

## Promoting Manufacturing Innovation

### Quad Cities Manufacturing Innovation Hub – Technology Playbooks

The Department of Defense's Office of Economic Adjustment Defense Industry Adjustment (OEA/DIA) grant has been crucial in maintaining global competitiveness and resiliency for the over 800 manufacturers and 1,200 Department of Defense (DoD) suppliers located within 90 miles of the Quad Cities (Illinois/Iowa). The goal of the region's Manufacturing Innovation Hub is to create an ecosystem that can help all manufacturers and others in the defense supply chain grow, diversify, stay competitive and to become leaders in manufacturing technology. OEA funds allowed the Hub to accelerate its initiatives, which included major research on vital manufacturing technologies and the implementation of programs and services critical to business resiliency and growth.

#### About the Technology Playbooks

Manufacturing accounts for more than 17 percent of employment in the region—double the national average. From creatively producing metals to innovatively using them to make world class products, the Quad Cities region's advanced manufacturing industry cluster has become an integral part of the DoD supply chain. These industries play a vital role in the regional economy, but they are facing changes in markets and the technologies critically needed for U.S. businesses to compete. A bold approach to help them grow, diversify, and remain competitive was needed – an ecosystem of 50+ partner organizations, called the Manufacturing Innovation Hub, was formed to support innovation and collaboration to drive growth in the region.<sup>1</sup>

Critical to the success of the Hub was the development of "Technology Playbooks". With OEA grant support, eight technology areas were identified as transformative for industry and the region. The areas were identified through an iterative, months-long Regional Technology Roadmap planning process involving interviews and focus groups with dozens of local manufacturers (large and small). Those transformative technologies identified included: Additive Manufacturing, Augmented Reality/Virtual Reality (AR/VR), Automation/Robotics, Computer-Aided Design & Manufacturing (CAD-CAM), Cybersecurity, Data/Analytics, Digital B2B Connection, and Enterprise Resource Planning (ERP). It was determined that an effective way to connect small and mid-size manufacturers and other firms with information on these vital manufacturing technologies was to provide a teaching tool – developed with the help of industry leaders with their fingers on the pulse of emerging technologies – to assist in learning about the changes that are and will transform the face of industry.

Each Technology Playbook is a "how-to guide" constructed to help businesses understand the technology, provide an overview of the current regional landscape, share best practices, identify opportunities for use, build the business case for, and outline steps toward implementation. Each playbook also contains links to expert resources and partners for training, education, integration, or other support to aid businesses. While topics differ from playbook to playbook, the basic format is similar between each one (see Figure 1).

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<sup>1</sup> For an overview of the Quad Cities Manufacturing Innovation Hub, watch the video:  
<https://www.youtube.com/watch?v=aVVgbfnozel&feature=youtu.be>

*Figure 1: Manufacturing Playbook Information Flow*



These “Technology Playbooks” (one for each technology area) are available on-line at:

<http://quadcitieschamber.com/playbooks>.

### **The OEA Investment and Expected Outcomes**

Each technology covered by the playbooks is potentially disruptive to the nation’s defense industrial base and national security. For example, Additive Manufacturing, the industrial version of 3-D printing, is an emerging technology that has the potential to revolutionize product realization on a global scale. Just since 2015, the global additive manufacturing has more than doubled to an estimated \$12.8 billion. By 2030, it is predicted that additive manufacturing technologies will enable companies to produce finished products on a large scale. For example, General Electric is making a radical departure from the way it has traditionally manufactured things. Its aviation division, the world’s largest supplier of jet engines, is preparing to produce a fuel nozzle for a new aircraft engine by printing the part with lasers rather than casting and welding the metal. GE chose the additive process for manufacturing the nozzles because it uses less material than conventional techniques. That reduces GE’s production costs and, because it makes the parts lighter, yields significant fuel savings for airlines.<sup>2</sup> This also has the potential to bring significant cost savings to DoD, as well as new types of weaponry and products supporting the warfighter. However, additive manufacturing requires GE’s supply chain, and other manufacturing firms, to adapt to this revolutionary technology. Together all eight of the technology playbooks uplift U.S. manufacturers and Department of Defense suppliers through increasing the understanding and investment in emerging technologies and to foster a culture of innovation in the manufacturing industry.

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<sup>2</sup> MIT Technology Review. *10 Breakthrough Technologies*. <https://www.technologyreview.com/s/513716/additive-manufacturing/>. Conventional techniques would require welding about 20 small pieces together, a labor-intensive process in which a high percentage of the material ends up being scrapped. Instead, the part will be built with a computer-controlled laser from a bed of cobalt-chromium powder.

# Developing the Workforce to Deploy Cold Spray Technology for DOD, its Contractors, and Commercial Uses

## University of Massachusetts – Lowell College of Engineering

The National Security Strategy seeks to rebuild US military readiness through business reforms, new partnerships, and a renewed commitment to a strong, resilient, and world-class defense industrial base. The Office of Economic Adjustment Defense Industry Adjustment program supports this mission by investing in a variety of initiatives, including the University of Massachusetts Lowell (UML) robotics program. The DIA investment specifically seeks to develop a new cadre of workers that can deploy advance manufacturing technologies that will help keep more high-value, lethal military assets (e.g., airplanes, helicopters, submarines, and ships) operational by reducing maintenance times and extending their service life.

The objective of the UML program is to create curriculum and train teachers that can help workers deploy cold spray technologies. Cold spray is an additive manufacturing process that attaches metal particulates (largely aluminum and magnesium) to a substrate at room temperatures. Using precision robotics, the particulates used to strengthen joinings and are diamond sanded to high tolerance levels to enable repairs of aviation, shipping, and submarines more efficiently than current high temperature joining technologies.

### About the Technology

Cold spray is cost-effective technique in replacing high value, high lead time gearboxes and housing components prone to corrosion and wear while in service. This can reduce the time that aircraft, submarine, or ships are out of service for repair. An environmentally friendly repair technology, the technology, the DOD Environmental Security Technology Certification Program (ESTCP) provided initial funding support for proof of concept. As the technology demonstrates its value, DOD is implementing cold spray more widely in its maintenance depots.

The technology has environmental benefits because it can reduce the need for magnesium, but it also demonstrates tremendous cost-savings to DOD. For instance, a 2015 study estimated annual cost savings at more than \$23 million -- a 9:1 benefit to cost ratio on DOD investments in the technology.<sup>1</sup> That analysis examined the benefits only to approved uses for the Bell H-1 helicopter, B-1 bomber, the Sikorsky UH-60 Black Hawk helicopter, the F-18 fighter jet, AH-64 Apache helicopter. This does not include the expansion of Service Life Extending Programs that would benefit from substantial reduction in the number of non-mission capable aircraft and other vehicles across the DOD. According to the U.S. Army Research Lab at Aberdeen Proving Grounds, DOD had approved the technology for 87 military components as of June 2017 and was reviewing 113 more approvals.<sup>2</sup> In addition, the Cold Spray Action team maintains that the technology's practical uses have grown such that the has entered the aerospace and defense market as an alternative solution distinct from thermal spray. Army Research Lab has also begun to identify commercial applications for the technology as well.

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<sup>1</sup> Thomas M. Pelsoci, PhD, "Benefit Cost Analysis: ESTCP Funded Cold Spray Technology for DOD Applications, Delta Research Company," August 14, 2015.

<sup>2</sup> [http://www.coldsprayteam.com/Champagne\\_VKC-CSAT%20Introduction-14%20June%202017-Final.pdf](http://www.coldsprayteam.com/Champagne_VKC-CSAT%20Introduction-14%20June%202017-Final.pdf)

## **The OEA Investment and Expected Outcomes**

Beyond materials, cold spray deployment also encompasses components of electromechanical robotics as cold spray application uses robotics arms to deposit the magnesium and aluminum materials with laser precision and micro-tolerances. As part of its OEA grant, U Mass Lowell is developing train-the-trainer certificates to prepare six instructors with the ability to teach 4- and 5-axis CNC machines, cold spray applications, and related CNC programming to help develop the workforce to manage and operate cold spray efforts both for DOD contractors as well as for future commercial uses. In support of this effort, the Army Research Lab is donating the first piece of equipment to UML and providing \$300,000 in funding to support the installation of the equipment and the development of the cold spray training program. The region already has one cold spray company that does business with DOD and the Army. UML expects not only that company to take advantage, but others across the country.

UML is collaborating with Penn State University to develop state-based training curricula that will ultimately be certified by the American Metal Society. In addition, with greater availability of the technology and workers skilled in deploying it, Massachusetts can be more responsive to other potential DOD uses. For instance, the Air Force Life Cycle Management Center is exploring use of cold spray technologies at Hanscom AFB to reduce maintenance time for two aircraft – the Boeing E-3 airborne warning and control system (AWACS) and Northrop Grumman E-8 Joint Surveillance Target Attack Radar System (Joint STARS). The goal is to reduce the amount of time the equipment is out of service for maintenance at the Lake Charles Maintenance and Modification Center (LCMMC).

UML expects to develop the curriculum and prepare trainers that can teach the technology to workers in Massachusetts for the benefit of DOD and its contractors. In addition, the technology's deployment will also create future opportunities to diversify those companies in support of US commercial aviation as well.

# Providing the Most Advanced Ballistic Concrete for DoD Training Facilities in Support of our Nation's Warfighters

## Amidon Inc., Wake Forest, North Carolina

Founded in 2006 and based in Wake Forest, North Carolina, Amidon Inc. provides products and services including training facilities and ranges, construction, historic preservation, professional services, and ballistic concrete. At the firm's peak, 85-90% of its business was from the Department of Defense and 100% was federal government. While the company initially specialized in residential construction, in 2008 it reinvented itself to move into federal contracting, expanding into training and then its signature product, ballistic concrete that features several patents. Over time, Amidon has reinvested in research and development, and the company now holds three patents for Amidon Ballistic Concrete (ABC). The product uses a unique forming technology for concrete curing that provides superior ballistic performance to valuable hard targets (e.g., seismic applications, protective solar transformers, etc.) compared to established ballistic concrete products. The ABC catches bullets (no ricochet), cures in a fraction of the time of standard concrete, and is 50% lighter than the competition.

## About the Technology

Amidon Ballistic Concrete® is a low maintenance, second generation ballistic concrete product developed by Amidon, Inc. It is used in live fire ranges and can absorb multiple different calibers of rounds to avoid ricochet and other hazards to the trainee. Amidon Ballistic Concrete® improves upon the properties of traditional Shock Absorbing Concrete (SACON®) in several ways. Amidon Ballistic Concrete® can be used for grenade houses and can stop multiple different size projectiles (9mm, 5.56mm, 7.62mm and .50 cal) making it useful for multipurpose training facilities and ranges. The mix design allows for higher vertical pours, which makes casting of larger blocks possible.

Furthermore, Amidon Ballistic Concrete® has a greater compressive strength, while still having the same bullet stopping capability, which makes for more stable structures and is safer for use in two story training structures. Amidon Ballistic Concrete® is environmentally friendly, containing additives that prevent lead leaching. Amidon has developed proprietary forms, a patented proprietary block design, and proprietary processes and procedures that allow for rapid and efficient production of Amidon Ballistic Concrete® blocks. Amidon has been awarded numerous contracts in support of the US Army and Marine Corps and in the construction of live fire buildings and villages using Amidon Ballistic Concrete including multiple contracts at Fort Bragg, NC, Fort Polk, LA, Twenty-Nine Palms Marine Corps Base, Fort Bliss, TX, and Fort Drum, NY.

Amidon offers a patented turnkey process for manufacturing ballistic concrete structures with exceptional ballistic performance and lower maintenance and lifecycle cost. Amidon's patent portfolio covers formulations, mixing and molding processes. Advantages of Amidon Ballistic Concrete include:

- Functions like standard concrete, but adds best-in-class ballistic protection
  - Stops 0.50 caliber rounds in 4-8 inches of penetration
  - Stops 5.56 mm M-16 rounds in 2 inches of penetration

- Enables forming of high vertical walls (up to 2-3 stories)
- Can be applied to existing structures as a retrofit solution
- Fast curing (in 20 hours vs. 28 days for standard concrete)
- Extremely durable
- Shock absorbing
- Is rapidly installed and repaired
- Low maintenance and life-cycle costs
- Sustainable
- Chemically aerated - no autoclaving
- 50% lighter than standard concrete
- Low carbon footprint compared to aerated autoclaved concrete

### The OEA Investment and Expected Outcomes

Amidon was forced to restructure because of sharp downturns in defense spending in recent years. The DIA pilot project enabled Amidon to evaluate the company objectively with expert guidance, examining the firm's competitiveness and deficiencies along with a clear assessment of competing firms in their market. While the timing was late to save the firm in its present incarnation, Amidon plans to re-open as a spinoff company within the next two years focused on selling their patented ABC ballistic concrete and their patented repair process. RTI has performed a Technology-Driven Market Intelligence (TDMI) analysis to identify new applications both commercially and with the Department of Defense, exploring ways to license the concrete product to reach new customers and markets.

Amidon is exploring options to continuously update their patents, for example by integrating carbon fiber into their ballistic concrete. They are working with the Department of Defense to ensure that their products meet the specifications and certifications required while protecting their patent and improving their technology to ensure continued superiority in the field. Because of ABC's technical superiority, survival of Amidon has implications for DOD's ability to protect critical infrastructure.

Amidon Ballistic Concrete has proven critical to the safe, effective, and most advanced live fire training to light infantry, special operations, and the U.S. Marine Corps. Participating in this pilot project has enhanced Amidon's resiliency in light of changes in Defense spending, and their continued operation impacts troop readiness via training and increases the combat lethality of our nation's warfighters.



Figure 1. MOUT Village, US Marine Corps Base, Twenty-Nine Palms, California

# Providing Warfighters with the Capability for Airborne Insertion

## Mills Manufacturing, Asheville, North Carolina

Airborne forces are military units set up to be moved by aircraft and dropped into battle, typically by parachute. Thus, they can be placed behind enemy lines and have the capability to deploy almost anywhere with little warning. The formations are limited only by the number and size of their aircraft, so given enough capacity a huge force can appear "out of nowhere" in minutes. The lethality of being able to rapidly insert airborne forces (special operations, light infantry, etc.) around the world on short notice is critical to the combatant commands or warfighters to deter enemy forces or respond to global contingency operations.

Mills Manufacturing is one of the critical manufacturers producing specialized components for the military to ensure troop readiness. As one of the three primary companies that manufactures military parachutes, Mills provides parachutes to all services of the Department of Defense (DoD) and selected allies. Mills is the oldest continuously American owned trusted supplier of military parachute systems that include airborne troop parachutes, cargo parachutes, deceleration parachutes, extraction parachutes, and emergency parachutes.

### About the Technology

Mills Manufacturing produces highly engineered, technical "cut and sewn products" such as parachutes for the military. They have a specialized expertise in personnel and equipment that has produced high quality products that meet military specifications for decades. The number of companies on the DOD qualified supplier list for cut and sew has dwindled from five (five years ago) to two now; developing employees with these specialized sewing skills is critical to meeting increased DOD demand. Mills manufactures:

Airborne Troop Parachutes - Mills has manufactured T-10 troop personnel parachutes since the early 1950s. Mills manufactures all models of the T-10 and MC1 series parachute assemblies and reserve systems. Mills is also approved to manufacture the MC-6 and T-11 parachutes for DoD.

Cargo Parachutes - Mills Manufacturing is one of the premier providers of cargo parachutes in the U.S. Used by each branch of the armed forces, cargo delivery systems deliver both light and heavy goods, such as ammunition and vehicles, to drop-zones where they are in high demand. Cargo parachutes can carry anywhere between 100 and 42,000 pounds, made with the most advanced cargo delivery technology. Mills manufactures many of the cargo parachute assemblies developed in the late 1940s and early 1950s (G-11, G-12) which remain the mainstay of airdrop and recovery operations.

Deceleration Parachutes - Also known as drag or braking parachutes, deceleration parachutes are used to slow down the speed of aircraft or other vehicles. Drag parachutes are effective for landings on wet or icy runways and for high speed emergency landing. Initially developed for use under such conditions, these parachutes proved so effective that they are now used for all landings, resulting in a substantial reduction in tire and brake wear. Most deceleration parachutes Mills manufactures (the 16-foot F-4 and the 15-foot F-5 parachutes) are procured by the U.S. Air Force and many NATO countries.



Extraction Parachutes - Helping to pull loads from airplanes, extraction parachutes are crucial in getting supplies and equipment to where they're needed most. Extraction parachutes are manufactured by Mills in several configurations, such as the 15-foot and 22-foot extraction canopies.

Emergency Parachutes - Emergency parachutes, also known as ejection seat parachutes or pilot emergency chutes, are critical components for aircraft pilot safety.

### The OEA Investment and Expected Outcomes

In March 2017, the Office of Economic Adjustment Defense Industry Adjustment Initiative awarded North Carolina State University (NCSU) and the North Carolina Department of Military and Veterans Affairs (NCDMVA) a \$2.2 million planning grant to conduct the first supply chain mapping of the North Carolina defense industry and complete a 10-company pilot project to assist small to medium defense contractors to grow and diversify into the commercial sector to increase resiliency within the defense supply chain.

Mills Manufacturing came to the North Carolina Defense Industry Diversification Initiative (NCDIDI) in search of diversification opportunities to reduce reliance on military spending. The pilot program helped the company identify opportunities based on their technical and engineered sewing capabilities, narrowing to a few markets and companies that were most promising. Mills completed a Technology-Driven Market Intelligence (TDMI) project with RTI International, completed an ISO update from North Carolina State's Industry Extension Services (IES), and completed Lean training from IES.

However, the timing wasn't right for diversification activities, as the military spending cycle once again ramped up and the company found itself challenged to meet increased DoD demand. The Lean training from IES has streamlined operations and reduced unit labor costs for flare chutes by more than half. This is essential to ensuring that Mills can efficiently and profitably respond to increased demand.

IES and NCDMVA will continue to work with Mills during execution of the upcoming OEA implementation grant and assist in increasing company productivity and identifying commercial market opportunities for Mills to grow and diversify. Moreover they will continue to help Mills develop employees with the specialized sewing skills and remain a reliable manufacturer in the DoD supply chain that is critical to ensuring the success of our nation's airborne forces.



*Figure 1. Brigadier General Linda Hurry, Commander, Defense Supply Center and Defense Logistics Agency Aviation, Richmond, Virginia speaking on August 16, 2018 at the North Carolina Military Business Center Aerospace Summit about the critical role of Mills Manufacturing in the defense industry supply chain.*



## Meeting Workforce Demand for Cybersecurity Preparedness

### Southeast Michigan Cyber Ranges – Pinckney High PCTI and Wayne State ATEC

The Office of Economic Adjustment Defense Industry Adjustment program supported Southeast Michigan's effort to meet the high demand for cybersecurity professionals in the region. There, employer demand for frontline cybersecurity occupations has increased four-fold in recent years. Demand is currently at an all-time high in the 13-county region that includes Detroit, Flint, Pontiac, Lansing, and Ann Arbor with 5,072 job postings.<sup>1</sup> A global shortfall of 1.8 million skilled cybersecurity workers is predicted by 2022 impacting defense and all major economic sectors. A significant shortage or mismatch of workforce talent can drive up business costs and inhibit growth strategies for companies, thereby weakening military operations and the nation's defense industrial base workforce. With OEA funds, Southeast Michigan developed two new cyber range facilities and Merit Secure Sandbox<sup>2</sup> testing centers in the region. These ranges help build the skill levels of the regional workforce to meet the growing defense and commercial job opportunities.

#### About the Cyber Ranges

One of the ranges supported with the OEA grant is the Pinckney Cyber Training Institute (PCTI), the state's only cyber range connected to a high school. Pinckney Community High School repurposed 5,000 square-feet of space in the school to support the new cyber range facility. Now, students in high school and college, along with IT professionals, can complete hands-on cybersecurity coursework, exercises, and labs through the institute. High school students can earn 12 to 18 college credits toward a cyber degree through the institute, having credit transfer agreements in place with Washtenaw Community College and Eastern Michigan University. The programs offered at PCTI lead to 22 different government-recognized and required certifications. The facility will significantly increase the supply of qualified cybersecurity workforce talent in the region and across Michigan. The cybersecurity courses offered at the Pinckney Cyber Training Institute also align with DoD's 8140/8570 standards and the National Initiative for Cyber Security Education Framework (NICE). Therefore, PCTI provides the means for any organization working to secure government contracts to complete the mandate. Also, being connected to a secure sandbox provides businesses a platform for software and product testing. A second cyber range, offering courses aimed at university students along with services to businesses, was established with the support of OEA funds at Wayne State University. This is the new WSU Cyber Range located at the university's Advanced Technology Education Center in Warren. Besides ADMC, the Michigan National Guard has been an important partner in support of the state's new cyber ranges. Another important partner has been Opportunity Detroit Tech (ODT), which is a partnership of 30-40 IT companies in Southeast Michigan that come together to explore talent needs and incubate career

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<sup>1</sup> WIN Cybersecurity Skills Gap Analysis, July 2017

<sup>2</sup> Located in a virtual cloud, the Merit Secure Sandbox simulates a real-world networked environment with virtual machines that act as web servers, mail servers, and other types of machines. Users can add preconfigured virtual machines or build their own virtual machines. Access to the Sandbox is provided through a web browser or VMware's View client from any location.

awareness and other solutions to address various IT-related skills gaps. ODT is an important connection to IT employers in the region.

### **The OEA Investment and Expected Outcomes**

As the modern world becomes more and more fused with information systems, those systems become a legitimate target for military operations. DoD faces continuing concerns about recruiting the types of individuals who would excel in the cybersecurity mission, needing many information security specialists stationed around the world, at military installations and in postings with partner governments.<sup>3</sup> Likewise all DoD contractors that process, store or transmit Controlled Unclassified Information (CUI) must meet the Defense Federal Acquisition Regulation Supplement (DFARS) minimum security standards. Tens of thousands of U.S. businesses now need access to specialized experience in the cybersecurity field.<sup>4</sup> The cyber ranges in Southeast Michigan help meet these demands for cybersecurity preparedness. They already have graduated capacity to reduce existing demand by 1% in the region and are scalable to meet more.

Both ranges (Pinckney High School [PCTI] and Wayne State University ATEC) are fully operational and sustainable. The hub at Pinckney High School (PCTI) has partnered with the following list of companies for a variety of reasons, including technical support, guest speakers, working with students on projects, etc.: Bulldog IT, SoarTech, Worksighted, Ford Motor Company, Duo Security, Lowry Solutions, Work Skills, Mobile Comply, Blue Cross Blue Shield, and Fifth Third Bank. In 2017, PCTI enrolled 63 people in cyber range exercises and 106 people in community workshops. In 2017-2018, 36 students were enrolled in courses and 332 students attended field trips or guest speaker engagements. Enrollment in Cyber Camps, CyberPatriot teams in both the middle and high school, and dual enrolled at Eastern Michigan University have all increased, as well as engagement with alumni employers in the region.

To date, the hub at Wayne State University has focused their efforts on undergraduate and graduate student populations. Over 70 students have taken courses and over 50 have obtained at least one of the following industry certifications: 1. Ethical Computer Hacking – C)PEH / Certified Professional Ethical Hacker; 2. Digital and Network Forensics – C)DFE / Certified Digital Forensics Examiner and C)NFE/ Certified Network Forensics Examiner; 3. Network Penetration Testing – C)PTE / Certified Penetration Testing Engineer; and 4. Introduction to Applied Cyber Security – C)ISSP / Certified Information Systems Security Professional. WSU has also held several events in partnership with other groups and associations to promote their programs and offerings. These include Utica Schools, SAE, Macomb County, Macomb Community College, MAGMA, PTACs of Michigan, and Michigan Manufacturing Technology Center. Lastly, they are participating with Macomb County's efforts to create a cyber career pathway.

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<sup>3</sup> Besides military personnel, DoD fields civilian cybersecurity teams, which now make up some 20 percent of the force. These teams primarily come from the Defense Information Services Agency.

<sup>4</sup> The Congressional Research Service estimated that DOD contracted with more than 50,000 companies. This number does not include subcontracts let by the primes themselves.

# Marking Appliance Reusable Chemiluminescence – Infrared (MARC IR) Technology

## Wright-Patterson Air Force Base – Air Force Research Laboratory

The Office of Economic Adjustment Defense Industry Adjustment program is supporting the Air Force Research Laboratory (AFRL) at Wright-Patterson Air Force Base to develop affordable warfighting technologies and capabilities to the United States air, space, and cyberspace forces. The goal is to expand the region's R&D capabilities, develop and produce market ready technologies in both defense and non-defense markets.

Through these efforts, the AFRL has taken the initial steps to address the issue of single-usage of traditional glow sticks, more commonly referred to as "chemlights", meaning that users in the field may have to carry hundreds of them to accomplish a singular task. Glow sticks have various military applications, such as directing vehicles or providing emergency lighting, or the fluid inside can be splashed onto a surface to mark routes or positions. Furthermore, glow sticks are widely available on commercial markets.

AFRL identified a pressure activated chemiluminescent material that would improve the glow stick technology. AFRL sought entrepreneurs to develop the technology into a product that could help the warfighter to create a battlefield advantage for the warfighter. Battle Sight Technologies took the opportunity and invented the MARC-IR (Marking Appliance Reusable Chemiluminescence – Infrared), a reusable pressure-activated "pen" that brings a glowstick-type reaction to a writing instrument that is only visible by infrared night-vision goggles.

### About the Technology

Battle Sight has identified a significant market opportunity by replacing current glow sticks with a new glow stick marker that can be reused. Soldiers, police officers, and first responders currently use glow sticks to mark rooms that have been cleared. These glow sticks are inefficient (because they cannot be reused) and unpredictable (because the mark can easily be detected by adversaries with widely available night vision technologies). Because they cannot be reused, it is bulky to carry many more than may be needed for a particular use.

Battle Sight uses Marking Appliance Reusable Chemiluminescence – Infrared (MARC IR) technology, which is a pressure-activated chemiluminescence writing instrument that works well in low-light and no-light conditions. It also has the capability to be invisible to enemy combatants. The MARC IR improves communication, increase speed when every second counts, reduce weight and waste, and minimize cost. This technology increases safety and gives an advantage to warfighters, law enforcement officers, and first responders by making a clear way for those who follow them.

### The OEA Investment and Expected Outcomes

The MARC IR product gives DoD a potential cost savings of about 80-90%. Currently, for safety reasons, glow sticks are not reused. Currently, DoD buys 15.6 million individual glow sticks at an estimated unit price of \$1.72. A single reusable MARC IR, at a price of \$69 per glow stick, would replace about 200 units

of those individual glow sticks. In addition to the cost savings for the product, it also reduces waste that glow sticks produce by 99.9%<sup>1</sup> and reduces the costs associated with glow stick waste management.

The Battle Sight product, MARC IR, provides U.S. forces with a technological superiority because it offers combatants the capability of writing messages on objects that are invisible to the naked eye or to any other technology that is not within infrared spectrums read by R night vision goggles. This puts the U.S. war fighter at an advantage to mark doors to rooms that have been cleared, providing a clear and safe form of communication to for those who follow them. The product also reduces the number of glow sticks that the war fighter needs to carry in the field and can help to reduce the time required to clear and mark a room by 7 seconds – a number than can add up quickly to many minutes in urban buildings.

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<sup>1</sup> <https://battlesighttech.com/products/>

# Emergency Management– Multi-Modal Communication System

## Wright-Patterson Air Force Base – Air Force Research Laboratory

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Through the technology developed by the AFRL, GlobalFlyte has created a cloud-based service that is compatible with existing incident response hardware. The software is integrated with mapping, imaging and smartphone technologies that enables individuals to listen to multiple radio channels at once. This platform is as useful to a small police or fire department as it is to a major urban disaster response agency. With no new equipment to purchase, GlobalFlyte works seamlessly with existing technologies to provide one cohesive incident response system.

The GlobalFlyte technology deploys a multimodal strategy as a way to ensure that first responders and their partners see and respond to vital messages. "Multimodal" means that communications systems provide messages through multiple forms, including traditional two-way radio, phones, computer desktop alert, mobile messages, and email. The idea is that messages – especially voice messages – are clearly communicated through multiple means in case messages get lost, servers fail, or messages are garbled in transmission. By using multimodal means, recipients increase their receivers' comprehension and reduce time repeating messages.

### About the Technology

GlobalFlyte improves on multi-modal communication solutions by providing 3D separation of radio channels. The technology offers simultaneous audio transcription with comprehension rates of 70 percent. So, written documentation of verbal communications is available immediately. The painstaking time required to generate after-action reports can be greatly reduced as the technology has already recorded and transcribed all radio traffic related to the incident.

The technology is being developed in partnership with ESRI (using their base map) and Minute Man application (to provide a smartphone application that makes the technology available for use in the field of operations). The user has the control to choose keywords-such as mayday, bomb, house fire, traffic accident, to significantly decrease time delays and improve situational awareness. This application addresses major concerns during combat, where multiple parties may be talking simultaneously, which can cause dialog to become indistinguishable, resulting in time wasted by constant repetition, potential communication misunderstanding, and the potential loss of critical data.

### The OEA Investment and Expected Outcomes

AFRL developed GlobalFlyte's multi-modal communication solution to address a major concern during combat. According to studies by AFRL, spatially separating the voice channels increases intelligibility by 30-40%<sup>1</sup>, by adding built-in transcription the overall comprehension increased up to 70%. In combat

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<sup>1</sup> <https://globalflyte.com/multi-modal/>

situations, multi-modal communications can reduce the likelihood that repeated messages will delay emergency personnel. The increased accuracy and reduced time associated with communications can mean vital seconds that could save lives.

For military operations, real-time planning, coordination, and directives must be transmitted to several operators to properly carry out their mission. The accuracy of the GlobalFlyte transcriptions caught the attention of the US military and National Guard, who now utilize this platform.

# Supporting Growth of the Texas Innovation Ecosystem for Defense

## MassChallenge Texas

The Office of Economic Adjustment's DIA program is supporting the development of the MassChallenge Texas (MCTX) business accelerator program. Entrepreneurs can efficiently access resources through MCTX to improve their odds of startup and survival. Without the jobs created by business startups, yearly employment growth in the U.S. would be negative.<sup>1</sup> Micro firms with one to four employees were especially significant, accounting for an average of 20 percent of new jobs each year. Business startups are also an important source for technological innovation - innovative ideas are what makes startups competitive. MassChallenge is a particularly effective model to support new businesses and their innovative ideas, linking to a global network of zero-equity startup accelerators. Headquartered in the United States with locations in Boston, Israel, Mexico, Switzerland, UK, and now Texas. An MIT study found that startups that participate in MassChallenge are 2.5x more likely to raise at least \$500,000 in funding and 3 times more likely to reach at least 15 employees.<sup>2</sup> For Texas, the goals for establishing MCTX are to enable new business growth, expand the state's R&D capabilities, and develop market ready technologies in both defense and non-defense markets.

### About MCTX Services

Collaboration and connection are essential to innovation. It is rare that a startup embarks on the entrepreneurial journey alone - it takes a network, and it takes a community. The first MCTX location is in Austin. MCTX entered the Texas startup scene in 2017 with a launch event in mid-October at the Bob Bullock Texas State History Museum. The launch was followed by a 7-week intensive roadshow across the state where the organization connected with thousands of entrepreneurs across eight cities, made 73 community partners, held 37 events, and several webinars. This was done to better learn about each area of the state: their current activities, their successes, their failures, and most importantly where they hope to go in the future. MCTX's conclusion is there exists a tremendous opportunity to make Texas one of the best innovation ecosystems in the world. MCTX secured five founding partners (Southwest Airlines, USAA, TMAC via OEA, Upstream, and Wework), more than 100 community partners, 16 event supporters, two corporate partners, and one media partnership. The Masschallenge model calls for applications to be submitted from promising startups to then be reviewed by an expert panel and a cohort selected to come to Austin and receive intensive support services. Applications are accepted from across the globe. For the inaugural MCTX class, 527 applications were received with 84 startups invited to Austin to help launch their business ventures. The startups invited to Austin were exposed to curriculum and mentorship, refined their business strategies, explored new pilot opportunities, and connected with state and global partners. The startups from the inaugural MCTX cohort represent 5 continents, 11 countries, 12 states, 5 major Texas metropolitan areas, and are 32 percent female founded. They support five major industries, including high tech, healthcare and life sciences, general consumer, social impact, and energy and clean tech. MCTX also awarded \$500,000 to eight of the highest-impact startups from the accelerator program. Announced at an Awards Ceremony

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<sup>1</sup> Kauffman Foundation and US Census Bureau data

<sup>2</sup> See <https://readymag.com/MassChallenge/Impact-2017/3/>



held at the Hyatt Regency Austin in August 2018, this was the top of the class form 84 of the world's highest potential, early-stage startups.

### **The OEA Investment and Expected Outcomes**

Multiple startups in the inaugural MCTX class give DoD the potential for cost savings, and access to new technology and technological superiority. MassChallenge is not defense-specific, but a number of the companies they work with have dual-use technologies. In addition, there is the potential in MassChallenge's vertical "tracks" to effectively provide global tech scouting for specific technologies of interest to DoD's development needs, including the "Big Six" modernization priorities. For example, Sempulse, a member of the inaugural MCTX class, has a patented lightweight wireless, non-invasive vital signs sensor that adheres to back of the ear and acquires patients' 5 major vital signs – cuffless blood pressure, pulse oximetry, heart rate, respiratory rate, and core body temperature, plus GPS for use anywhere. The product helps save valuable minutes for soldier triage which holds the possibility of saving thousands of lives. Over 50 percent of the U.S. fatalities in Iraq and Afghanistan were deemed "potentially survivable". Sempulse is working with U.S. Special Operations Command (SOCOM) on user testing. Company leadership credits MCTX with providing effective mentorship (e.g., advice on securing FDA approval), exposure to funders (e.g., including a \$100k cash prize from MCTX), and new relationships leading to new opportunities (e.g., introductions leading to meetings with NATO and the French military). This is but one example. Because MassChallenge companies are based on market-driven opportunities, differentiated advantages are matched against the market segments based on current conditions, not historic business trends. New defense technologies can be developed, while older defense technologies may find new life in alternate commercial markets worldwide, or by having high-growth companies become valuable strategic partners for companies that have traditionally been defense-focused. The state's long-term plan is to have three full-sized MassChallenge hubs in Texas (Austin/San Antonio, Houston, and Dallas/Fort Worth) in operation by 2021, launching 128 companies each annually (384 total), and then extend "bridge" programs to the outlying areas of the state. Additionally, a portion of the Austin/San Antonio hub will be focused entirely on commercialization and acceleration of cybersecurity technologies.

# Damage Tolerance of Composite Scarf Repair

## University of Utah, Utah Composites Laboratory

The Office of Economic Adjustment Defense Industry Adjustment program is supporting the Utah Advanced Materials and Manufacturing Initiative (UAMMI) in the development of a supply chain map of the Utah composites ecosystem with the goal of identifying economic diversification opportunities in the industry. One key aspect of the supply chain map is tracking the ongoing research and development activities in the cluster. It is where industry can go to find researchers to help solve their issues. Through the supply chain efforts, UAMMI discovered a significant need for applied research in damage tolerance of composite repair, i.e. how well it holds up. With increasing numbers of composite-intensive aircraft entering service, damage repair strategies are of great importance. While there is a fair amount of activity focused on improving the repair technologies, it is important to understand how tolerant those repairs are to damage. This information will help maintainers determine the effectiveness of repairing a specific defect; given the skill and material costs of repairs it may be determined that the repair action may cause more damage than the actual defect.

### **About the Technology**

UAMMI connected the University of Utah's Utah Composites Laboratory (UCL) and the Air Force Research Laboratory (AFRL) to study the effectiveness of composite repair, resulting in a \$1M contract. UCL will use AFRL's in-house research code B-Spline Analysis Method (BSAM) for the simulation of damage in a variety of idealized composite geometries and damage states. Repair methods used in composite structures differ significantly from those used for metallic structures. Whereas metallic structures are typically repaired by bolted, riveted, or bonded patches, composite structures are commonly repaired by scarfing out the damaged area and filling the scarfed area with layers of composite material that produce the same stiffness as the material removed. However, an important aspect of composite scarf repair is the ability to understand damage progressions and failure modes to instill confidence that the repaired structure will function as intended. This project will extend the use of BSAM beyond the research realm, by applying it to sustainment engineering problems supporting the United States Air Force's mission.

### **The OEA Investment and Expected Outcomes**

Through the connection made between UCL and AFRL initiated by Utah's OEA grant, the potential for DoD cost savings is substantial. The Office of the Assistant Secretary of Defense for Logistics and Material Readiness recently stated that DoD spends an estimated \$600M+/year on composite material maintenance and repair. Currently, there is no way to know if the repair activity is beneficial, detrimental, or even unnecessary. UCL's project can solve this quandary with great benefit to DoD. For example, if the method is eventually used to determine that just 10% of the repairs completed today are either detrimental or unnecessary, the result would be a \$60M/year savings across the DoD.

## Wichita State University OEA DIA Project Case Study

The Department of Defense's new National Security Strategy places great emphasis on rebuilding US military readiness via a host of strategies, including business reforms, new partnerships, and a renewed commitment to a strong, resilient, and world-class defense industrial base. Via its DIA program, the Office of Economic Adjustment is making critical investments to support these missions. Its investments to enhance capacity at Wichita State University's National Institute for Aviation Research reflect these priorities.

Wichita, KS is an historic center of innovation for the global aerospace industry, dubbed the Air Capital of the World. It was home of the first commercially produced aircraft, and spawned major industry players like Beech, Boeing, and Cessna. The area's aerospace assets remain strong today, hosting major companies and major research centers, including the National Institute for Aviation Research (NIAR) at Wichita State University (WSU).

First opened in the 1980s, NIAR remains a crown jewel in Wichita's strong aerospace and defense cluster. It maintains world class capabilities in a number of areas, such as aerodynamics, virtual reality, and computational mechanics. It also hosts four Centers of Excellence, with specializations in composites and advanced materials, airworthiness, safety, and aviation research.

With funding and support from the US Economic Development Administration and the DoD Office of Economic Adjustment, WSU has built out its Experiential Engineering Lab. With new equipment and capacities, NIAR can now offer new host of new services to local manufacturing firms. These facilities are a centerpiece of WSU's new Innovation Campus.

NIAR has developed close partnerships with the military services, and major OEMs such as Boeing and Lockheed-Martin. These partnerships have helped pioneer new technologies that enhance military capabilities while saving taxpayer dollars as well. Thanks to support from the OEA, NIAR's research expertise, equipment and capabilities are now available to smaller manufacturers, operating in both defense and commercial markets. These investments have been used to purchase equipment and expand NIAR's service offerings in two core areas:

1. Electromagnetic effects: How to protect systems and components from electromagnetic-related attacks or hacking, and
2. Design to Build: How to develop new approaches that reduce the lifecycles for moving from product design to final production.

As cell phones and other communications device become commonplace on aircraft, the potential dangers of electromagnetic disruptions are growing. Facilities like NIAR allow contractors to test equipment and components to the most rigorous standards on equipment that no small firm could afford to purchase. For example, NIAR operates a facility that simulates the effects of direct lightning strikes on aircraft or related equipment. By tapping these capabilities, smaller aerospace manufacturers can test new technologies and ensure both their safety and performance. Thanks to support from OEA, 173 firms have been supported by NIAR's Electromagnetic Effects Lab.

With OEA support, NIAR is also pioneering new approaches in the area of design to build. These efforts are housed at WSU's new 3D Experience Center which is enabling new approaches to enable 3D advanced product development, virtual simulation and next generation manufacturing. Computer aided design (CAD/CAM) programs, like Dassault's CATIA system, are the norm in aerospace today, but NIAR and its partners are testing new approaches that generate massive reductions in time (and costs) for design and production. DIA funds have been used to test new methods originally developed in a pilot project focused on creating a new unmanned aerial vehicle (UAV) to support search and rescue mission. Previously, the life cycle to reach full production of a new UAV system took anywhere from 18 months to two years. Using the new tools developed at NIAR, an engineering team was able to cut this cycle time down to 11 months, and further reductions are expected. A similar project—to create a new thrust reverse prototype—was recently overseen by an engineering team from Airbus. Working with NIAR's equipment and expertise, the team was able to deliver a new prototype in just 84 days, a massive reduction in time from design to delivery.

These faster cycle times save money, but, most importantly, they allow for faster injection of new technologies into the field. In the past, many of these innovations remained classified and were only available for use on military projects. The results from this process are declassified, and can be accessed by smaller American manufacturers who want to build new capabilities in the growing UAV market.