Manufacturing USA®

Rapid Response to COVID-19

Advanced Manufacturing Leadership to Support National Resiliency

2021

NIST Office of Advanced Manufacturing

Department of Defense Manufacturing Technology Program Office

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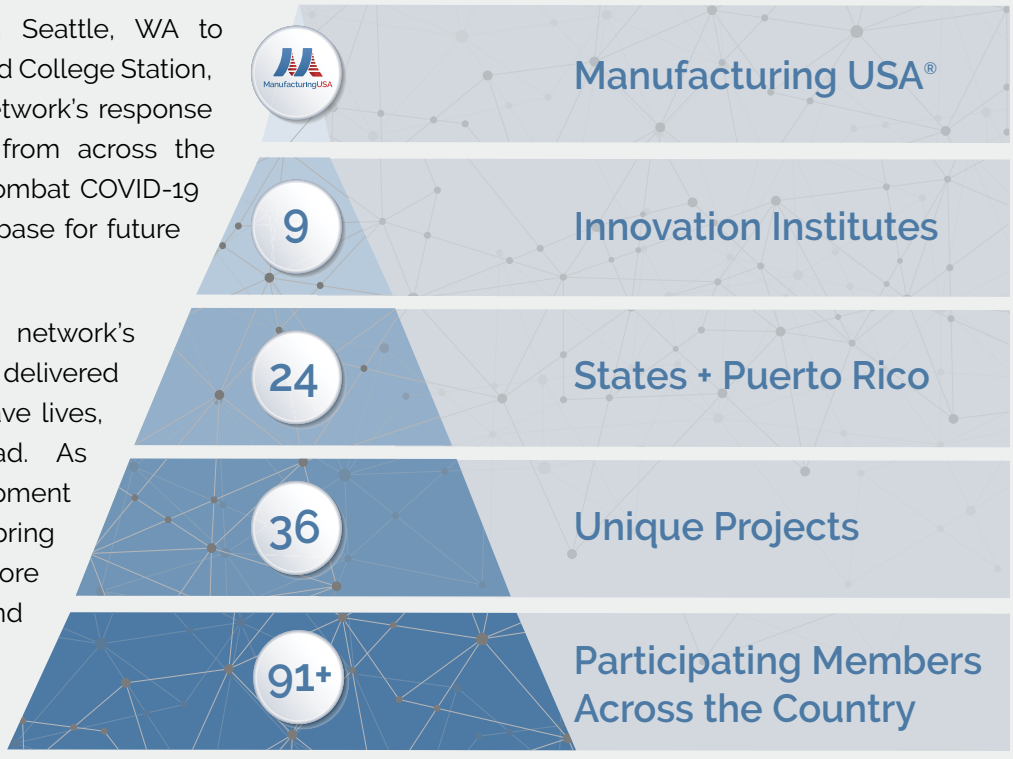
EXECUTIVE SUMMARY

COVID-19 hit with a speed and force that commanded the best in government, academia, and industry to gather at an unprecedented pace and accelerate innovations to address the needs of our nation. In the earliest stages of the pandemic, the institutes in the Manufacturing USA network assessed the domestic manufacturing situation. Their analysis indicated an urgent need for better domestic supply chains, data analysis, and novel manufacturing products and processes.

The Manufacturing USA network, comprising federal agencies and their sponsored manufacturing innovation institutes, assembled and utilized the flexibility, skills, and knowledge of their nationwide membership to address issues and begin developing solutions. These public-private partnerships convened members from industry, academia, and government enabling a rapid response to the developing needs across America based on their access to information and ability to deploy resources. The $73M in Coronavirus Aid, Relief, and Economic Security (CARES) Act funds from the Department of Commerce (DOC) and Department of Defense (DoD) propelled them to execute dozens of technology development and education and workforce development projects.

This report details the network's response to the COVID-19 pandemic and how the institutes leveraged their resources to rally the nation in this time of national crisis. Alongside their government partners, the institutes are advancing innovative manufacturing technologies from pre-vaccine protein development to equipping the currently home-bound workforce for future manufacturing careers. From Seattle, WA to Burlington, MA to Detroit, MI and College Station, TX, the Manufacturing USA network's response has convened organizations from across the country to work together to combat COVID-19 while preparing the industrial base for future crises.

The Manufacturing USA network's COVID-19 response has already delivered impacts that are helping to save lives, and there is more work ahead. As the research and development continues, their results will bring significant benefits towards a more resilient United States for this and future national emergencies.



MANUFACTURING USA STEPS-UP

Public-Private Partnerships Innovating in the Fight Against COVID-19

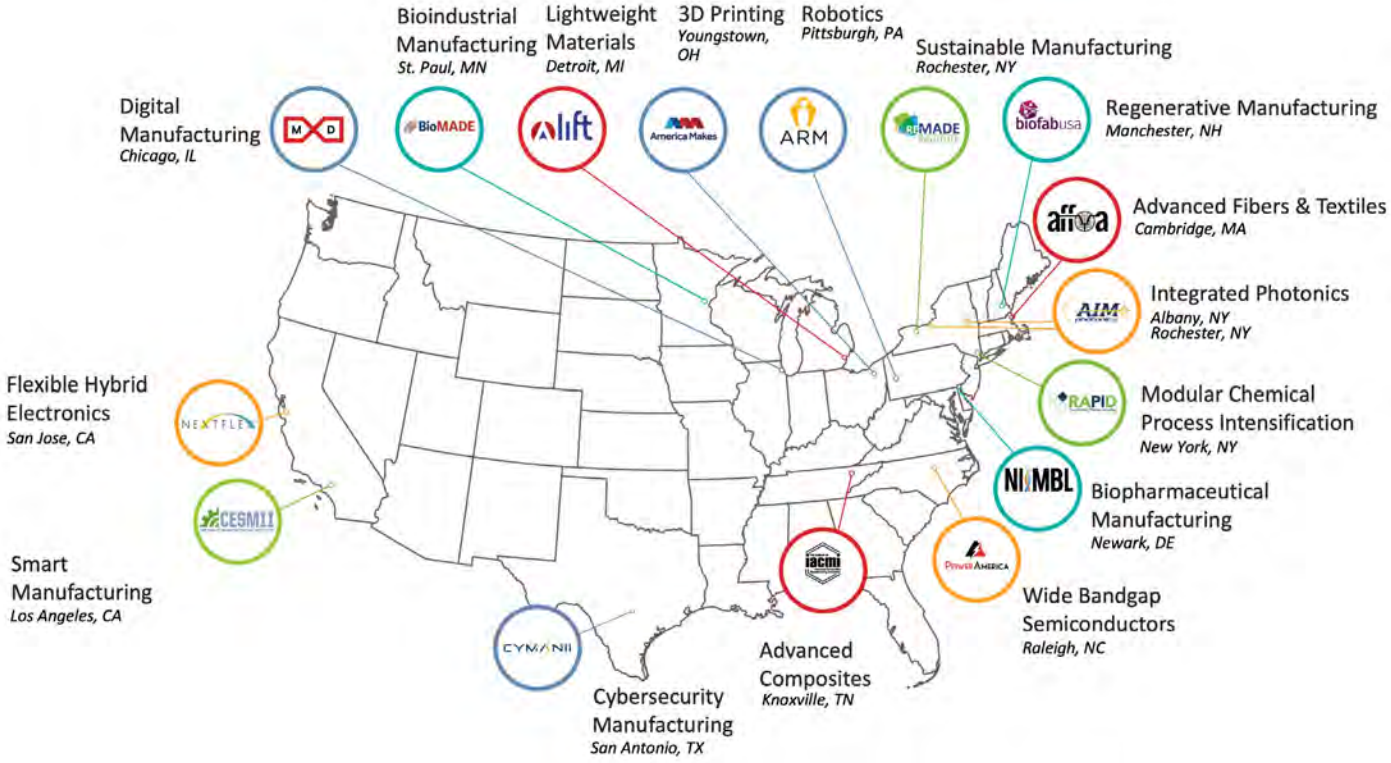
Convened in 2014, Manufacturing USA is a national network dedicated to securing U.S. global leadership in advanced manufacturing through large-scale public-private collaboration on technology, supply chain, and education and workforce development. Three Federal agencies individually sponsor and manage the government's relationships with manufacturing innovation institutes: Department of Commerce (DOC) oversees one institute, while the Department of Defense (DoD) manages nine, and the Department of Energy sponsors six. These three agencies and 16 institutes also collaborate with six additional agencies to help solve the nations' manufacturing problems. Determined by the sponsoring agency's top priorities, each institute specializes in a particular advanced manufacturing technology and unites members of industry, academia, and government to work on the country's most urgent issues.

Prior to the COVID-19 outbreak, the institutes fostered an ecosystem of over 2,000 members collaborating on 500+ major research and development projects and engaging over 70,000 people with workforce knowledge and skills in advanced manufacturing.

With thousands of small manufacturers, two-thirds of Fortune 50 U.S. manufacturers, and nearly every top-ranked research and engineering university in the country working together on the biggest manufacturing challenges of the day, the institutes were well-positioned to work with their partners to quickly respond to the nation's COVID-19 manufacturing innovation needs.

Early Institute Responses to the Pandemic

When COVID-19 hit the U.S. there was an overwhelming need for personal protective equipment (PPE) supplies, testing, and pre-cursor elements of the vaccine development process.. As Congress worked to appropriate funding to aid the nation's response, the government's existing investments and relationship with the institutes was paying off. Responding to the needs of their local communities and nation, the institutes quickly responded to the need by convening their members and working



with Federal, State, and local public sector leadership to distribute much needed resources that would protect their communities. Many institutes used their facilities and capabilities to manufacture PPE for frontline workers or connect companies to create an end-to-end supply chain.

Because of their existing physical and relational infrastructure, the institutes were able to make a significant impact and initiate responses in a matter of days. For example, NIIMBL (DOC-sponsored institute on biopharmaceutical manufacturing) started to develop projects focused on pharmaceutical processing agents. America Makes (DoD-sponsored institute on additive manufacturing) rapidly partnered with the Food and Drug Administration, National Institutes of Health, and Veterans Affairs to efficiently and safely match health care provider needs for PPE with manufacturers capable of providing 3D-printed supplies. In addition to these initiatives, many institutes engaged early on to support their local communities, including:

BioFabUSA Executive Director Dean Kamen, Senator Jeanne Shaheen, Rep. Chris Pappas, Gov. Chris Sununu, and Acting VA Deputy Secretary Pamela Powers met a shipment of PPE at the Manchester-Boston Regional Airport. Credit: BioFabUSA

- **BioFabUSA** (DoD-sponsored biofabrication institute) Executive Director Dean Kamen harnessed the manufacturing and supply chain expertise of his team to deliver more than 2.2 million pounds of protective equipment to the State of New Hampshire and to the Veterans Administration..

- **LIFT** (DoD-sponsored lightweight materials institute) supported the production of ventilators by leveraging their relationship with automakers. They also used 3D printers on their factory floor located in Detroit, MI, to produce face shields and N95 masks and cloth face masks while working closely with a local university to design and engineer ventilator splitter valves.

- **MxD** (DoD-sponsored digital manufacturing institute) produced downloadable step-by-step instructions for 3D printing of face shields. These instructions were made available to the general public enabling any American with off-the-shelf 3D printing equipment to manufacture and donate face shields to their community organizers and first responders.

- **AFFOA** (DoD-sponsored advanced fabrics institute) was selected to participate on the Commonwealth of Massachusetts' Manufacturing Emergency Response Team. Alongside the Massachusetts Technology Collaborative, AFFOA helped administer $5.6M in funds for PPE through the Massachusetts Manufacturing Innovation Initiative program for domestic manufacturers pivoting to manufacture PPE, identified opportunities to rapidly optimize the PPE supply chain, matched PPE manufacturers with producers of raw materials, and connected hospitals to manufacturers to quickly produce needed products. AFFOA also built a distributed PPE material testing network to assist hospitals, state emergency management agencies, first responder organizations, and domestic manufacturers to test their materials and PPE products and ensure product performance and regulatory clearance.

Top: MxD produced downloadable step-by-step instructions for 3D printing of face shields. Credit: MxD

Bottom: AFFOA receives 45,000 NIOSH Certified N95 Respirators from Alpha Pro Tech. Credit: AFFOA

Quickly Responding to CARES Act Funding Opportunities

The Manufacturing USA network response to the pandemic was greatly enhanced with the arrival of rapid-response project funding from Congress. Prompted by the passing of the Coronavirus Aid, Relief, and Economic Security (CARES) Act, DOC and DoD quickly collaborated with the institutes to develop 36 projects to address manufacturing technology, supply chain, and education gaps. DOC awarded over $12M in CARES Act funds for over 10 projects across 5 of the institutes. DoD Office of the Secretary of Defense Manufacturing Technology (OSD ManTech) Program awarded over $60M in CARES Act funds for more than 20 projects across 7 of the DoD manufacturing innovation institutes.

INSTITUTES ACCELERATE NATIONAL RESPONSE THROUGH RAPID ACQUISITIONS PROCESS

The manufacturing innovation institutes were established with the ability to rapidly accept, solicit, and release federal funding. Because of their unique design with a deep and diverse U.S.-based membership, the institutes have a ready-made community in which to quickly release project calls for federally-sponsored projects. The accelerated award and obligation of DOC and DoD appropriated CARES Act funding provides an excellent example of how these public-private partnerships not only offer the government an expedited contracting option, but also how they can respond quickly to the Nation's most urgent needs.

In March 2020, Congress appropriated funding to DOC's National Institute of Standards and Technology (NIST) for rapid, high-impact projects that supported the nation's response to the COVID-19 pandemic. By May, NIST had made its first awards to institutes.

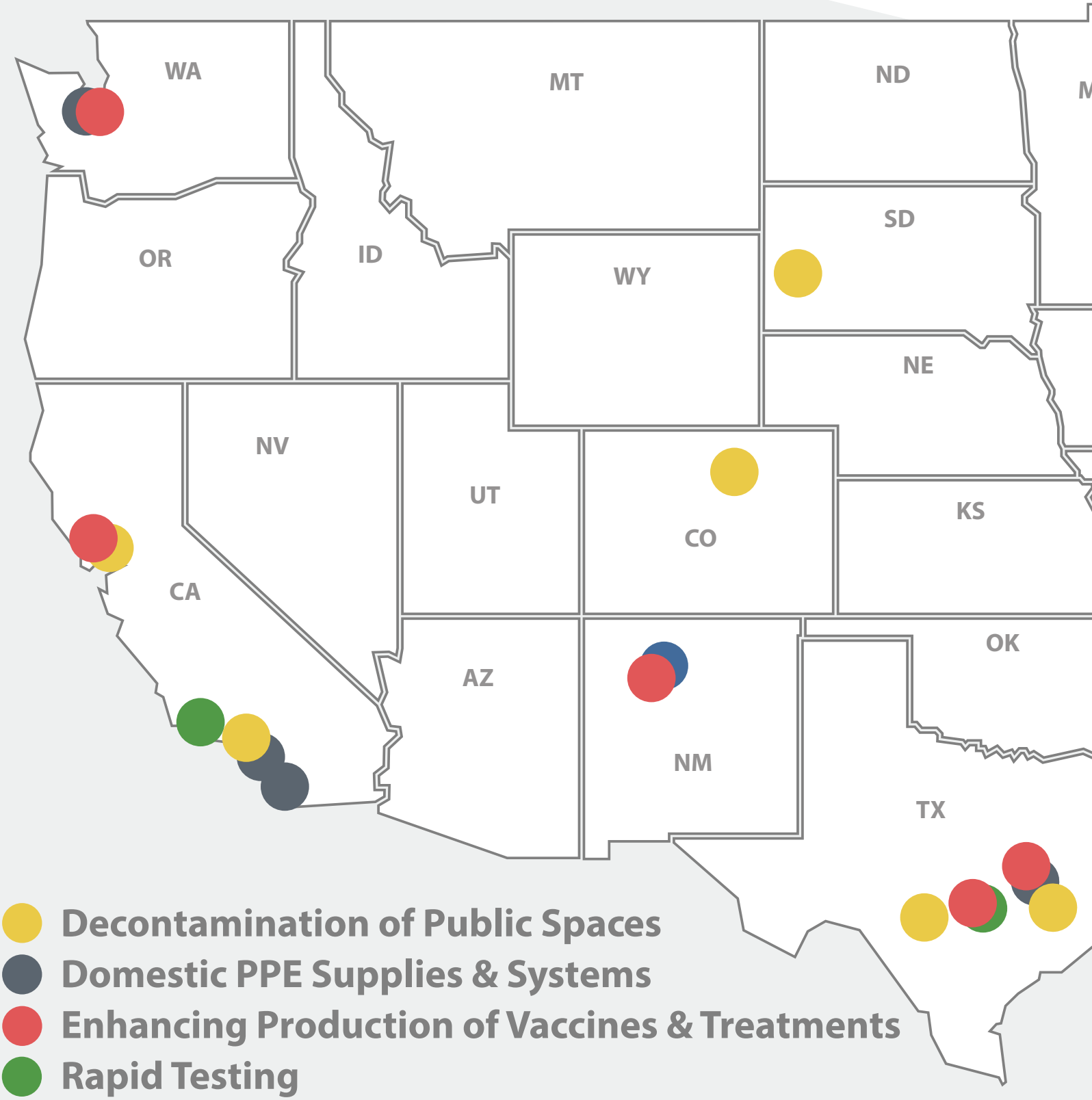
Concurrently, Congress appropriated funding to DoD, and the Under Secretary of Defense for Research and Engineering (R&E) quickly released requests for COVID-19 response projects. Within 2 days of requesting inputs, the OSD ManTech Office received 13 COVID-19 response project proposals from the institutes. The DoD institutes' network of over 1,400 members across 45 states equipped them to be one of only a few R&E programs to respond. DoD ultimately awarded over $60M in funding for all projects; money was released and project work initiated within 5 weeks of OSD ManTech approval.

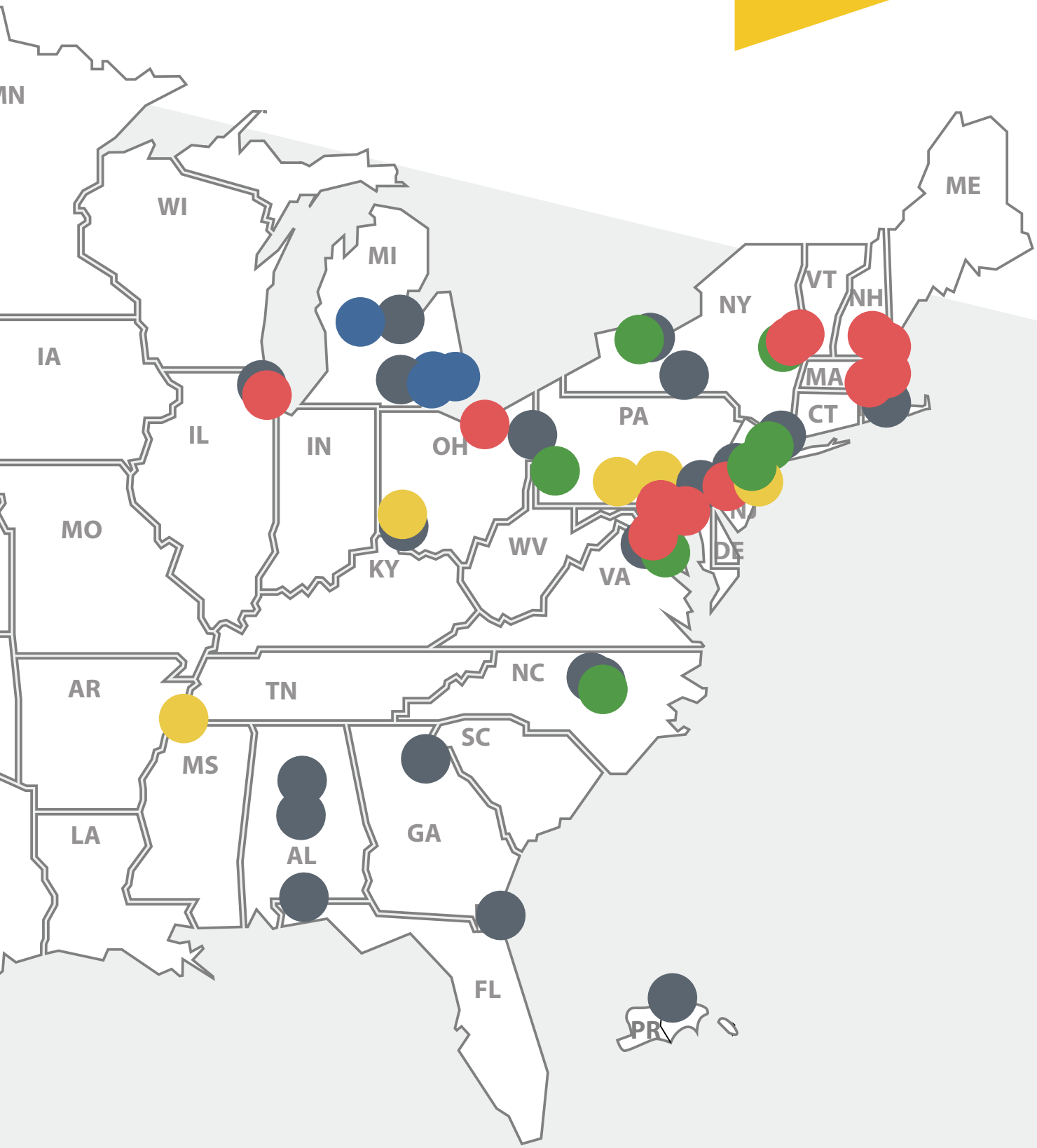
The institutes' unique design also aided the DOC. Within 24 hours of the funding opportunity notice, NIIMBL issued an emergency project call to its 140 members across 24 states. Forty-eight hours later, NIIMB had received an astounding 200 technical proposals. Ultimately NIST awarded NIIMBL $9M, which covered 9 of those projects. NIST also funded an additional $3.5M for projects at four of the DoD-sponsored institutes.

In total, NIST and DoD awarded more than $73M in CARES Act funding to 9 institutes for 36 high-impact pandemic response projects.

A Nationwide Contribution to the Manufacturing Response

DOC and DoD provided a combined 36 competitive awards to 9 institutes combined, involving more than 90 industry and academic institute members across 24 states and Puerto Rico. These projects demonstrate a united and rapid response of advanced manufacturing solutions to COVID-19 alongside geographic and topical diversity covering PPE and testing to workforce initiatives for pandemic-affected populations.

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DOMESTIC PPE SUPPLIES

At the start of the pandemic, supply chain disruptions contributed to a lack of sufficient PPE for American essential workers and the public. In addition, other manufacturing supply chain and preparedness issues also emerged. Due to their key role as manufacturing technology ecosystem conveners, the institutes were strategically positioned to help combat this disruption through novel technology solutions, roadmaps, and systems development. Out of the 36 total projects, NIST and DoD funded 14 institute projects focused on building a more agile, resilient, and secure U.S. manufacturing base for the current and future pandemics. These projects are designed to enable increased production of qualified PPE, test kits, and vaccines, and to decrease time required for vaccine manufacturing.

14 institute projects focused on building a more agile, resilient and secure U.S. manufacturing base for this and future pandemics

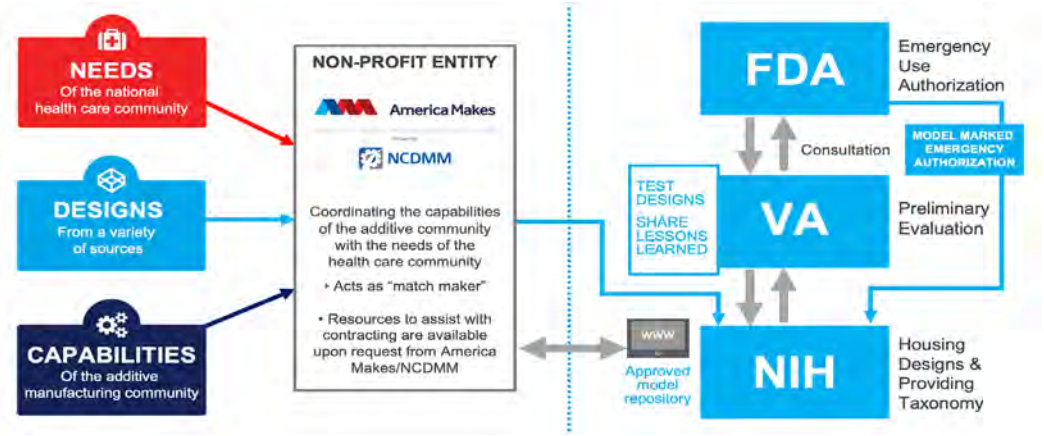
America Makes Online Repository System. Credit: America Makes

Developing an Advanced Manufacturing Crisis Production Response + Pandemic Additive Manufacturing Design Innovation Program

INSTITUTE: AMERICA MAKES (CARES Act funding: NIST and DoD)

PROJECT PARTICIPANTS: MxD (Chicago, IL), Deloitte (Arlington, VA), Quotient (Columbia, MD)

DESCRIPTION: America Makes initiated early action before funding to promote PPE development. America Makes later developed the Advanced Manufacturing Crises Production Response (AMCPR) system to establish a strategic framework for advanced manufacturing capabilities with NIST funding. This project also developed a rapid method for design submission and approval of 3D PPE designs under DoD funding.



America Makes Online Repository System. Credit: America Makes

IMPACT: During the early phases of the COVID-19 pandemic, additive manufacturing served as a key solution to supply chain disruptions. The speed of re-tooling, repositioning, and customization of manufacturing made the technology naturally conducive to solving shortages. The institute connected the additive manufacturing industry to the medical care provider community to accelerate design and clinical review of 3D-printed PPE medical devices currently in short supply. The project used a centralized process developed at America Makes, and in partnership with the FDA, NIH, and VA, that matched capabilities with health care needs in the NIH 3D Print Exchange (owned and operated by the National Institute of Allergy and Infectious Diseases) for open-sourced designs to be fast-track reviewed. The result enhanced America Makes' COVID-19 online portal and created an enduring infrastructure to prepare the nation for future crises. This strategic framework serves as a proof of concept to address future supply chain issues.

As of February 25, 2021, more than 624 published designs for PPE were available on the Exchange, with 34 designs optimized for clinical use and 28 designs optimized for community use. These designs have been downloaded over 200,000 times with more than 2.5 million views. Through the effort, America Makes assisted front line workers in obtaining hundreds of thousands of pieces of critical PPE supplies from qualified manufacturing across the United States.

2.

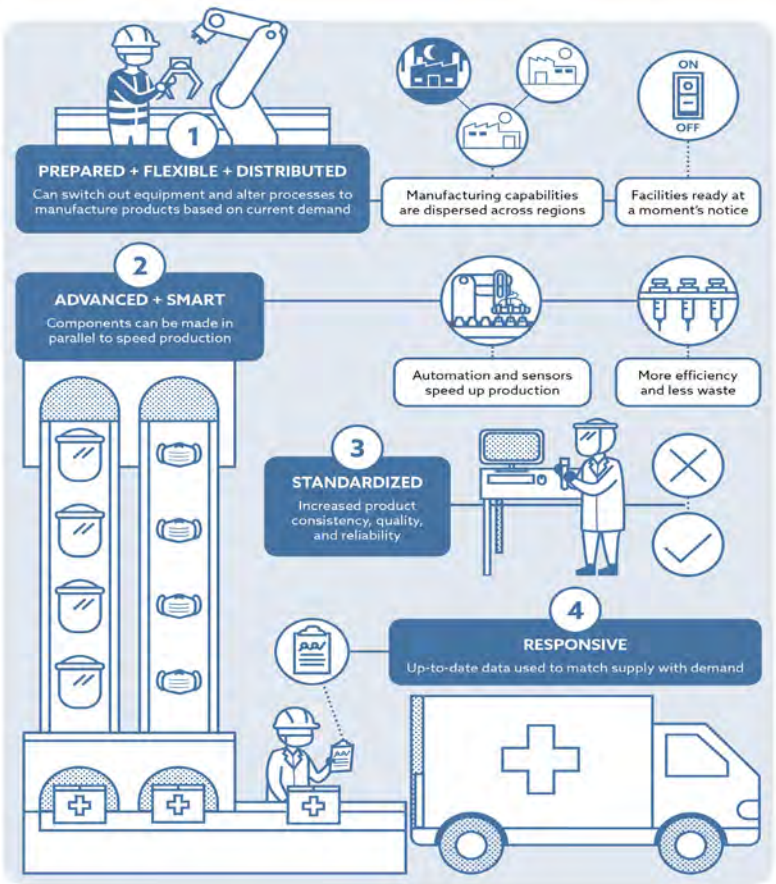
Mitigating COVID 19 and Moving Forward – Creation of a National Technology Roadmap for Pandemic Response and Recovery

INSTITUTE: BIOFABUSA (CARES Act funding: NIST)

PROJECT PARTICIPANTS: ARMI (Manchester, NH), Nexight (Silver Spring, MD)

DESCRIPTION: A multidisciplinary community of healthcare, manufacturing, biosecurity, academic, and government stakeholders contributed to the National Technology Roadmap for Pandemic Response and Recovery. The road map identified and prioritized needs related to supply chain issues, manufacturing production bottlenecks, and rapid delivery of test kits and vaccines to the right places. The final product included a coordinated pandemic response toolkit for: 1. supply chains; 2. data infrastructure; 3. predictive capabilities; 4. regulatory processes; 5. deployment and access; and 6. manufacturing ecosystems.

IMPACT: The manufacturing sector is at the center of a stronger, faster and more coordinated U.S. response to COVID-19 and future pandemics. The roadmap is the first pandemic roadmap driven by the manufacturing sector, and outlines a technology-based action plan for strengthening and accelerating U.S. pandemic response and preparedness. It outlines the current technical gaps to achieving a more rapid response and recovery for future pandemics, specifically in addressing containment of the initial spread of the disease, accelerating the development of testing and treatment approaches, enabling rapid vaccine production and delivery at scale, and equipping an augmented healthcare workforce to more quickly and effectively treat patients.



BioFabUSA leveraged its network across healthcare, manufacturing, and biosecurity to develop a "pandemic roadmap." Credit: BioFabUSA

Mask. Credit: NIIMBL

3.

Designing a Test Kit Supply Chain in Response to COVID-19

INSTITUTE: NIIMBL (CARES Act funding: NIST)

PROJECT PARTICIPANTS: North Carolina State University (Raleigh, NC)

DESCRIPTION: This project generates a protocol for updating deliverables and modelling test kit supply and demand conditions alongside: 1. a supply chain map for COVID-19 virus and antibody test kits, from first-tier suppliers through final distribution to testing sites; and 2. a supply allocation model for distributing test kits based on prioritized testing needs. This team developed a working paper on the COVID-19 testing ecosystem to identify trends in:

- virus resurgence
- quantity and state of testing demand and supplies
- bottlenecks in supply chains.

The team also developed a working paper on tracing spreading events and approaches to infectious isolation strategies to support the reopening of the economy and improvements in public health.

IMPACT: The team plans to build a web-based platform that reflects updated test conditions and supply-chain limitations to facilitate communication between manufacturers and government agencies. The products of this project will provide a coordinated response to testing, tracing and isolation protocols.

4.

Identifying Alternative Domestic Supply Chains to Reduce Foreign Dependence for Respirators and Masks

INSTITUTE: NIIMBL (CARES Act funding: NIST)

PROJECT PARTICIPANTS: Nonwovens Institute , North Carolina State University (Raleigh, NC)

DESCRIPTION: This team manufactured a novel filter material suitable to produce surgical-grade masks or N95 respirators to reduce the shortage of high-filtration materials. This new material does not require electrostatic charging and can be reused and re-sterilized.

IMPACT: This team has provided enough material to produce over 100 million masks since March 2020 for front-line healthcare workers, and directly provided North Carolina State University with approximately 60,000 face masks each month since the start of the current pandemic.

North Carolina State University Nonwovens Institute Production & Spunbond Material. Credit: NIIMBL

5.

Developing a Supply Chain Risk Alert Platform

INSTITUTE: MXD (CARES Act funding: DoD)

PROJECT PARTICIPANTS: Software AG (Herndon, VA), Supply Dynamics (Loveland, OH), RAAD360 (Newark, DE), Llamasoft (Ann Arbor, MI), Dow Chemical Co. (Midland, MI), Supply Chain Risk Management Consortium (SCRMC) (Bethlehem, PA), Iterate Labs (Ithaca, NY), Defense Logistics Agency (Fort Belvoir, VA)

DESCRIPTION: This institute project is developing a platform for supply chain risk management that brings together data sources and advanced analytics that overlays them with a supplier network.

IMPACT: A key challenge for manufacturers in the digital transformation of the supply chain is developing a culture of trust for sharing data between suppliers. This institute project will develop and demonstrate proof-of-value for connected, artificial intelligence/machine learning (AI/ML) based supply chain mapping and risk management platform to: 1. provide end-to-end visibility into a manufacturer's supply chain to support informed, efficient, and systematic decision making; and 2. provide advance warning of supply chain risks to promote proactive risk management in order to improve resiliency.

6.

Creating a Blueprint for Manufacturing During Periods of Surge Demand

INSTITUTE: AFFOA (CARES Act funding: DoD)

PROJECT PARTICIPANTS: AFFOA (Cambridge, MA), Massachusetts Institute of Technology (Cambridge, MA), U.S. Army Combat Capabilities Development Command –Soldier Center (Aberdeen, MD), University of Massachusetts Lowell (Lowell, MA), and MIT Lincoln Laboratory (Lexington, MA), Pennsylvania Fabric Discovery Center at Drexel University (Philadelphia, PA), University of Georgia (Athens, GA), NECFAinc (Watertown, MA), Alogus Innovation (Somerville, MA), RTI International (Research Triangle Park, NC), ITC InfoTech (Paramus, NJ), PTC (Chicago, IL), MSC Software (Newport Beach, CA)

DESCRIPTION: This institute project will develop a manufacturing blueprint for PPE production to prevent product shortages in the current and future respiratory pandemics. The goal is to assist non-traditional domestic manufacturers to rapidly pivot their production lines and produce PPE products or necessary materials for their construction. AFFOA is providing project product management and oversight for : 1. developing a tool to predict future PPE demand during surge events and during steady state; 2. researching and assembling a supply chain map of domestic manufacturers; 3. creating a government owned PPE product design and technical specifications, process and production instructions; 4. sustaining and expanding the PPE material and product testing network; and 5. developing novel materials and processes to provide alternatives for critical filtration materials as well as developing pathways to product decontamination and reuse.

IMPACT: The continued work of AFFOA's PPE testing network through the CARES Act has resulted in more than 4,000 tests conducted on more than 750 unique products. This ensured that both the emergency management agencies of the states of Massachusetts and Rhode Island were able to provide effective, foreign-sourced materials to medical providers, ensure that hospitals, first responders and other medical personnel on the front lines were using effective PPE. It also assisted more than 20 domestic PPE manufacturers to start producing PPE in the US. Early learning from working with domestic manufacturers allowed AFFOA to continue to develop and formalize a manufacturing blueprint plan for the current pandemic to increase domestic PPE production and better prepare for the next pandemic. In addition, creating a modelling tool to assess supply vs. demand and assembling a supply chain database will result in government-owned Technical Data Packages (TDPs) for respiratory protection and end-to-end mask prototyping and testing capabilities, as well as establishing a blueprint in the form of a Product Lifecycle Management system to inform response to future surges in PPE demand.

7.

Assessing Capacity and Mobilization of Pharmaceutical Life Sciences Industry with Digital Technologies to Optimize/ Scale-Up Production

INSTITUTE: MXD (CARES Act funding: DoD)

PROJECT PARTICIPANTS: IAAE (Blue Bell, PA), ARMI/BioFabUSA (Manchester, NH), Horizons Control Group (Blue Bell, PA), MIT (Cambridge, MA), Illumina (San Diego, CA), Medtronic (Tempe, AZ)

DESCRIPTION: MxD is working with BioFabUSA in collaboration with the FDA and two manufacturers to develop and validate digital twins of their production, which allows emergency scenario exploration without operational impact. This model enables proactive response plan formulation and what-if scenario analysis for early problem impact identification and will publish emergency scenario results as a resource guide for other manufacturers.

IMPACT: This institute project will optimize supply chain and production gaps in our pharmaceutical life sciences manufacturing industry and promote advanced digital design and manufacturing technologies capabilities to expand U.S. pharmaceutical manufacturing capacity. It will demonstrate the benefits of digital twin technology in improving response speed and decision quality in the case of foreseen or unforeseen emergency events and provide a roadmap for other manufacturers to adopt similar technology.

8.

Deploying Medical Devices and Instrumentation Rapidly and Securely

INSTITUTE: MXD (CARES Act funding: DoD)

PROJECT PARTICIPANTS: Fast Radius (Chicago, IL), Siemens (Princeton, NJ), Johnson & Johnson (Jacksonville, FL)

DESCRIPTION: This institute project will develop a framework to connect the FDA to the medical device industry to digitally validate processes for automatic, facilitated, or expedited authentication of a device during fabrication using a digital methodology framework.

IMPACT: There has been an explosion of innovation on COVID-19 solutions through additive manufacturing, but the innovation outpaces capacity for review. This means too many of these solutions cannot currently be utilized due to long lead times for approval and validation. Connecting the FDA to the medical device industry through a digital methodology framework will enable digital validation of the process in a future state that will allow for automatic, facilitated, or expedited validation.

9.

Building a Demand Forecasting Dashboard for Medical Supplies

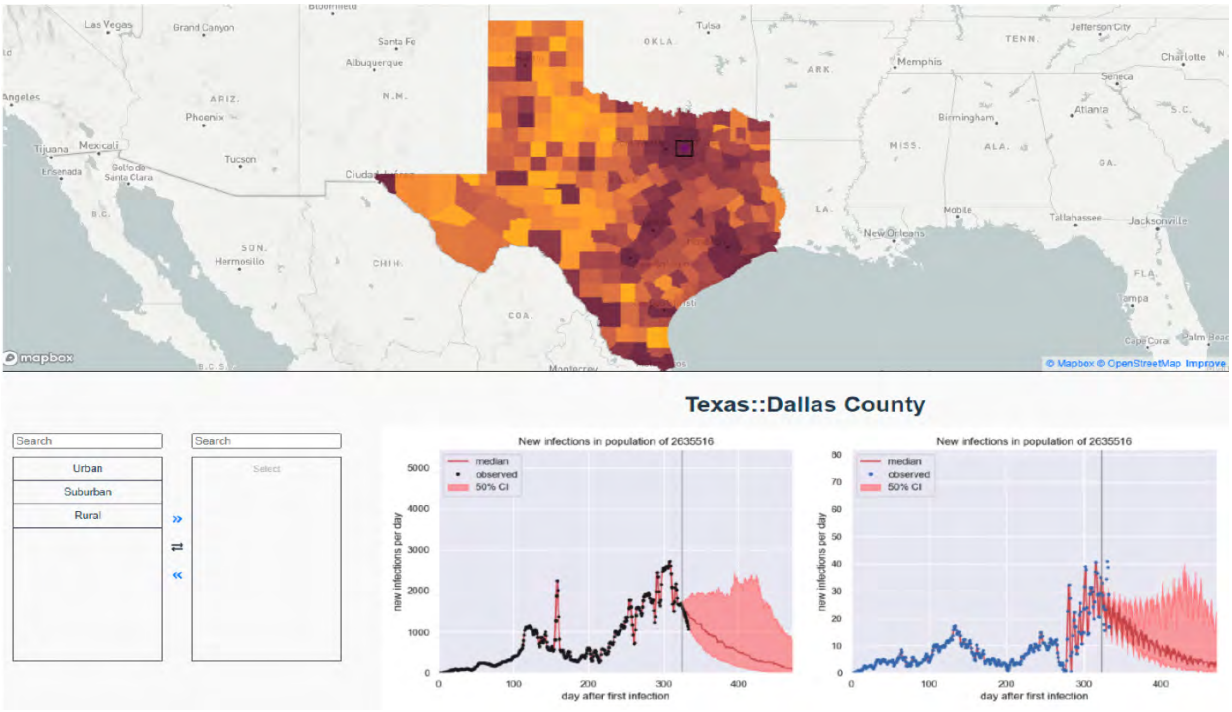
INSTITUTE: BIOFABUSA (CARES Act funding: DoD)

PROJECT PARTICIPANTS: Neurite (Birmingham, AL), BioFabUSA (Manchester, NH)

DESCRIPTION: This institute project developed and deployed a demand forecasting dashboard to equip local health systems and local governing officials with accurate projections of hospitalizations and resource utilizations, allowing for more efficient planning for staffing, ward design, and resources allocation in the pandemic response.

IMPACT: During a pandemic, typical market signaling mechanisms are inadequate for communicating demand for PPE. This project addressed the need by implementing an inventory forecasting dashboard to establish normalized demand information and response capability for PPE requests. The data science team deployed the first predictive models in partnership with the nation's largest public health system in the early days of the pandemic response. The model, trained on live data, was validated when it accurately predicted the second wave's timing, duration, and patient volume. By the third wave, the dashboard's predictions had been incorporated into the health systems planning process and was used as the basis for decision making around designation of COVID wards, resource utilization (PPE), testing materials, other necessary pandemic resources, and staffing allocations to accommodate additional patient intake. Systems level modelling was reported as being more actionable for planning purposes (as opposed to national and regional models) and public health officials relied upon these projections as part of their planning process.

> *"This capability is saving lives every day.*



Demand forecasting dashboard for Dallas, TX. Credit: BioFabUSA

10.

Developing an On-Demand Cell Therapy Platform for Pandemic Response

INSTITUTE: BIOFABUSA (CARES Act funding: DoD)

PROJECT PARTICIPANTS: KBI Biopharma (The Woodlands, TX), Pluristyx (Seattle, WA), Worldwide Clinical Trials (Durham, NC)

DESCRIPTION: This institute project will develop a new generalized system for the rapid scaling of quality-controlled cell-based therapies for the COVID-19 pandemic or other emergency responses.

IMPACT: Many living cell-based treatments require rapidly deployable production of clinical samples for emergency use approvals, which is beyond the capacity of most product developers. While the immediate focus of the program is to respond to the ongoing COVID-19 health crisis, the platform will be uniquely placed to provide scalable surge capacity for either allogeneic or autologous cell-based drug products for use in future pandemic crises and for other current infectious diseases.

11.

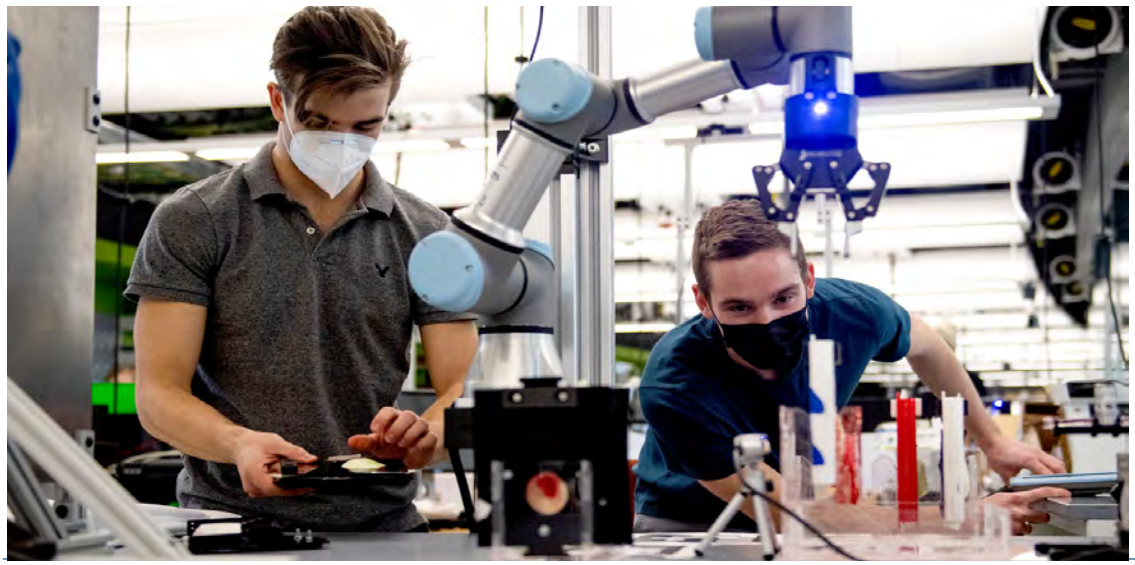
Automation of Characterization and Evaluation (ACE) in PPE Manufacturing

INSTITUTE: ARM (CARES Act funding: DoD)

PROJECT PARTICIPANTS: Northeastern University (Boston, MA), Merrow Manufacturing (Fall River, MA)

DESCRIPTION: This project aims to develop a robotic system to automate the quality assurance tests for PPE inspection, thus improving the performance, productivity, and efficiency of PPE manufacturing in the United States.

IMPACT: The quality assurance procedures for PPE such as facemasks is labor intensive and time-consuming. Sample testing of PPE has become a priority, not only in manufacturing plants, but also at medical centers. The national labs providing validation testing for PPE report lead times up to 75 days due to lack of qualified technicians and overwhelming volume of new requests. A working prototype of the robotic system for PPE quality assurance testing will be available in the Fall of 2021.



Students at Northeastern University work on an ARM Institute project using robots to automate quality assurance for PPE. Credit: Matthew Modoono/Northeastern University

12.

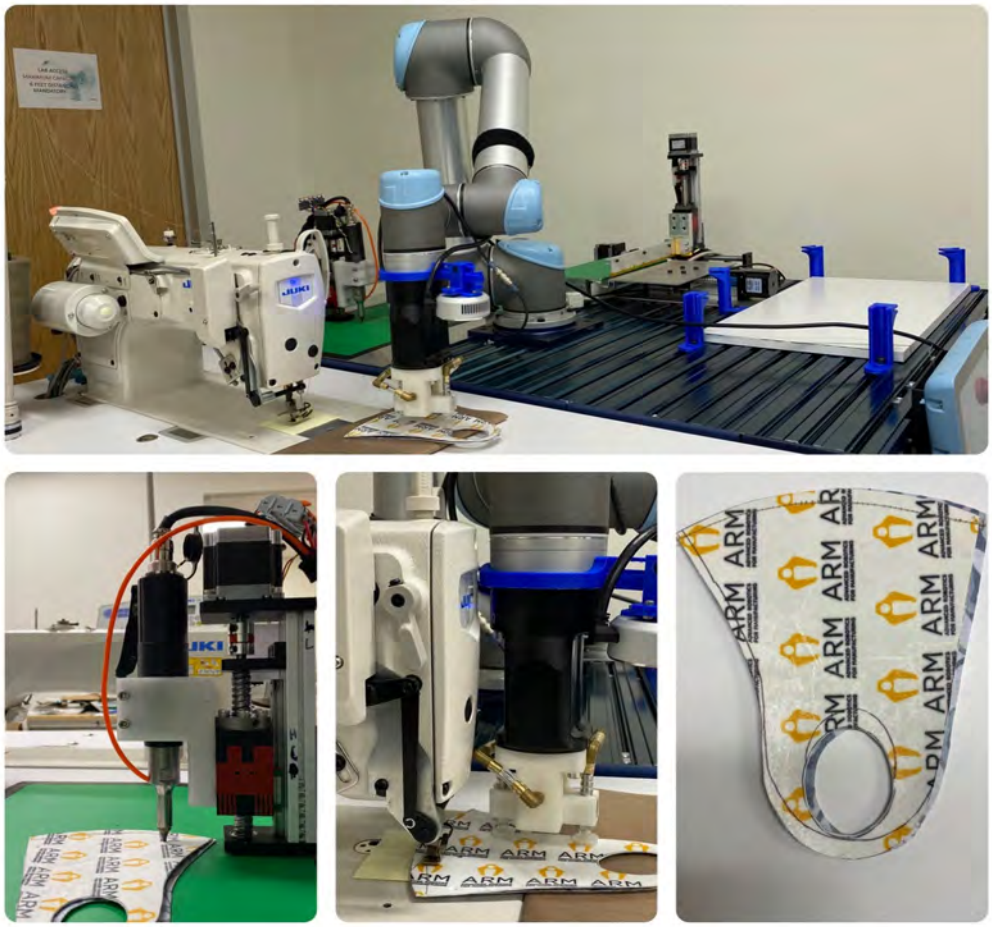
Built-By-Bot: Customized Mask Assembly Using Robots

INSTITUTE: ARM (CARES Act funding: DoD)

PROJECT PARTICIPANTS: Siemens Corporation Corporate Technology (Princeton, NJ), Henderson Sewing Machine Corporation (Andalusia, AL), Sewbo Inc (Seattle, WA), Bluewater Defense (Corozal, PR)

DESCRIPTION: The institute has funded a number of projects related to robotic sewing, one of the remaining human-intensive labor tasks in the world. This project will build upon the outputs from other ARM projects to automate the robotic production of cloth face masks for PPE.

IMPACT: The Centers for Disease Control and Prevention (CDC) has identified cloth masks as playing a vital role in slowing the spread of COVID-19, but the supply has often not been able to keep up with the demand. Robotic sewing presents a technical challenge because it requires the manipulation of flexible materials, fine motor control, and precise part recognition. The technology to automate the sewing of some fabric mask components, developed by ARM and its members, will be demonstrated in the Fall of 2021, and will help to solve some of these technical issues that have long prevented further automation of fabric sewing.



Demonstration of a robotic arm guiding a sewing machine to create a fabric mask. Credit: Siemens Corporation Corporate Technology

13.

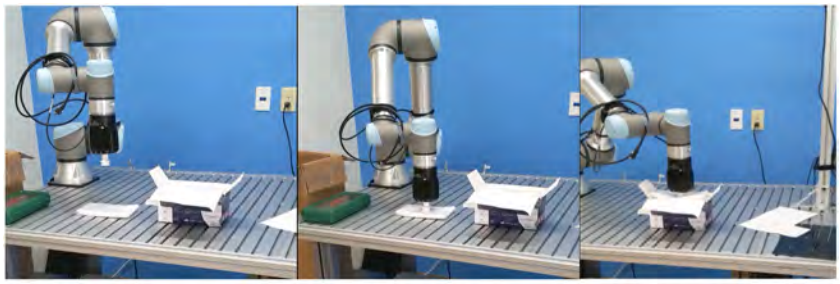
Rapid PPE Production through Automation & Robotics (RAPPAR)

INSTITUTE: ARM (CARES Act funding: DoD)

PROJECT PARTICIPANTS: Siemens Corporation Corporate Technology (Princeton, NJ), Henderson Sewing Machine Corporation (Andalusia, AL), Yaskawa Motoman (Miamisburg, OH), HomTex Inc (Cullman, AL)

DESCRIPTION: This project will improve existing automated mask production in the US by including robotic automatic visual inspection, picking-and-sorting, and end-of-line packing and palletizing.

IMPACT: The COVID-19 pandemic has exposed critical vulnerabilities in the global health care supply chain. At the beginning of the pandemic, U.S. manufactures were unable to meet the significant demand for PPE, resulting in shortfalls and long lead times. A prototype of this project will be available in the Fall of 2021.



A robotic arm inspects and packs PPE. Credit: Siemens Corporate Technology

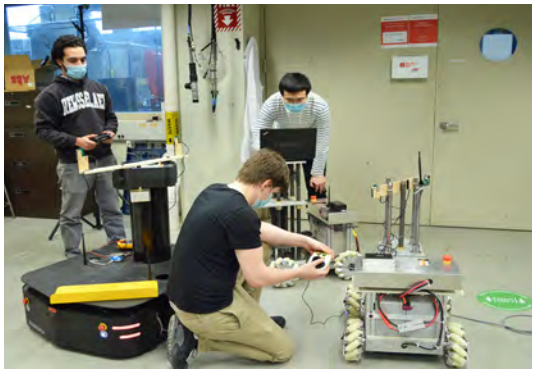
14.

Swarm Robotics for Large Structure Manufacturing

INSTITUTE: ARM (CARES Act funding: DoD)

PROJECT PARTICIPANTS: Rensselaer Polytechnic Institute (Troy, NY), Air Structures American Technologies Inc (Rye Brook, NY)

DESCRIPTION: COVID-19 has highlighted the urgent need to rapidly deploy negative pressure spaces as additional facilities. These air-supported structures are rapidly deployable with performance advantages over traditional tents, and are ideal for use as expeditionary hospitals, quarantine facilities, housing, and other disaster relief or military applications. Production of these structures is labor-intensive, but can be expedited with the development of robotic technology to aid manufacturing personnel. This project aims to solve the problem of moving and manipulating a large, heavy, flexible material over a large area by developing a fleet of self-aware, human-directed robotic platforms to take on the hard work of moving the material around the production floor.



Rensselaer Polytechnic Institute students work on programming the robots to manipulate the materials needed to create a large, temporary structure for disaster relief. Credit: Rensselaer Polytechnic Institute.

IMPACT: This manufacturing technology will help ARM team member Air Structures American Technology Inc (ASATI) produce a "hospital in a shipping container" that can be set up in a parking lot in only 72 hours with a crew of 8 to 10 and a forklift. ASATI will be able to reduce cost and manufacturing lead times of these critical structures through the implementation of this development. A prototype will be demonstrated in the Fall of 2021.

ENHANCING PRODUCTION OF VACCINES AND TREATMENTS

Federal officials quickly identified the vital importance of a COVID-19 vaccine to stop the spread of virus. As technology experts within their manufacturing technology fields, the institutes are equipped to conduct innovative research and development alongside their world renowned members.

Creating Key Components for Vaccine Development and COVID-19 Treatments

One method toward vaccine development and treatment therapies requires isolating and purifying proteins that trigger immune responses inside our bodies and produce antibodies that protect us from getting the virus. Early in the pandemic, an inadequate supply of proteins existed for antibody therapy testing so multiple funding projects were dedicated to the development of these COVID-19 treatment building blocks. These projects focus on alleviating the limited supply of relevant proteins available to researchers and clinicians for vaccine and therapy development.

15.

Developing Novel Methods to Test for COVID Antibodies

INSTITUTE: NIIMBL: (CARES Act funding: NIST)

PROJECT PARTICIPANTS: NY State Department of Health - Wadsworth Center (Albany, NY) and Mass Biologics (UMass Medical School; Mattapan, MA)

DESCRIPTION: This team is producing and analyzing proteins to measure sensitivity and specificity of COVID antibodies in human blood samples. This will assist in identifying individuals with high levels of SARS-CoV-2- virus-neutralizing antibodies that may indicate recent or prior infection.

IMPACT: This project will effectively identify: 1. COVID-19 recovering patients willing to serve as antibody donors; 2. screening capabilities for quarantined essential workers wishing to return to work; and 3. benchmarks for vaccine trials to assess efficacy. It also provides technical knowledge to quickly scale protein production if additional materials are needed for subsequent waves of viral infections or mutations.

Wave Bioreactor – Cell Culture Platform. Credit: NIIMBL/ MassBiologics

16.

Emergency Production of COVID-19 Spike Protein for Therapeutic Antibodies and Diagnostics

INSTITUTE: NIIMBL (CARES Act funding: NIST)

PROJECT PARTICIPANTS: Texas A&M Engineering Experiment Station – National Center for Therapeutics Manufacturing (NCTM), (College Station, TX) in partnership with Army Research Lab (ARL) (South, Austin, TX)

DESCRIPTION: This team is creating proteins for therapeutic antibodies and a complementary diagnostics tool in response to COVID-19 with the same project impacts listed in the above project. Collaboration between ARL and NCTM focuses on scaling-up the process and distribution of therapies within various networks that include the U.S. Army Combat Capabilities Development Command Chemical Biological Center.

IMPACT: This project will provide the framework to create the best processes for producing and scaling protein development that ultimately leads to the creation of vaccines.

AxiChrom column packed with IMAC FF. Credit: NIIMBL/ NCTM

17.

Using Advanced Biomanufacturing Technologies to Develop a Quantitative Test to Screen for the Best Plasma Donations

INSTITUTE: NIIMBL (CARES Act funding: NIST)

PROJECT PARTICIPANTS: Johns Hopkins University (Baltimore, MD), Rensselear Polytechnic Institute (Troy, NY), ProMechSys (Halethorpe, MD), Sartorius Stedim (Boston, MA), and in collaboration with the National Institute of Health and MilliporeSigma (Burlington, MA)

DESCRIPTION: The FDA issued a call for recovered patients to donate plasma to assist recovery efforts since plasma therapy has demonstrated immediate immunity in treating previous infectious disease outbreaks. This team implemented advanced biomanufacturing technologies with quantitative tests to screen plasma donation candidates and evaluate the most effective protective response. The team is analyzing the patient recovery effort and comparing multiple production systems to identify the most promising therapy response for different COVID-19 patients.

Robotic Feed for ELISA Immunoassay. Credit: NIIMBL/Johns Hopkins University/ProMechSys-RLP, LLC

IMPACT: This treatment will provide a rapid non-vaccine approach to treat COVID-19 as well as an organized outline for assessing affected parties and their potential participation for therapy development.

18.

High-Dimensional Design of Experiments-Based (HD-DOE) Identification of Antiviral Combinations to Use Against COVID-19

INSTITUTE: BIOFABUSA (CARES Act funding: DoD)

PROJECT PARTICIPANTS: Trailhead Biosystems (Cleveland, OH), IITRI (Chicago, IL) Red Oak Bio (Cleveland Heights, OH)

DESCRIPTION: This institute project will use an high-dimensional design of experiments-based approach to conduct tests with combinations of more than 300 antiviral drugs, employing predictive algorithms to enhance the ability to design and test multi-therapy solutions. The product in development can be a combination of therapies directed against the virus to help reduce symptoms of those severely impacted by COVID-19.

IMPACT: Combinatorial therapy is emerging in importance for multiple diseases, including viral infections. A combinatorial therapy for SARS-CoV-2 would be highly applicable for Emergency Use Authorization approval and testing in humans.

Developing and Scaling Vaccine Production for COVID-19 Treatments

A novel virus requires innovative approaches to vaccinate the nation. The following projects prioritize vaccine or therapy development quickly and at a scale in response to the growing need to reduce spread, increase immunity, and improve possible treatment options.

19.

Building an End-to-End Manufacturing Test Bed for Biopharma Companies, Universities and Government Collaboration

INSTITUTE: NIIMBL (CARES Act funding: NIST)

PROJECT PARTICIPANTS: University of Delaware (Newark, DE) in partnership with 13 major biopharmaceutical companies and agencies (Amgen, AstraZeneca, Bristol Meyers Squibb, Eli Lilly, MilliporeSigma, FDA, GSK, Merck, NIST, Pfizer, Roche Sanofi, and Sartorius)

DESCRIPTION: Thirteen major biopharmaceutical companies are working with NIIMBL and University of Delaware to develop a novel end-to-end process for faster and more flexible drug manufacturing in the U.S. This project team is building a testbed to demonstrate new approaches to manufacturing vaccines using continuous manufacturing.

IMPACT: This testbed will be the foundation for future flexible manufacturing facilities' rapid response to future pandemics and also bolster domestic manufacturing capabilities. The uniquely collaborative shared environment between companies, universities, and federal agencies aims to demonstrate the capabilities to revolutionize continuous manufacturing of medicines – often considered too risky for any one company to pursue.

20.

Developing Antibodies to Assess Manufacturability

INSTITUTE: NIIMBL (CARES Act funding: NIST)

PROJECT PARTICIPANTS: Just Evotec Biologics (Seattle, WA), Army Research Lab (South Austin, TX)

DESCRIPTION: The objective is to screen multiple antibody sequences and rank those with the best chance for clinical and commercial scale manufacturing as a medical countermeasure to treat COVID-19.

IMPACT: This project will provide a cost-effective investment shift toward tiered antibody treatments with the most promise for efficacy.

21.

Developing Potential Therapeutics for Treating COVID-19

INSTITUTE: NIIMBL (CARES Act funding: NIST)

PROJECT PARTICIPANTS: MilliporeSigma – BioReliance (Rockville, MD), Centivax (South San Francisco, CA)

DESCRIPTION: This project supports the development of high-concentration monoclonal antibodies as potential therapeutics for the treatment of COVID-19.

IMPACT: Successful clinical trials will allow an up-concentration of the antibody for efficient packaging, transport, storage and administration, which will increase the speed of patient treatment.

22.

Manufacturing of Virus-Free Red Blood Cells from Stem Cells

INSTITUTE: BIOFABUSA (CARES Act funding: DoD)

PROJECT PARTICIPANTS: ARMI (Manchester, NH), Trailhead Biosystems (Cleveland, OH), Pluristyx (Seattle, WA)

DESCRIPTION: This institute project will develop a new alternative source of red blood cells free of the constraints imposed by an aging donor population and free of pathogens, including viruses, that pose a risk to recipients being treated for trauma and disease.

IMPACT: This project will address these challenges to achieve an ongoing, large-scale, low-cost supply of red blood cells derived from the stem cells of a few healthy donors. The ultra-high density red blood cell cultures will drive down cost, and the process automation will promote consistency and scalability.

Novel Drug Delivery System

INSTITUTE: BIOFABUSA (CARES Act funding: DoD)

PROJECT PARTICIPANTS: DISC (Manchester, NH), Skorpios Technologies, Inc. (Albuquerque, NM)

DESCRIPTION: The project will develop a new drug delivery platform with: (1) microneedle technology; (2) an easy manufacture/fill reservoir for vaccines/drugs; and (3) an actuation method for administration according to protocol. This institute project will deliver lifesaving vaccines or drugs via mail, enabling U.S. citizens to accurately administer vaccines or drugs to themselves. Initial focus is intradermal administration of COVID vaccines.

IMPACT: The project will result in development of a drug delivery platform for people with no specialized knowledge to completely and accurately administer vaccine according to protocol. Several COVID vaccines under development require large doses and precise administration protocols. Intradermal delivery via microneedles may substantially lower vaccine dose required, provide additional efficacy, and cause no pain upon administration.

RAPID TESTING

Early on there was a significant need for improved testing technologies – especially rapid testing. To aid in developing the next generation of COVID-19 testing, NIST and DoD funded five institute projects focused on developing new processes and products that accelerate the results and improve efficacy of COVID-19 testing.

24. Next Generation Sequencing Test Bed for Rapid Release of Biopharmaceutical Products for COVID-19 Response

INSTITUTE: NIIMBL (CARES Act funding: NIST)

PROJECT PARTICIPANTS: The University of Delaware (Newark, DE)

DESCRIPTION: This project is developing a platform for accelerated scheduling in next-generation sequencing testing of process streams for vaccines, therapeutic proteins, and cell and gene therapy products to expedite patient access to vaccines and medical countermeasures. The test bed can compare traditional testing methods with next-generation sequencing (traditional methods take 2 to 4 weeks to perform compared to the new approaches in 2 days).

IMPACT: This project is creating protocols, approaches, and data sets available to the public for increased awareness of next-generation sequencing testing and to aid in regulatory filings, as well as reducing the potential testing time for vaccines by up to a factor of 10.

25.

Increased Throughput for COVID-19 Diagnosis Using Real-Time PCR and Detection System

INSTITUTE: NIIMBL (CARES Act funding: NIST)

PROJECT PARTICIPANTS: University of Delaware (Newark, DE), Roche Diagnostics (South Hackensack, NJ), Incyte (Wilmington, DE), Christiana Care Health System (Newark, DE)

DESCRIPTION: After identifying a disrupted supply chain early during the pandemic, this team reconfigured an instrument from Roche to diagnose COVID-19 and delivered the test capability to a local clinic within two weeks. The team published their method for other organizations to enable and enhance testing capability and capacity with their available instrumentation.

IMPACT: The alternate assay the team developed to diagnose COVID-19 allowed a large medical center to proceed with in-house testing rather than rely on sending patient samples to third parties and created a novel method to re-purpose other machines for COVID-19 testing.

26.

Collaborative Robots to Automate COVID Testing Leads to 300% Increase in Lab Throughput

INSTITUTE: ARM (CARES Act funding: NIST)

PROJECT PARTICIPANTS: Wilder Systems (Austin, TX)

DESCRIPTION: This team built a deployable automated testing instrument with a seven-axis robotic arm requiring minimal human interactions to address the lack of skilled technicians to operate COVID-19 testing instrumentation at full capacity and minimize exposure of medical personnel.

IMPACT: Current testing capacity is limited by the number of technicians in the U.S. By augmenting the labor force with robots, this project set out to increase the number of tests conducted at hospital and university labs and minimize exposure to essential medical personal. This system improved testing time seven-fold using the same number of staff. As a result, more people to have access to testing and more rapid test results through continuous and automated advanced manufacturing innovation. This robotic work cell was conceived, funded, developed, produced and utilized in Austin, TX in less than 5 months.

Robotic arm places COVID-19 saliva samples for fast and cost-effective automated testing. Credit: Wilder Systems

27.

Low-Cost Photonics for Biomedical Assays: Rapid, Compact, Microfluidic COVID-19 Test

INSTITUTE: AIM PHOTONICS (CARES Act funding: DoD)

PROJECT PARTICIPANTS: Ortho Clinical Diagnostics (Rochester, NY), Syntec Optics (Rochester, NY), USCB (Santa Barbara, CA), NY CREATES (Albany, NY)

Description: This project will create an optical chip on a disposable card that can detect exposure to multiple viruses within a minute—including the coronavirus that causes COVID-19—from a single drop of blood, and can be manufactured in multiple chip foundries in the US.

IMPACT: The availability of rapid COVID-19 antibody tests is important for assessing vaccine performance. Combined with a commercial high-volume clinical analyzer, this will result in a functional point-of-care testing within facilities such as hospitals that currently own these existing analyzers. The card will enable clinicians not only to detect and study COVID-19, but also to better understand potential relationships between COVID-19 infection and previous infections and immunity to other respiratory viruses, including circulating coronaviruses that cause the common cold. The test is designed to address ongoing needs including vaccine response and immunity to mutant COVID-19 strains.

Demonstration of the automation of LFA (rapid) test strip evaluation using advanced vision systems and flexible robots. Credit: Siemens Corporation Corporate Technology

28.

Rapid Robotic Diagnostic Kit Discovery

INSTITUTE: ARM (CARES Act funding: DoD)

PROJECT PARTICIPANTS: Siemens Corporation Corporate Technologies (Princeton, NJ), Maxim Biomedical Inc (Rockville, MD), Siemens Healthineers (Cary, NC)

DESCRIPTION: This project will develop a solution utilizing advanced vision systems and flexible robots to accelerate Lateral Flow Assay (LFA) test development by automating LFA test-strip evaluation. LFA test strip evaluation today requires at least two technicians – one to run the assay and one to interpret results using analyzers that image and quantify individual strips.

IMPACT: While many tests for COVID-19 have been developed, the U.S. still has not reached the scale necessary for effective management and control. COVID-19 Polymerase Chain Reaction (PCR) tests can have long turnaround times (2 to 3 days for lab results). Rapid development of COVID-19 LFA tests would dramatically aid the United States' efforts towards large-scale testing for current and future pandemics.

DECONTAMINATION FOR PUBLIC SPACES

While using hand sanitizer and disinfectants is the norm, the institutes' technology focus areas allow for novel approaches to decontaminating surfaces. NIST and DoD have funded six projects to develop methods and tools that rapidly decontaminate affected spaces in response to uncertainty of the virus lifecycle (as an aerosol and on surfaces). The success of these projects may help ensure public health sufficiently to allow a more rapid return to normal operations. As the country returns to the work place, these products could help restore the economy.

29.

Vapor-Phase Hydrogen Peroxide as a Rapid Viral Decontamination Agent for Clinical and Public Spaces

INSTITUTE: NIIMBL (CARES Act funding: NIST)

PROJECT PARTICIPANTS: PMT, Inc. (Longmont, CO) in collaboration with Solvay (Houston, TX)

DESCRIPTION: This team is developing and analyzing effectiveness of vapor-phase hydrogen peroxide spray fogging technology for decontamination of clinical and public spaces. The team designed a testing protocol around Environmental Protection Agency (EPA) Product Performance Testing Guidelines and is working to scale a quick and minimally invasive way to decontaminate larger spaces.

IMPACT: This project will provide effective decontamination technology to reduce public exposure to unsanitary conditions for airborne and surface-borne contaminants across healthcare and high-traffic industries (transit, travel, transport).

Vapor Phase Fogging and Detection Equipment. Credit: NIIMBL/ PMT (USA) LLC

30.

Automated Continuous Cleaning to Fight COVID-19 and Other Severe Pathogen

INSTITUTE: NEXTFLEX (CARES Act funding: DoD)

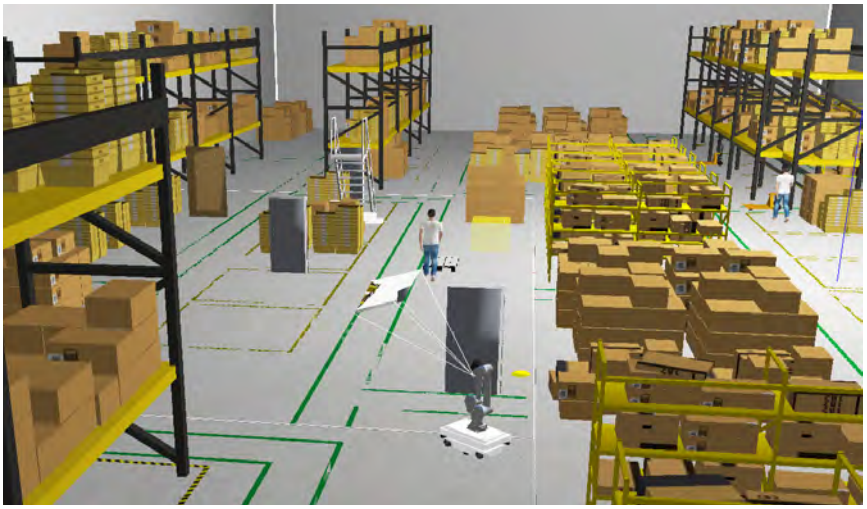
PROJECT PARTICIPANTS: Aionx Antimicrobial Technologies, Inc. (Hershey, PA) and Contamination Source Identification (CSI), LLC (Huntingdon, PA)

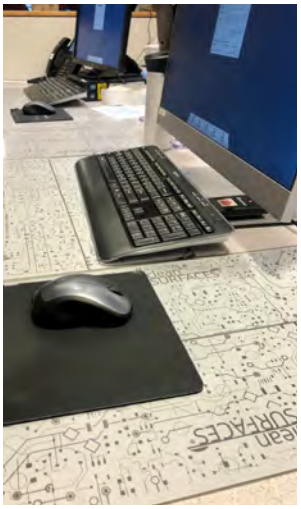
DESCRIPTION: The pandemic has intensified the need to keep surfaces clean, and hospitals are vowing to clean high-touch surfaces as often as possible to build public trust and maintain safety. Despite this, surface contact infections remain high for viruses and bacteria, and can often remain after surface cleanings even if proper episodic procedures are followed. The break between cleanings is the focal point of Aionx's research and development because any surface can harbor new microbes as soon as cleaning ceases. Aionx, in partnership with NextFlex, utilized novel RNA sequencing technology from CSI to prove the environmental contamination existence and transmission pathway, and refined and expanded production capacity of antimicrobial mats called cleanSURFACES. Any time microbes contact a mat's surface, an embedded circuit board sends a micro-electric impulse along printed conductive traces to that location to activate antimicrobial silver and copper ions that quickly eradicate the microbes.

IMPACT: This technology can be used to fight hospital-acquired microbial infections, COVID-19 in the short-term, and potentially the variants of COVID-19 that arise in the future. The application of this innovation to public, medical, and retail infrastructure in the long-term could impact control of future outbreaks, especially during flu seasons. Recognizing this, Aionx reached out to the neighboring University of Pittsburgh Medical Center (UPMC) hospital system to bring the technology onboard for a successful validation study. Study partner, CSI, used unique RNA sequencing techniques capable of isolating and identifying with strain-level specificity the RNA of thousands of microbes from simple surface samples which demonstrated the impact on a hospital unit's surface microbiome. Together, Aionx (a member of NextFlex) and UPMC are now installing the technology in six hospital ICUs for a six-month experiment to measure pre- and post-infection rates.

Left: Simulation of autonomous warehouse disinfection system. Credit: Siemens Corporation Corporate Technologies

Right: Aionx CleanSurface mat. Credit: Nextflex





31.

Autonomous Robotic Spraying and Disinfection in Warehouses and ShipYARDS

INSTITUTE: ARM (CARES Act funding: DoD)

PROJECT PARTICIPANTS: Siemens Corporation Corporate Technologies (Princeton, NJ), Fedex Corporation (Memphis, TN), and Yaskawa Motoman (Miamisburg, OH)

DESCRIPTION: This project will develop an autonomous warehouse disinfection system that can automatically navigate, locate, and disinfect heavily touched surfaces and potentially contaminated areas. This process will minimize the human role in harmful disinfecting procedures while reducing costs.

IMPACT: Logistics and support operations have played a vital role in supporting the nation by supplying medical supplies and essential goods to millions of Americans. To control the spread of COVID-19 in these facilities, more frequent and reliable disinfection is required. A demonstration of this robotic system will be available in Fall 2021.

32.

Mobile Autonomous Industrial Disinfector (MAID)

INSTITUTE: ARM (CARES Act funding: DoD)

PROJECT PARTICIPANTS: Lockheed Martin Advanced Technologies Laboratories (Cherry Hill, NJ), GrayMatter Robotics (Los Angeles, CA), Southwest Research Institute (San Antonio, TX), Lockheed Martin Rotary Mission Systems (Washington, D.C.)

DESCRIPTION: This project will develop an autonomous mobile robot with a mounted collaborative multi-axis robotic arm capable of manipulating both a disinfection system and a sensor suite. The system will identify areas that need to be disinfected, execute the disinfecting process, and keep records of the cleaning tasks completed.

IMPACT: Due to the rapid transmutability of COVID-19, frequent surface disinfection is required for businesses and workspaces to operate safely. The current method of manual cleaning is not ideal because it puts into the space another person who could get sick or transmit the virus. A demonstration of the robotic system will be available in fall 2021.

33.

Autonomous Mobile Capability for Room Disinfecting Robots

INSTITUTE: ARM (CARES Act funding: DoD)

PROJECT PARTICIPANTS: QinetiQ North America (Waltham, MA), MassRobotics (Boston, MA)

DESCRIPTION: Schools, offices, military bases, and manufacturing floors need to be disinfected between shifts to minimize the spread of COVID-19. The Decon–X (DX1) disinfecting system has proven its effectiveness in Europe, but currently lacks the mobility and autonomy to disinfect spaces without an operator. An automated solution is required to ensure workers return to a COVID-free environment each day.

IMPACT: This project is aimed at adding mobile autonomous capabilities to the DX1 room disinfection system to automate the consecutive treatment of multiple rooms and spaces within workplaces. The addition of mobility and autonomous navigation to the DX1 will enable the robot to move from room to room and perform a series of treatments with little to no human intervention. A demonstration of the robotic system will be available in Fall 2021.

34.

Robotic Application of Anti-Microbial Copper Coatings

INSTITUTE: ARM (CARES Act funding: DoD)

PROJECT PARTICIPANTS: Siemens Corporation Corporate Technologies (Princeton, NJ), VRC Metals System (Box Elder, SD)

DESCRIPTION: This project will develop a robotic anti-microbial copper application system (cold spray), integrating a scanner and developing an automated path generation and quality assurance tools to apply the copper coating to components like doorknobs, hospital benches, carts, handrails, etc.

IMPACT: Copper-coated surfaces rapidly kill coronaviruses like COVID-19, but these have not been widely manufactured due to low demand. However, the pandemic has highlighted the need for self-disinfecting surfaces. Robotic cold-spraying of copper will enable rapid production to meet the new demand. Wide adoption of copper-coated surfaces will reduce the spread of COVID-19 without the need for frequent cleaning. The robotic application of copper coating will improve the manufacturability of these parts. A demonstration of this system will be available on Fall 2021.

WORKFORCE TRAINING IN COVID-19 IMPACTED COMMUNITIES

According to Deloitte/Manufacturing Institute an estimated 2.4 million manufacturing jobs will go unfilled by 2028. The gap between available advanced manufacturing jobs and the required skilled workforce existed long before COVID-19. Understanding the institutes' core commitment to advancing manufacturing education and workforce development, NIST funded a project geared towards taking advantage of the ever increasing virtual environment. This project seeks to adopt programs to support manufacturers and their workforce impacted by COVID-19 to retool and upskill as companies adopt new technologies and increasingly virtual operations.

Collaborating to Increase Opportunities in Careers in Additive Manufacturing

35.

INSTITUTE: AMERICA MAKES (CARES Act funding: NIST)

PROJECT PARTICIPANTS: SME ToolingU (Southfield, MI), MxD (Chicago, IL), NOCTI (Big Rapids, MI), Bull City (Durham, NC), Fab Lab Hub (Sante Fe, NM)

DESCRIPTION: As part of the above-mentioned AMCPR project, America Makes is working with key partners to encourage, inspire, and train workers and students affected by the COVID-19 pandemic.

IMPACT: Career pathway resources for middle/high school students to college programs to reskill/upskill current workers are being created as of this writing. These resources will include, among other things: funding for 1,000 scholarships for incumbent workers/students to access Tooling U/SME additive manufacturing content; 85 scholarships for SME credentials, validated by America Makes, in a variety of additive manufacturing categories; and more than 10 eLearning modules for middle schoolers and a new industry credential for high school students.

36.

Adapting Operation Next – a Successful Transitioning Military Training Program – for Civilians Impacted by the Pandemic

INSTITUTE: LIFT (CARES Act funding: NIST)

PROJECT PARTICIPANTS: Catalyst Connection, a PA Manufacturing Extension Partnership (MEP) Center (Pittsburgh, PA), and Workforce Intelligence Network (Detroit, MI). Performance-based training partners are at Allegheny County Community College and New Century Careers in Pittsburgh and the LIFT Learning Lab and Henry Ford and Macomb Community Colleges in Detroit.

DESCRIPTION: As post-pandemic economic recovery begins, manufacturers are expected to accelerate technology integration, and it is critical that incumbent and returning-to-work employees have the competencies to be successful in changing workplaces. LIFT is implementing the proven Operation Next accelerated curriculum to upskill small and medium manufacturers' employees. In addition, the collaborative is leveraging the unique assets of the Operation Next learning platform to provide higher level training in topic areas specifically aligned to each regional economy. The training is also being made available to dislocated workers and individuals struggling to establish career pathways in the midst of the pandemic.

IMPACT: This training provides attendees the skills necessary for rapid transition into the advanced manufacturing industry and arms incumbent workers with requisite new skills and competencies. These pilot programs will create models that can be replicated nationally to train individuals for in-demand advanced manufacturing jobs.

In another educational initiative, LIFT distributed kits to students who had been participating at the LIFT Learning Lab as part of its IGNITE: Mastering Manufacturing program when their schools closed due to the pandemic. Three different kits provided hands-on study and projects for students to learn and practice the basics of electronic circuitry, software, and Newton's laws of energy. Credit: LIFT

Kenny Murphy practices his new welding skills in the LIFT Learning Lab. Credit: LIFT

LESSONS LEARNED

American innovation and can-do spirit are illustrated every day through the pioneering work of the manufacturing innovation ecosystems generated and nurtured by the Departments of Commerce, Defense, and Energy and their sponsored institutes. The pandemic has magnified both challenges and opportunities facing our nation. The institutes' work reveals that regional collaboration was critical for the small manufacturers where unique facilities were needed to validate an approach or ecosystem coordination was required. The lessons from COVID-19 also reveal that public-private partnership enabled a whole of nation response through rapid and efficient solutions.

The pandemic response revealed that supply chain resiliency is ever evolving. When disruptions occur, experts need to be convened to harness the full capability of the nation. While the COVID-19 projects above address some of the immediate challenges, the projects also reveal greater opportunities to modernize and strengthen U.S. manufacturing resiliency and better prepare for the future.

The Manufacturing USA network will continue to meet present and future challenges and opportunities to reimagine manufacturing in America and improve our future preparedness through:

- **Expanding regional collaborations to support advanced manufacturing** – A stronger connection between government, industry, and academia can help small manufacturers with technology transfer, access to information and resources to help their business grow, and prepare for and rapidly respond to the next national crisis.
- **The public-private partnership model at the foundation of the manufacturing innovation institutes shows proven success in bridging industry technology gaps** – Enabling novel advanced manufacturing technologies supports U.S. competitiveness, national security and economic resiliency.
- **Building supply chain resiliency** – A nationwide system of supply chain, data exchange, and technology expertise on demand could help guide manufacturing through the next large disruption.
- **Accelerating advanced manufacturing workforce development** – A stronger jobs pipeline from K-12 to technical, vocational post-secondary, and advanced STEM education for worker reskilling and upskilling, returning veterans, and underserved regions and populations will address severe skilled worker shortages across the nation.

For more information and institute contacts visit ManufacturingUSA.com.

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