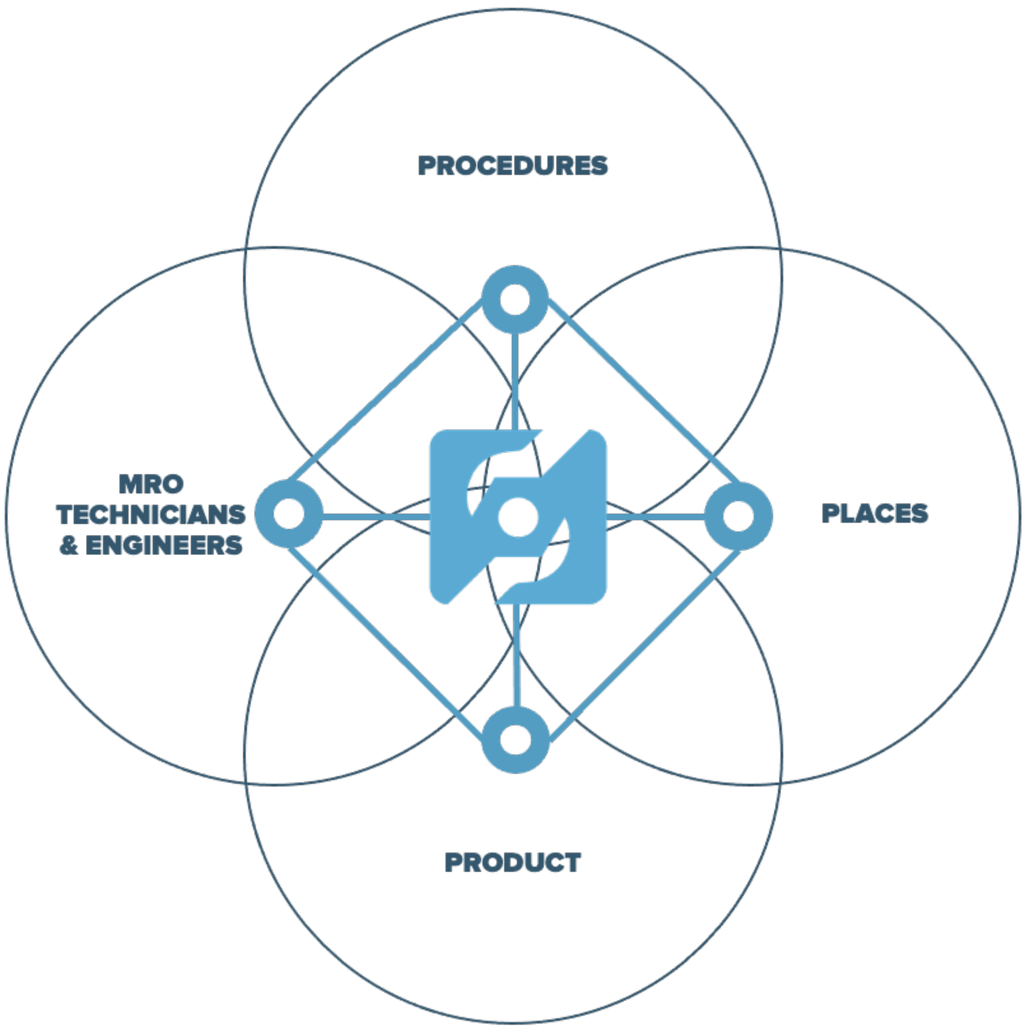
Taqtile's Manifest leverages AR and cloud computing to remove operational silos. It provides a platform to capture expertise, document procedures and provide guidance and direction to enable flawless operational workstreams everywhere and every time. Manifest unites four domains of operations:

- **Procedures.** Tasks and directives are digitized, documented, and augmented with audio, video, and spatially anchored AR elements. Work instructions are used to accurately execute tasks, and results are archived for analysis and future performance optimizations.

- **MRO Personnel.** Engineers and technician and other MRO staff. Regardless of skill level and experience, institutional knowledge, expert assistance, and team collaboration is enabled and available – whenever it is needed. Even in times of communication blackouts.

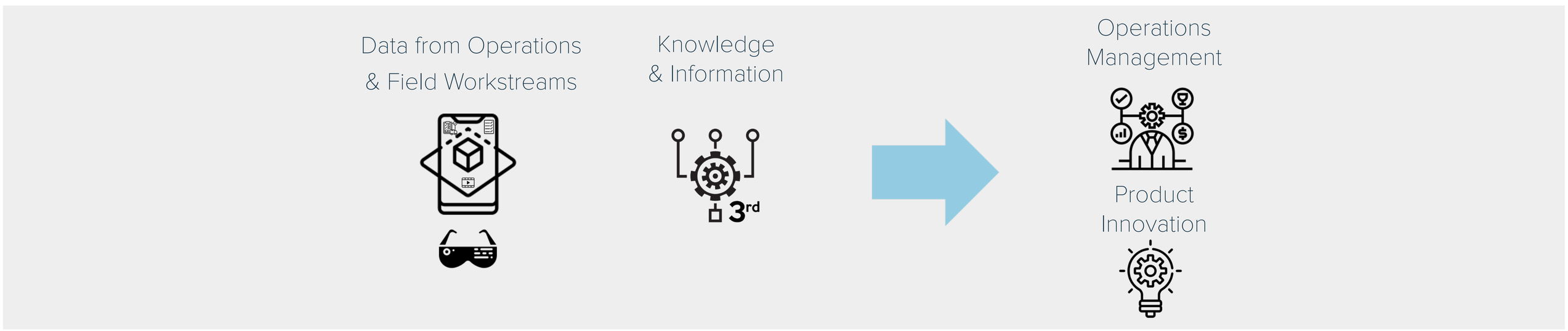
- **Places.** Traditional physical barriers disappear. Work gets done at the same speed and quality regardless of individual, team, or hardware locations. Autonomy is enabled anywhere.

- **Product.** Technicians interact with aircraft, components, systems and sensors, in real-time. Information is available within heads up displays and then data is integrated with systems for archiving.



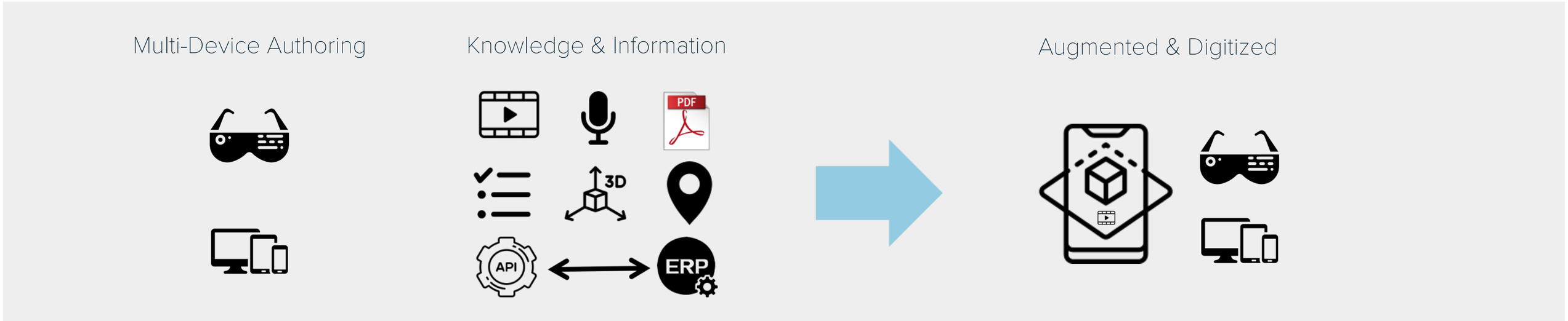
Manifest unites four data domains to digitally augment MRO operations

More precisely, Manifest is a software suite for deskless work that supports digital transformation. It does this by capturing expert process-based knowledge, integrates with key sources of data and fuses the information into an intuitive augmented- and mixed-reality format to create digitally augmented workstreams. The software includes the ability for deskless workers to reach-back for assistance using built-in remote assistance. Key workstream data is captured in real-time to update the sources of data so that the leaders in "mission control" can monitor progress and adapt tactics. (Fig. 2)



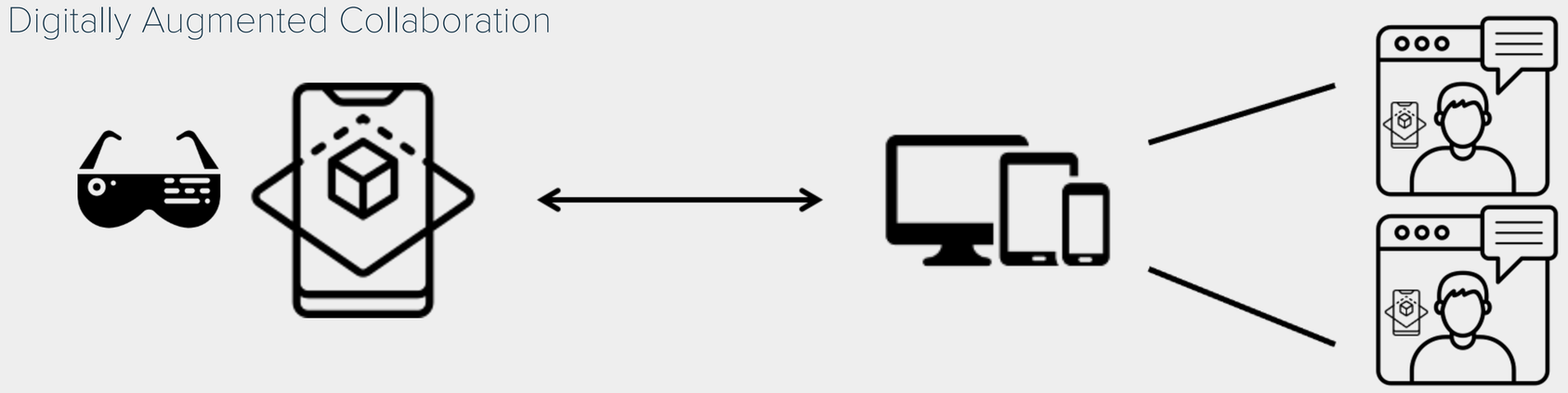
Manifest utilizes APIs to display sources of data within a spatial context to support MRO operations (Fig. 2)

Organizational knowledge is leveraged because domain and process experts capture their specialized knowledge enabling deployment to MRO technicians who follow the workstreams to complete complex and unfamiliar tasks efficiently. These digitally augmented workstreams can be authored and executed across a number of supported hardware devices. (Fig. 3)



Manifest enables subject matter experts to document their knowledge (Fig. 3)

MRO technicians can work independently or collaborate and share workstreams with engineers and other teammates (Fig. 4). Integrated communications capabilities allow workers to reach out to experts whenever they run into unforeseen problems. Audio, video, and text chats as well as video sharing allows experts to remotely obtain context and offer guidance. With the Manifest open API, IIoT/IoMT, SCADA, and PLC data can be integrated to provide real-time sensor data, and warnings within the space worker's field of view so faster and better decisions can be made while performing procedures.



Manifest has integrated features enabling MRO technicians to reach-back for procedural support (Fig. 4)

Manifest boasts several key features and benefits that make it the unparalleled platform for digitization of defense operations, see Table 1.

Table 1: Manifest feature set enables uninterrupted workstreams everywhere, every time

FEATURE	BENEFIT
Multi-Layer Security	Enterprise-grade access control, encryption, and location-level data capture control at the application level.
Flexible Deployment and Administration	Cloud, on-premise, hybrid, offline
Fully Integrated Team Collaboration & Remote Assistance	Teams able to execute jobs whether collocated or remote with task orchestration and visibility. Locate the right expert the first time while sharing visibility of the job or issue at hand.
Multi-Device	Utilize a variety of form factors and devices best suited for the use case and environment. Manifest runs on browsers, iPads, Android phones, RealWear monocular HMDs, and mixed-reality HMD's like Magic Leap and HoloLens.
Integrated Sensors/IoT	Visualize live sensor data to better inform operators and create rules based on hardware telemetry to keep gear and personnel safe.
PDF Viewing	Display entire technical manuals and documents and/or bookmark specific page references pertinent to the in-process task.
In-situ Authoring	Turn spatially-enabled devices into content-creation engines that capture step-by-step procedures over real-world environments and hardware without need of 3D CAD or programming skills.

Because Manifest offers Integrated Digital Augmentation (IDA), engineers and technicians have real-time access to all the necessary data to trouble shoot and make quick decisions and are able to obtain support from remote experts or pre-documented instructions to carry-out complex tasks. The augmented workstreams support elegant distributed collaboration by presenting the relevant data within the field of view of the technician while simultaneously showing what they are seeing. Manifest therefore augments cognition, reduces cognitive stress, and captures operations data in real-time.

Manifest utilizes spatial markers associated with instructions to show technicians where to perform a procedure.

ADAPTIVE OPERATIONS FROM DIGITAL THREADS

Manifest weaves together digital threads that can capture, enhance and evolve operations across MRO stakeholders (Fig. 5). It creates the digital threads by using APIs to integrate with the most important sources of data, such as status of systems, sensor data, logistics systems, supply chain systems, and other partner systems.

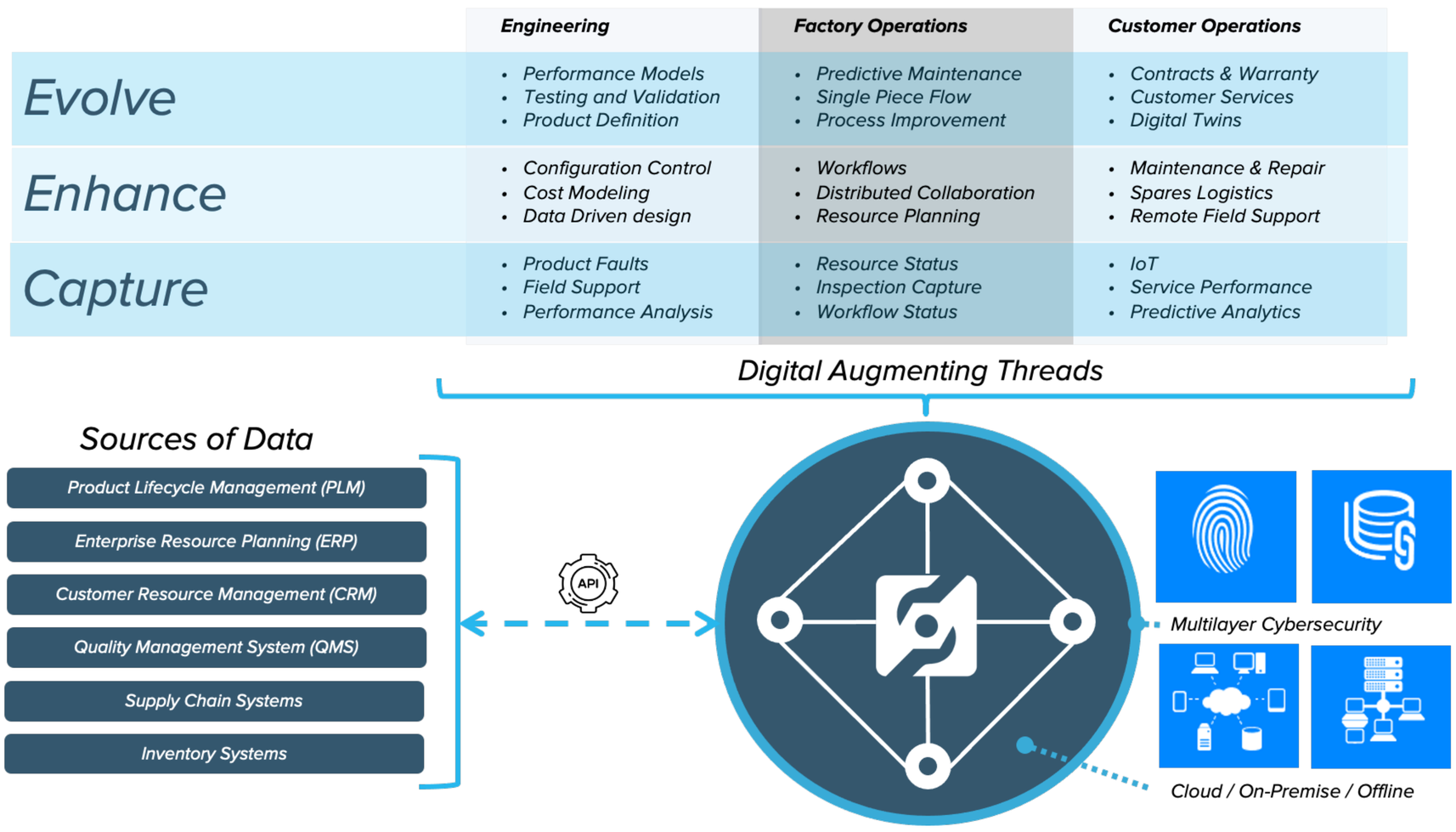


Figure 5: Manifest connects engineers and technicians with sources of data to create digital threads across MRO operations

HIGH-VALUE USE CASES

Manifest demonstrates highest value in complex and/or high-pressure scenarios, especially where systems of systems need to work flawlessly or when processes are sensitive, which makes it particularly valuable for many different organizations and efforts associated with MRO. Figure 6 combines these perspectives to suggest four high-value use cases: hardware setup & maintenance, dynamic workstreams and just-in-time training. Aircraft and components are growing in complexity and prevalence, making it difficult to maintain proficiency for those that must keep their knowledge current. Alternatively, managing distributed operations that involve flawless interaction between humans and aircraft and components is the nature of many MRO procedures where decisions must be framed correctly, good alternatives identified and the data available to support decision choice made available.

- Maintenance procedures for aircraft, components, and systems
- Inspection and fault reporting tasks for aircraft, components, and systems
- Technician troubleshooting tasks

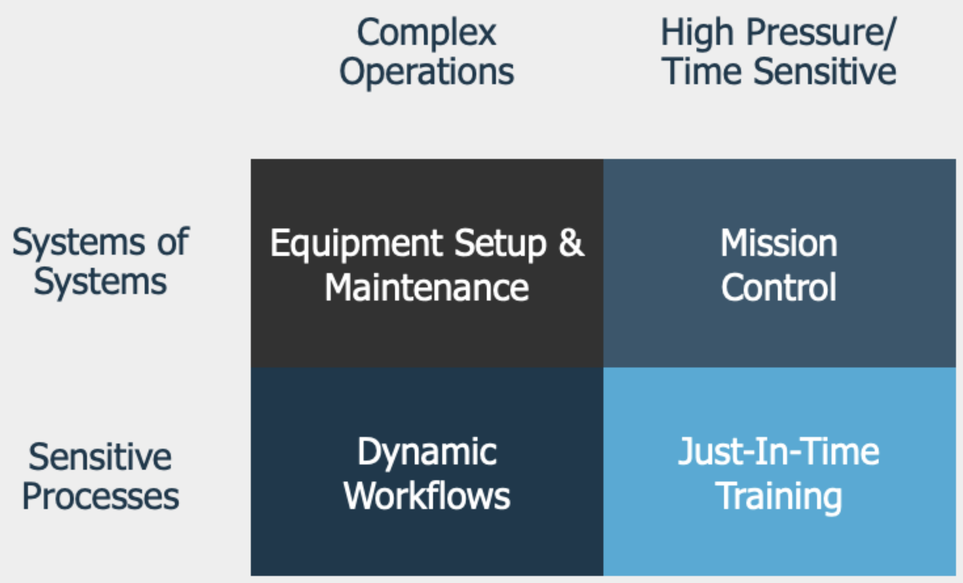
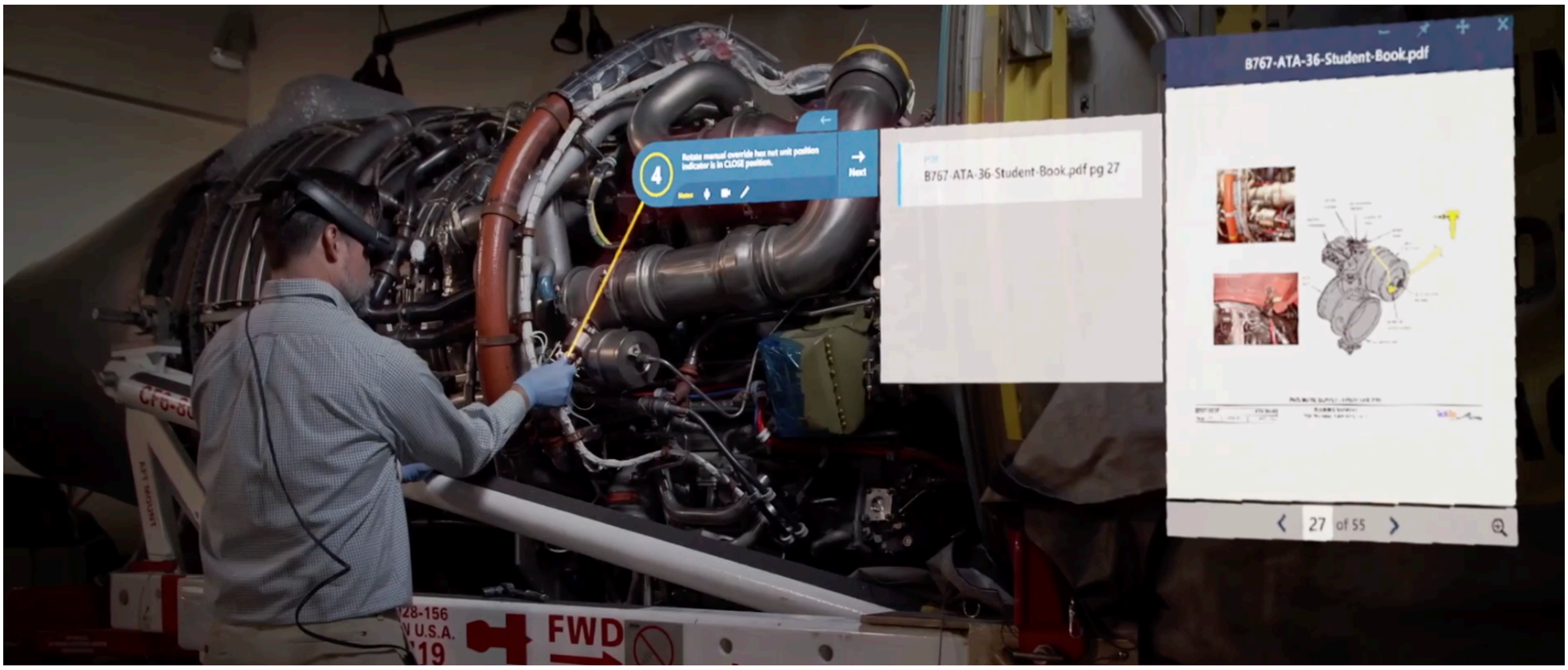


Figure 6: Manifest augments MRO technician's cognition and decreases cognitive stress in several scenarios



ABOUT TAQTILE

As companies around the world race to realize the promise of Industry 4.0, the deluge of new technology can be overwhelming and companies can struggle to understand where to begin. Taqtile, and our Manifest solution can provide a solid first step along the journey of fully digitizing operations by enabling deskless workers the ability to have their effort guided, chronicled and integrated digitally into backend systems, allowing for greater knowledge share, safety and efficiency in maintenance and production.

Experts matter. We believe the increasing complexity of industrial machinery, combined with retiring experts, means that experts matter more today than they ever have.We have made it our mission as a company to make everyone an expert and we accomplish this by giving them knowledge when and where they need it.

We make Manifest. A platform to harness, distribute and apply what you know. Manifest gives deskless workers instant virtual access to, and step-by-step guidance from, your most experienced technicians and trainers anywhere, anytime.

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Taqtile Website: https://taqtile.com/
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