Mixed Reality and the Multi-Capable Aircraft Maintainer

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ABSTRACT

As the Air Force postures aircraft maintenance manning requirements in a time of low retention of 5-level and 7-level maintainers and in an environment with a growing threat of becoming more contested, it has become vitally important to find ways to yield a greater return from the human capital investments the Air Force has already made. One such effort highlighted in Air Force Doctrine Note 1-21, Agile Combat Employment (ACE), is the employment of Multi-Capable Airmen (MCA) with a diverse foundational set of skills capable of performing tasks outside their core Air Force Specialty (AFS). The ability to field and sustain these diversely capable Airmen are the key to the success of the operational concept of ACE to support joint all-domain operations (JADO). When applied to aircraft maintenance there is no doubt that the MCA is vital to the success of ACE, but the truth is clear that the value of an MCA maintainer exists operationally in both peacetime and wartime environments with the sole question residing in how to properly grow and sustain an MCA maintainer in order to overcome the inherent risks of trying to do more with less. The purpose of this paper is to detail the application and value of Mixed Reality (MR) immersive technology as applied to aircraft maintenance MCA in peace and wartime operations. Through cost analysis and research, this project evaluated the potential to use MR technology to supplement on-site engineering and 7-level technical proficiency worldwide through the force projection of out of theater human resources, as well as its use in a contested environment through force projection and protection. Results lead to potential risk avoidance in MCA proficiency gaps through projecting expertise in existing human capital, the reduction in MCA training requirements and costs, as well as the suitability and scalability of MR technology in peace and wartime environments to other Air Force and Department of Defense specialties.

ABOUT THE AUTHOR

Captain Thomas O'Brien is the Maintenance Director of Operations for the 86th Maintenance Group (MXG). He enlisted into the Air Force in 2009 serving 5 years as an Avionics Test Station Specialist and 3 years as an F-35 Integrated Avionics Specialist. He was commissioned through Officer Training School in 2017 and has since acquired experience with the F-22, C-130J and Operational Support Aircraft. In his current capacity, he provides leadership in managing the 86 MXG's central agencies responsible for maintenance training, command and control, quality assurance as well as monitoring and developing long-range strategies of fleet management to sustain the health of the fleet for the 86 Airlift Wing (AW). Capt O'Brien holds a Bachelor of Arts in History from American Military University and an Applied Science degree in Aircraft Maintenance from the Community College of the Air Force.

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INTRODUCTION

In 2018, a Spark Tank idea on the incorporation of immersive technology in aircraft maintenance was presented to Air Force leaders in Orlando, Florida. Although not selected as the competition winner, then-Air Force Secretary Heather Wilson selected this idea to champion within the Air Force training environment. This event triggered the creation and evolution of the Member Operations Training Analytics and Reports (MOTAR) program within Air Education and Training Command's (AETC) serving as the focal point for the application of immersive technology within the Air Force learning environment (Air Force Magazine, 2022). In the years since, conversations regarding immersive technology and the integration it offers between the virtual and physical environment have largely centered on the training applications afforded by Augmented Reality (AR) and its digital overlay of the real-world environment, as well as Virtual Reality (VR) and its fully immersive digital environment (Intel, 2022). The application of these immersive technologies has led to widespread acceptance in many formal training environments. Even now, this innovation is continuing its evolution in training centers across the enterprise as organizations are finding ways to innovate their training practices to utilize immersive technology. While the value of immersive technology in training applications has already provided high gains, it is time to ask the question…What is next? Due to limitations in resources coupled with the dynamic shift in thought and subsequent preparation for operating in a contested environment, it is essential to shift the discussion regarding immersive technology in the training environment to identifying and executing its application in the operational environment. This technology is of paramount importance to accomplishing the "Accelerate Change or Lose" strategy set forth by Air Force Chief of Staff General Charles Q. Brown. Immersive technology is the evolutionary bridge in fundamentally challenging the operational concepts of our past and allowing the acceleration of instituting new concepts and capabilities to support not just a Multi-Capable Airmen (MCA), but a Joint All-Domain Warfighter required to win the nation's future fights.

PROBLEM STATEMENT

The concept of a Multi-Capable Airman, was created by Air Force Doctrine Note AFDD 1-21, *Agile Combat Employment*. Centralized on the thought of decentralized operational execution, Agile Combat Employment (ACE) is "a proactive and reactive operational scheme of maneuvers executed within threat timelines to increase resiliency and survivability while generating combat power throughout the integrated deterrence continuum (LeMay Center for Doctrine, 2021, p. 3)." The MCA serves as the bedrock of achieving this flexible posture without the significant increase in human capital costs. As the Air Force definition identifies, an MCA is an Airman that is capable of performing tasks beyond their assigned Air Force Specialty (AFS) (LeMay Center for Doctrine, 2021, p. 3). The model used to grow an MCA centers on the Cross-Utilization Training (CUT) model which focuses on training to the task proficiency required by the AFS for whom the task is required. For example, an aircraft crew chief is required to be proficient at mission generation tasks to include launching and recovering an aircraft, fueling an aircraft and performing both basic and advanced troubleshooting in response to aircraft system failures. In an ACE environment, non-aircraft maintenance AFSs such as a loadmaster or civil engineer would be required to train to a proficiency level on maintenance tasks to provide the flexibility of movement and supplement manning constraints created by having to support multiple dispersed locations. Aircraft maintenance is not alone in this requirement as ACE enablers include any AFSs necessary to "provide mission generation (MG), command and control, and base operating support (BOS) as mission dictates (LeMay Center for Doctrine, 2021, p. 4)."

Although the CUT model has proven successful in communities with similar AFSs, those selected to participate are generally hand-selected therefore guaranteeing a high level of success. When applying this concept outside similar communities, there is a fundamental concern when levying a required proficiency in expanding the tasks an MCA would be expected to perform. A study conducted by the RAND Corporation highlights this concern within the F-35 community's merged AFS concept. This study highlighted an inverse relationship between the increase of tasks and the resulting decrease in Airman proficiency. The researchers did identify a lack in standards for measuring proficiency but that the inverse relationship and skill decay were evident enough in their research to warrant concern that required addressing prior to employing a merged AFS concept (A. J. Wirth and T. Romano, 2020, p. 65). In light of these concerns, it is vitally important to understand the limitations in proficiency as applied to the expectations of the ACE concept. No one can argue with the necessity of ACE but how the Air Force defines and subsequently builds its MCA is key to the successful execution of ACE. In today's digital age, and the existence of immersive technology, one can better challenge the aging concept of the CUT model. By incorporating immersive technology, more specifically Mixed Reality, to bridge the gap between a capability and proficiency, the enterprise would be able to create the true flexibility needed to employ ACE in support of joint all-domain operations without increasing its risk or human capital investments.

Current Framework of Training

The current framework of training for most Air Force organizations still follows the traditional classroom model based on a combination of lecture and hands-on training. As immersive technology has increased in popularity, the largest application of immersive technology has focused on the use of VR during Air Education and Training Command (AETC) provided Initial Skills Training (IST) which incorporates AFS specific training after entry into the Air Force. This training is required for an individual to be awarded their 3-skill level (Department of the Air Force, 2020, p. 2). The incorporation of VR in the training environment of operational units has been hindered by the availability of resources required for the purchase of both system hardware as well as the development of learning modules. As such, the use of immersive technology in any form in the operational units is limited to those organizations that have prioritized their own funding to not only stand up the system requirements but also to fund module development. It should be noted that there are applications of the use of AR, such as Microsoft's HoloLens, in some units to support aircraft maintenance directly, but many of the efforts to utilize immersive technology primarily focus solely on the training environment.

As an example, the current training model at the 86th Maintenance Group (MXG) utilizes VR as a supplement to the training requirements of its technicians. Table 1 identifies the most common AFSs within the 86th MXG and the additional academic days required to bridge the gap between a member's initial skills training and their advanced skills training. The time represented in this table includes all current United States Air Forces in Europe – Air Forces Africa (USAFE-AFAFRICA) requirements for Field Training Detachment (FTD), On the Job Training (OJT) and Upgrade Training (UGT) courses required for an 86th MXG maintainer to obtain their respective 5- and 7-level certification in their assigned AFS. Of note, these times are subject to change annually as dictated by USAFE-AFAFRICA's Mandatory Course Listing (MCL) (Headquarters United States Air Forces in Europe, 2020).

Table 1. Advanced Skills Training Requirements (5- and 7-Level)

AFSC	AFSC Title	Training Time (Academic Days)
2A531	Airlift/Special Mission Aircraft Maintenance	40
2A631	Aerospace Propulsion	34
2A632	Aerospace Ground Equipment	N/A
2A634	Aircraft Fuel Systems	6
2A635	Aircraft Hydraulic Systems	35
2A636	Aircraft Electrical and Environmental Systems	75
2A731	Aircraft Metals Technology	N/A
2A732	Nondestructive Inspection	N/A
2A733	Aircraft Structural Maintenance	N/A
2A831	Mobility Air Forces Integrated Comm/Nav/Mission Sys	32

2A832	Mobility Air Forces Integrated Instrument & Flt Control Sys	43
2P031	Precision Measurement Equipment Laboratory	N/A
2R031	Maintenance Management Analysis	15
2R131	Maintenance Management Production	10

While the aforementioned Advanced Skills Training are based on the traditional classroom and lecture structure, the emergence of immersive technology has opened the door for the use of VR to support limitations in human capital associated with the availability of time and instructors. Across the Air Force, many of the different airframe communities are developing VR modules to expand their current supplemental use into a potentially more permanent replacement of the traditional classroom model. Included within this effort is the Air Force's C-130 community which includes the 86th MXG. Table 2 breaks down the current C-130 VR modules that have been developed.

Table 2. C-130J Virtual Reality Training Modules

Module Title
C-130J Aircraft Inspection (OPS)
C-130J Full Aircraft Jack
C-130J Pre-flight Inspection
C-130J Thru-flight Inspection
C-130J External Electrical Power and APU
C-130J Tire and Brake Removal and Install
C-130J Walk around

Cost Benefit Analysis

When considering the current framework of maintenance training and its application to the MCA concept, it is important to understand the costs associated with maintaining that status quo to get a better appreciation of the value associated with leveraging today's immersive technology to evolve not just the training process but the framework of operational execution. For a brief, 30,000-foot view, in its Fiscal Year (FY) 2022 budget request, the Air Force requested $491,286,000 for Specialized Skill Training. Table 3 drills down further into the costs of the Initial Skills Training for Mobility Air Force AFSs and the times associated with them (Headquarters Air Education and Training Command, 2019). These costs of time and money represents what it takes to build a 3-level technician in a given AFS. Putting this into perspective, with over 100,000 active duty and reserve maintainers, a conservative estimate of $50,000 per maintainer for Initial Skills Training represents a human capital investment of $5 Billion in support of the Air Force's largest enlisted AFS (U.S. Government Accountability Office, 2019). Now when added to the average costs for technician upgrade to 5- and 7-level, it becomes clearer that significant investment is made by the Air Force into its human capital. Protecting this investment becomes more necessary when matched with a career field such as aircraft maintenance that has historically higher attrition rates than other AFS.

Table 3. FY19 – Air Force Specialty Initial Skills Training Costs – Mobility Maintenance AFSs

AFSC	AFSC Title	Training Time (weeks)	Cost
2A531	Airlift/Special Mission Aircraft Maintenance	10.95 [2]	$83,540 [2]
2A631	Aerospace Propulsion	11.95 [2]	$47,042 [2]
2A632	Aerospace Ground Equipment	17.4	$52,821
2A634	Aircraft Fuel Systems	7.2	$42,005
2A635	Aircraft Hydraulic Systems	9.8	$44,708
2A636	Aircraft Electrical and Environmental Systems	17.4	$52,724

2A731	Aircraft Metals Technology	13.6	$48,791
2A732	Nondestructive Inspection	9.8	$45,658
2A733	Aircraft Structural Maintenance	15.8	$52,203
2A831	Mobility Air Forces Integrated Comm/Nav/Mission Sys	27.6 [2]	$63,476 [2]
2A832	Mobility Air Forces Integrated Instrument & Flt Control Sys	18 [2]	$53,872 [2]
2P031	Precision Measurement Equipment Laboratory	24.2	$62,655
2R031	Maintenance Management Analysis	11	$46,269
2R131	Maintenance Management Production	6.6	$41,510
*Note 1 – BMT costs included in AFSC Cost. *Note 2 – Derived from the average of all similar shreds of the same AFSC			

In addition to the human capital costs, the operating costs associated with aircraft maintenance are considerable. The costs identified in Table 4 represent the Fiscal Year 2022 cost per flying hour for various Mobility Air Force (MAF) airframes (Air Force Cost Analysis Agency, 2021). While these costs only represent the hourly flying costs there are multiple other costs associated with maintaining and repairing aircraft both at home-station as well as off-station. One of the more sizeable costs to consider are those required to repair aircraft that have broken off-station away from the logistical and technical support afforded by home-station operations. These repair events often require the deployment of Maintenance Recovery Teams (MRT) which are responsible for repairing the aircraft by either delivering parts to an onsite repair team, delivering parts and a skilled technician to perform the task or delivering just a skilled technician. As common as MRTs are, MAF has a special team in place known as Logistics Control (XOCL) which operates within the 618th Air Operations Center (AOC) and is tasked with initiating and controlling MRTs in support of expediting the repair of disabled mobility aircraft world-wide (Air Mobility Command, 2019, p. 4-5).

Table 4. Air Force Operating and Support (O&S) Cost by MDS

Mission Design Series (MDS)	FY22 Cost Per Flying Hour
C-5A/M	$20,208
C-17A	$16,298
C-40B/C	$7,729
C-130H	$9,046
C-130J	$5,336
KC-10A	$16,604
KC-46C	$8,538
KC-135R	$9,967
KC-135T	$9,780
HC-130N	$9,434

When trying to assign costs associated with MRTs, there are multiple variables to consider such as standard operating costs for recovery, manpower and support costs for repair as well as lost value due to aircraft down time resulting in mission delay or loss. While the operating and support costs are relatively easy to assign, the cost associated with the loss of mission capability is not as readily surmised. Table 5 below highlights key MRT data points connected to various Air Mobility Command MDSs from 2017 to 2022 and the total number of hours lost due to Non-Mission Capable conditions. Additionally, it identifies the reimbursable rate per flight hour for those airframes and the overall costs linked to the length of time the aircraft were broken (Office of the Under Secretary of Defense, 2021, p. 2-3).

Table 5. Air Mobility Command MRTs by MDS - 2017-2022

Mission Design Series (MDS)	Number or MRTs	Time Broken (Hours)	FY22 Reimbursable Rate Per Flight Hour	Loss Due to Aircraft Non-Mission Capable Status

C-5A/M	2,132	158,875	$30,961	$4,918,928,876
C-17A	6,374	225,833	$16,298	$3,680,626,234
C-40B/C	3	53	$7,729	$409,637
C-130H	144	10,761	$11,876	$127,797,636
C-130J	430	22,914	$6,131	$140,485,734
KC-10A	528	33,714	$16,673	$562,113,522
KC-46C	11	665	$9,201	$6,118,665
KC-135R	1,328	93,481	$15,703	$1,467,932,143
KC-135T	235	14,482	$15,516	$224,702,712
HC-130N	1	46	$9,782	$449,972

As transition of focus moves away from the costs associated with the current model of human capital investments and aircraft operations, it is important to realize that modernizing and innovating current practices to incorporate immersive technology into operational use does not replace the need for qualified technicians within the Air Force's inventory. Rather, immersive technology bridges both the physical and proficiency gaps for both normal operations and wartime contingencies as implied in an ACE construct. Not only is it impossible and impractical for the Air Force to guarantee enough proficient maintainers to meet all mission requirements wherever and whenever they are needed, it is also both impossible and impractical to expect a maintainer and non-maintainer alike to be proficient in all necessary mission generation (MG), command and control, and base operating support (BOS) tasks required to adequately meet the current framework of the ACE MCA. As such, a higher level of risk exists when applying current models to the modern concept of ACE. The question then must be asked, can one lower the risk while guaranteeing what seems both impossible and impractical?

As recent as a few years ago, the answer to the aforementioned question would be no. Without the Air Force increasing its manpower inventory and establishing a greater operational and logistical footprint, the risk would remain unchanged. However, both the rapid development and fielding of immersive technology makes answering this question to the positive much easier. As VR and AR have shown significant value in redefining the Air Force learning environment, MR now offers equal if not greater value in redefining the operational environment as it "merges real world and digital elements allowing the user to manipulate both physical and virtual items and environments (Intel, 2022)." The emergence of a growing level of competition has brought the ability and cost of investing in MR to a more attainable level. Table 6 highlights several varieties of both AR and MR that could be operationalized on a large scale within the Air Force maintenance community and approximate initial, off-the-shelf cost per unit.

Table 6. Off-the-Shelf AR & MR

Manufacturer	Model	Cost
Iristick	G2 PRO	$3,500
Microsoft	HoloLens 2	$3,500
Google	Glass Enterprise Edition 2	$1,139
Magic Leap	Magic Leap 1	$2,295
Vuzix	M400	$1,799
Epson	Moverio BT-40S	$999

The application of MR technology could be immediately used in day-to-day home-station operations to improve quality of maintenance through real time connectivity. It can serve as a mode of connection to engineers for real time point of view technical assistance rather than assistance reliant upon pictures, grainy video or trying to walk through what the technician is seeing over the phone. Additionally, MR can serve as a mode of connection to out-of-theater 7-level technicians to support manning constrained work centers and ACE MCA anytime, anywhere. The value of this capability to tap into the Air Force entire human capital, regardless of AFS, for world-wide projection is the single most important element to successfully operating in a contested environment that will allow not just the ability to degrade gracefully but also unlocks the ability of the MCA to become a joint all-domain technician, a true force multiplier.

FRAMEWORK

In its infancy, it is understandable that the concept of ACE must be flexible enough to evolve in both theory and execution. The need for this flexibility is captured by the authors of AFDN 1-21 adding a note to the working definitions of key terms to highlight the necessity to facilitate further discussion to best define what Air Force doctrine will eventually state (LeMay Center for Doctrine, 2021, p. 2). Therefore, in the spirit of further discussion, this author argues the doctrinal note definition of an MCA better fits with the concept of capability rather than proficiency and MR connects proficiency to capability. The framework to be discussed centers on the delineation between proficiency and capability as it pertains to an MCA. Only after the idea of proficiency is divorced from the requirement of capability can one realize the full lethality of ACE as well as the improved support in peacetime and wartime operations through the incorporation of immersive technology.

So, what defines a Multi-Capable Airman? The current AFDN 1-21 definition aligns with Merriam-Webster's definition of proficient which is someone that is "well advanced in an art, occupation, or branch of knowledge (Merriam-Webster, n.d.)." Through the CUT model, an MCA is trained to a required proficiency level in both their primary AFS as well as the tasks associated with mission generation, command and control and base operating support. Table 7 illustrates how the Air Force weighs AFS proficiency standards (Department of the Air Force, 2020, p. 21). In contrast to proficiency, Merriam-Webster simply defines capable as "having or showing general efficiency and ability (Merriam-Webster, n.d.)."

Table 7. AF AFS Proficiency Code Key

	Scale Value	Definition: The individual
Task Performance Levels	1	**IS EXTREMELY LIMITED** (Can do simple parts of the task. Needs to be told or shown how to do most of the task.
	2	**IS PARTIALLY PROFICIENT** (Can do most parts of the task. Needs only help on hardest parts.)
	3	**IS COMPETENT** (Can do all parts of the task. Needs only a spot check of completed work.)
	4	**IS HIGHLY PROFICIENT** (Can do the complete task quickly and accurately. Can tell or show others how to do the task.)
Task Knowledge Levels	a	**KNOWS NOMENCLATURE** (Can name parts, tools, and simple facts about the task.)
	b	**KNOWS PROCEDURES** (Can determine step-by-step procedures for doing the tasks.)
	c	**KNOWS OPERATING PRINCIPLES** (Can identify why and when the task must be done and why each step is needed.)
	d	**KNOWS ADVANCED THEORY** (Can predict, isolate, and resolve problems about the task.)
Subject Knowledge Levels	A	**KNOWS FACTS** (Can identify basic facts and terms about the subject.)
	B	**KNOWS PRINCIPLES** (Can identify relationship of basic facts and state general principles about the subject.)
	C	**KNOWS ANALYSIS** (Can analyze facts and principles and draw conclusions about the subject.)
	D	**KNOWS EVALUATION** (Can evaluate conditions and make proper decisions about the subject.)

How an MCA is defined allows one to better discuss the constraints and risks associated with both. To start with capability, it is easy to understand there is a high level of risk associated to a capable only Airman in aircraft maintenance. Using the scale in Table 7, a capable Airman would have very little task or subject knowledge and would only rate as a 1 or 2 in the task performance scale. These technicians do exist within the maintenance community and can be equated to individuals going through their initial skills training for their specialty or members assigned to non-maintenance MDSs. One would be assuming significant risks if relying solely on these Airmen to perform tasks unsupervised. Quite contrary to capability only, proficiency ensures a technician is knowledgeable in both task and subject and is capable at varying degrees to perform tasks unsupervised. Although proficiency implies greater capability, there are risks associated to proficiency. In the framework of current training requirements and actual task performance, there are multiple instances of 5- and 7-level technicians causing damage to aircraft and/or personnel due to errors in performance. Many variables have been said to play into these events such as task saturation, complacency, and skill decay because of not regularly performing the task. Either way, it is important to note that these risks exist.

MR Technology

Given the risks associated with both capability and proficiency, why then would proficiency not be the goal to reach when establishing the MCA concept? Quite honestly, an MCA concept built on capability opens the aperture of how the Air Force employs talent management without the added expense of significant human capital investments both in manning increases and increased proficiency training which is training "provided to personnel to increase their skills and knowledge beyond the minimum required for upgrade (Department of the Air Force, 2020, p. 3)." As the reliance on the MCA concept exist the greatest in the contested environment, what then will allow for the dynamic shift from proficiency to capability? It is the use of MR that allows for this shift in thought and begins to address the concerns highlighted in the F-35 RAND study referenced below.

Taking the digital overlay provided by AR, which would provide great value to the maintainer, MR technology's value lies in its ability to unite both the physical and digital environment allowing the user to interact in both realms to enhance both the knowledge and capability. Referring to Table 7's proficiency scale, MR creates an interactive environment that connects the user to task and subject knowledge to increase capability in task performance. In the absence of a required AFS technician, MR provides any user regardless of AFS that can perform a task the necessary tools for performing the needed tasks. Additionally, the technology would have the ability to connect to any human capital resource world-wide to provide real time assistance and validation of task performance. This action alone now transfers the risk acceptance from the aircraft commander and places it with a subject matter expert, effectively reducing the risks that would otherwise rest on the reliance of the one performing the tasks regardless of proficiency level. This capability afforded by MR technology now allows the foundation for defining an MCA to be based on capability rather than proficiency alone affording greater force projection and force protection when needed.

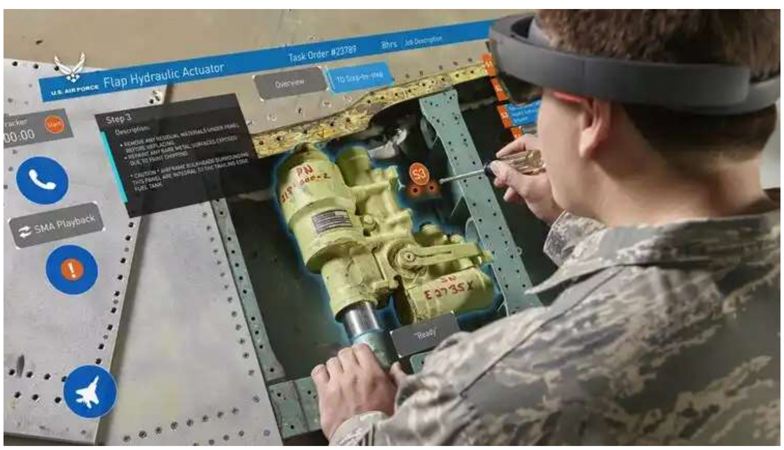

Figure 1. Inhance Digital, 2020, AFRL Aircraft MRO in HoloLens: USAF, Photograph.

CASE STUDY

Due to the infancy of the MCA concept, very little data exists to support either its current framework or potential evolution. Most organizations have been tasked with defining their own concept of ACE and MCA and as such they are developing their own requirement to fit their idea of what an MCA should be. The 86th MXG is one such organization that has not only established their local idea of an aircraft MCA, but they have also developed a course designed to "build" an MCA serving as Headquarters Air Force's first MAF MCA training concept. In addition to the advanced skills requirements highlighted in Table 1, the 86th MXG crafted an MCA development program meant to meet the mission generation expectation of the AFDN 1-21 ACE concept. Much like the current state of maintenance training, the foundation of this MCA program centers on the CUT concept which entails assigning additional tasks to a technician outside their assigned AFS. Table 8 illustrates what AFSs have already transited through the 86th MXG's MCA program and the additional tasks they had to gain proficiency in above their primary AFS. As a capstone of the program, the MCA in training will partner with an evaluator from the 86th Aircraft Maintenance Squadron for mission deployment during which time they will be evaluated on the skills they were taught during the classroom instruction. Upon mission return, if the member passed their evaluation, they will have graduated the MCA program. It is important to note that at this stage, the MCA course focuses on meeting the requirement for mission generation. Further course development will be necessary to meet all expectations and will include Airmen from non-maintenance AFSs.

Table 8. 86 MXG C-130J MCA Program

AFSC	Title	Air Force Specialty 5-Lvl Core Tasks	Number of Additional MCA Tasks
2A631	Aerospace Propulsion	85	32
2A632	Aerospace Ground Equipment	42	42
2A634	Aircraft Fuel Systems	79	30
2A635	Aircraft Hydraulic Systems	35	38
2A733	Aircraft Structural Maintenance	80	42

With an understanding that further course development is necessary, the 86th MXG continues to refine the course to best develop a repeatable and scalable process both inside and outside the maintenance community. In addition to course refinement, the 86th MXG plans to look at incorporating none maintenance AFSs into the course as it works to integrate base support as well as command and control tasks into the curriculum. In conjunction with this course development, the unit is working to acquire both AR and MR technology that would allow field testing immersive technology during normal off-station and dispersed ACE operations. Examples of this include providing MR to Flying Crew Chiefs (FCCs) as they travel with aircraft sent on multi-day missions throughout the European and African theaters as well as sending MR along with the unit's MCA trained members for ACE dispersal exercises. In both cases, and in the absence of real world situations, simulations can be used to have these maintainers perform 5- and 7-level tasks while utilizing immersive technology to communicate with the home unit. These current and future efforts are clearly meant to create a localize answer to the MCA question, but they also establish a framework with data points for future case studies that would provide insight into guiding the future of an enterprise-wide discussion.

CONCLUSION

There can be no doubt that value exists in the implementation of immersive technology within aircraft maintenance. As VR has dominated the discussion, there needs to be enterprise level expansion of support to include immediate use of VR and MR technology. While it is understandable that MR technology is still developing and further advancements in the technology are occurring rapidly, it is important to ensure the Air Force does not miss this opportunity to accelerate change in thought and practice. To help develop this conversation further and broaden the lens by which one views ACE and the MCA, a look at what efforts have been done and what efforts are ongoing are necessary to frame a united way forward for all.

Great insight was given by RAND in its study on the F-35 merged AFS concepts. This opened a much-needed conversation on the management of human capital and limitation that must be considered if expanding the capabilities of our constrained manning resources would be successful. This study subsequently also provided an early look at a potential framework for the MCA concept. This level of review is vital to improving current practices of talent management within the maintenance community and it would be highly recommended to replicate the framework of this study as data develops on the MCA concepts.

In addition to the RAND study, the current and future actions of the 86th MXG would add significant data for further research into this topic over the course of next 18 months. In this time their MCA course development as well as milestone success in incorporating non-maintainers would yield valuable insight into both the successes of the program as well as afford adjustment capabilities for the continued evolution of the MCA concept and provides scalability for increased versatility of an MCA concept that transcends both MDS and AFS.

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