The Glenn Research Center Regional Economic Development (RED) program seeks to establish regional partnerships with external organizations that lead to economic development by the private sector in business sectors of critical importance to the region and the Nation. RED’s goal is to create jobs, new technologies and products, and new and expanded supply chains for NASA; and to increase, in measurable ways, the commercialization and deployment of NASA-developed technology.

The RED program connects Glenn’s competencies with comparable competencies in the region, creating a unique approach to Midwest economic development that can be applied at the local, regional, and national levels. Glenn’s core competencies are:

- Air-Breathing Propulsion
- Communications Technology and Development
- In-Space Propulsion and Cryogenic Fluids Management
- Power, Energy Storage and Conversion
- Materials and Structures for Extreme Environments
- Physical Sciences and Biomedical Technologies in Space

Despite being a newer initiative, the RED program has seen an abundance of activity with exciting results, including the creation of new products, increased revenue, and additional jobs for companies in the Midwest region.

RED has three primary products: the Adopt-a-City program, Technology Roadshows, and Tech Connect events. These initiatives present opportunities to collaborate with industry partners to ensure that NASA capabilities and expertise help create innovative research and engineering solutions to the toughest technical challenges. RED accelerates technology commercialization and innovation by making Glenn’s assets — intellectual property, subject matter experts, test and evaluation services, and more — available to the community.

Glenn leads the Agency’s Water Initiative, which is designed to identify and mine water-related technologies across the 10 NASA centers and deploy them to address technology challenges for small and midsized companies in the water space. In 2017, RED played a pivotal role in Erie Hack, an international water innovation competition and accelerator program with the Cleveland Water Alliance, who awarded over $100,000 to encourage creative, enduring solutions to regional water challenges.

As with any investment, the real impact of programs like RED are difficult to measure by calendar year. This report focuses instead on success stories over the life of the program, allowing us to celebrate with companies like Fire-Dex, whose involvement in a 2015 Roadshow led to recent innovations in evaluating new heat-resistant gear for firefighters, and Pile Dynamics, Inc., whose consultations with NASA experts through the 2012 Adopt-a-City program helped refine the sensor technology used in pilings supporting Cleveland’s eastbound George V. Voinovich Bridge, completed in 2016.
ADOPT-A-CITY

Leveraging NASA’s Subject Matter Experts To Solve Technological Challenges in the Greater Cleveland Area

Adopt-a-City provides up to 40 hours of pro bono NASA Glenn subject matter expert assistance to small and midsized manufacturers to help solve technical challenges with a new or existing product. In addition to the 40 hours of assistance, finalists are also eligible for up to $50,000 in low-interest loans from the city of Cleveland and Cuyahoga County.

Adopt-a-City is a joint effort by NASA Glenn, the city of Cleveland, Cuyahoga County, and the Manufacturing Advocacy and Growth Network (MAGNET).

Adopt-a-City focuses on challenges where a quick solution will result in significant revenue and/or job creation for the company. Adopt-a-City’s success is in helping companies make informed decisions early on in the design cycle, whether it is for a new product, an existing product, or a process used to get a product to market. This reduces risk and improves the chances for strengthening the company’s economic footprint.

As a result of their interaction with Glenn SMEs, Adopt-a-City participants report that they have been able to:

- Improve a new product design for better efficiency
- Modify an existing design to meet new regulatory requirements
- Evaluate a material processing technology to mitigate wear on items in their current process
- Increase production rates to meet a growing market need
- Gain insight into the state of the art in materials testing, which may lead to a new product line

In 2016, eight companies were selected to participate in the third iteration of Adopt-a-City. The technical effort for six of the companies is complete, with closeout planned for early 2018.

Economic Impact Realized by Adopt-a-City Participants

<table>
<thead>
<tr>
<th>Reported as of December 31, 2016</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of units sold</td>
<td>763,814</td>
</tr>
<tr>
<td>Revenue generated</td>
<td>$6,203,680</td>
</tr>
<tr>
<td>Private dollars invested in projects</td>
<td>$35,299,822</td>
</tr>
</tbody>
</table>

*Metrics collected by MAGNET using MEP approach.

Company: BioInVision, Inc., located in Cleveland, Ohio, was developing a 3D microscopic cryo-imaging system that can detect and spatially map nearly every stem cell in a mouse or organ to help solve biotechnology problems in cancer and stem cell research.

Challenge: To reduce overall system size and cost by eliminating complex 2D scanning.

Solution: NASA Glenn’s electro-optical specialists worked with BioInVision to recommend and test a low-cost image capture device system that met the company’s requirements.

“We will be able to augment our line of existing products … and grow our revenue as well as our employment. … NASA was a huge advantage to us.”

– Debashish Roy, President, BioInVision

Company: Zuga Medical, Inc., is a Cleveland company that designs, manufactures, and markets innovative dental implant systems.

Challenge: Zuga sought NASA’s expertise to find the right material for a new implant and abutment system that would enable dental professionals to reduce chair time, eliminate some outsourced patient and laboratory services, and allow general dentists to perform the complete patient services with fewer visits.

Solution: A team of NASA chemical, ceramics, and materials and structures subject matter experts conducted an analysis of alternative polymeric and ceramic materials to identify potential abutment materials. Zuga chose a high-temperature polymer matrix resin developed at NASA Glenn as a viable candidate.

“NASA actually helped Zuga Medical to develop this project, from material selection to material stress and fatigue testing. Overall, NASA helped us a lot and I am really happy to be working with them.”

– Dr. Chan Wang, MDD
Chief Executive Officer and Founder, Zuga Medical, Inc.

ADOPT-A-CITY PARTICIPANTS

2012
- BioInVision, Inc. (Cleveland)
- Zuga Medical, Inc. (Cleveland)
- MegaJoule Storage, Inc. (Cleveland)
- Morrison Products, Inc. (Cleveland)
- Pile Dynamics, Inc. (Sutton)
- Gotta Groove Records, Inc. (Cleveland)
- Vadco Energy (Cleveland)
- Sensor Development Corporation (Elyria)

2013
- AlSher APM LLC (Cleveland)
- Mace Security International (Cleveland)
- MegaJoule Storage, Inc. (Cleveland)
- Mescoaat, Inc. (Euclid)
- SkyXun LLC (Bay Village)
- Steanotics, Inc. (Cleveland)

2016
- AlSher APM LLC (Cleveland)
- Arzel Zoning Technology, Inc. (Warrensville Heights)
- Eneco Group, Inc. (Cleveland)
- Health-Mor, Inc. (Strongsville)
- Hunt Imaging (BerEA)
- Infinite Arthroscopy, Inc., Ltd. (Cleveland Heights)
- NSL Analytical Services, Inc. (Warrensville Heights)
- Sustainable Coatings, Inc. (Strongsville)
TECHNOLOGY ROADSHOWS
Leveraging NASA’s Subject Matter Experts To Solve Technological Challenges in the Greater Cleveland Area

Glenn Technology Roadshows are one of the ways Glenn is fulfilling the NASA RED mission to catalyze and infuse regional ecosystems with NASA capabilities for a stronger economy. Roadshows offer regional manufacturers unique access to the expertise of NASA researchers and technologists.

Companies are competitively selected to receive up to 8 hours of dedicated consultation with NASA experts who are committed to helping them solve technological challenges with a specific process or product.

Each company submits a technical challenge statement during the application process. RED works with MAGNET and other development organizations to select the companies that will participate. Company representatives then consult with NASA subject matter experts, who delve into alternative methods to solve the technical issues.

Partnering with MAGNET and others, Glenn has hosted five Roadshow events since 2013. Glenn experts have helped 36 companies solve technical challenges ranging from computational modeling, tire coatings, and RFID technology to ambulance sterilization, 3D printing, and heatproof materials testing. A 2014 Roadshow focused specifically on fuel cell technology.

TECH CONNECT
An expansion of NASA’s Technology Roadshows, Tech Connect events leverage technical knowledge gained through NASA mission work to solve manufacturing problems and improve the local economy. Tech Connect provides an opportunity for companies to receive up to 40 hours of assistance from NASA experts to find innovative solutions to their specific technological challenges.

Selected companies initially receive up to 8 hours of consultation with NASA subject matter experts. They can then apply and compete for an additional 32 hours of expert assistance from NASA. A total of 19 Ohio and Pennsylvania companies were served through Tech Connect events in 2016.

“Tech Connect events
2. FASTLANE TECH CONNECT – August 23, 2016. Dayton event hosted by FastLane, a nonprofit West Central Ohio Manufacturing Extension Partnership (MEP) affiliate led by the University of Dayton Research Institute.
3. CATALYST CONNECTION TECH CONNECT – November 16, 2016. Onsite Glenn event hosted by Catalyst Connection, Pittsburgh’s regional MEP.

ROADSHOW SUCCESS
Company: Catacel, a manufacturer of catalysts on thin metal foil substrates for a variety of energy applications.

Challenge: Setting up test models for computational fluid dynamics and extracting the appropriate data.

Solution: After consulting with NASA experts Chris Johnson and Maria Kuczynska, Catacel’s technical team was able to advance their models and extract the data they needed. Their technology subsequently attracted a global catalyst company.

“Did you know that NASA consultation led to additional understanding that made Catacel technology more attractive to our new parent company?”
– Catacel cofounder William Whittenberger

TECH CONNECT SUCCESS
Company: Jordan Valve, a division of Richards Industries in Cincinnati.

Challenge: Jordan Valve was seeking a unique type of coating to improve performance of one of their sliding gate technologies in high-temperature environments. Improving the hardware would allow them to compete in a new business sector.

Solution: Glenn experts from the Mechanisms and Tribology Branch and Fluid and Cryogenic Systems met with Jordan Valve representatives and pointed them to a new coatings source.

“This is definitely going to add to our workforce, it’s going to add to our product line, and it’s just going to make our operation a lot healthier, that’s for sure.”
– David Meyer, Adaptive Development Corporation Dayton FastLane Tech Connect participant

Francisco Solá-Lopez, RED Specialist, discusses technologies with Dave Ellis, subject matter expert from Glenn’s Materials division.

Nigel Glenn’s RED team answers questions at a networking event sponsored by the Ohio Federal Research Network (OFRN) at the Ohio Aerospace Institute.

Tech Connect events
A shared commitment to protecting and improving Great Lakes water systems has resulted in a strong and productive partnership between NASA Glenn and the Cleveland Water Alliance (CWA). In 2015, Glenn and the CWA co-led the Ohio Water Innovation Summit, an event that focused on serious water issues in the Great Lakes and worldwide. This collaboration led to a January 2017 Space Act Agreement centered on sparking economic growth in the water innovation sector. The Great Lakes region, with over 20 percent of the world’s fresh water and a regional economy that generates almost $6 trillion annually, presents a significant opportunity for economic growth. Glenn RED has partnered with the Cleveland Water Alliance and The Water Council (Milwaukee), who will serve as bridges between regional technology needs and NASA capabilities. NASA RED will act as a connector and catalyst, connecting people, companies, and ideas to RED resources, both physical and advisory.

In March 2018, The Water Council (Milwaukee) will host the first-ever NASA Tech Connect event based on water technologies. Competitively selected water technology companies will consult with NASA subject matter experts on water-related technological challenges.

In February 2017, 45 teams ranging from high school students to experienced professionals selected a challenge statement and the corresponding toolkit assembled by their regional research partner. Teams competed for $100,000 in prizes for the most creative and effective hacks. A number of local foundations provided funding support. Mentors from sponsoring organizations helped teams construct data-driven solutions to present at an April 13 challenge event held at Cleveland’s Global Center for Health Innovation, featured keynote speakers Jeff Hoffman, partner and cofounder of ColorJar and Priceline, and Rebecca Kwiat (ATS) of the NASA Creativity and Innovation Team.

From left to right: Mads Warming, Danfoss Drives Global Segment Director for Water and Wastewater; Laurie Stauber, NASA Water Initiative Lead; and Rebecca Kwiat (ATS) of the NASA Creativity and Innovation Team.

Erie Hack winning team from Wayne State University.

Dr. Jay Famiglietti, senior water scientist at NASA’s Jet Propulsion Laboratory.

Water Initiative Lead, and Rebecca Kwiat (ATS) of the NASA Creativity and Innovation Team. They held six ideation sessions with participants from government, foundations, universities, and city and environmental organizations.

Three ideation sessions were held in Cleveland and one each in Toledo, Buffalo, and Detroit, all cities adjacent to Lake Erie. Windsor

invasive species to algal blooms and toxic agricultural waste.

Challenge statements for the competition were captured in a series of ideation sessions conducted by Laurie Stauber, NASA Water Initiative Lead, and Rebecca Kwiat (ATS) of the NASA Creativity and Innovation Team. They held six ideation sessions with participants from government, foundations, universities, and city and environmental organizations.

Three ideation sessions were held in Cleveland and one each in Toledo, Buffalo, and Detroit, all cities adjacent to Lake Erie. Windsor

“NASA’s role in this initiative is to share our intellectual technologies, and other capabilities for freshwater solutions for the Great Lakes and the Nation. Ultimately, the goal of Erie Hack is to encourage new industry and create jobs to improve the regional economy.”

– Laurie Stauber, NASA Water Initiative Lead

Director of the Ohio Environmental Protection Agency; Karl Gebhardt, Executive Director of the Ohio Lake Erie Commission and Deputy Director of the Water Resources Ohio Environmental Protection Agency; and many others, including a panel of NASA subject matter experts.

The winning team, Micro Buoy (Wayne State University), received $40,000 in cash and close to $10,000 in support services to help commercialize their hack—a buoy-based nano-sensor designed to detect and report contaminants in water. ExtremeComms Laboratory (University of Buffalo) took second place with their design for a network of underwater sensors to transmit information long distances. Water Warriors (University of Akron) placed third with a spectrometer designed to detect nitrogen and phosphorus in the lake. PuriLytics (University of Michigan) placed fourth with a system for tracking home water usage.

Erie Hack follow-on activities included the Internet of H2O summit in Port Clinton (October 2017) and the Internet of Water Roundtable in Detroit (November 2017).

Adapted in part from the April 2017 Aerospace Frontiers article “Glenn Partners to Solve Lake Erie Challenges.” Read the full article online at https://www.nasa.gov/sites/default/files/atoms/files/af_april2017r.pdf
Fire-Dex manufactures protective clothing worn by firefighters.

**CHALLENGE**
The number one job-related injury for firefighters is heat stress, so Fire-Dex is always looking for ways to test and improve their thick, heavy products. They were interested in learning how NASA tackles issues of heat stress and efficiency in designing and testing gear for astronauts.

**NASA RED CONNECTION**
Fire-Dex was selected to participate in a Canton Roadshow jointly sponsored by Glenn, the Manufacturing Advocacy and Growth Network (MAGNET), the Greater Akron and Canton Chambers of Commerce, Stark Economic Development, and Stark State College.

**SOLUTION**
Fire-Dex representatives consulted with three NASA experts who conduct research on astronaut space suits: Senior Materials Research Engineer Fran Hurwitz at Glenn; Evelyne Orndoff, Soft Goods Development and Testing, Lead, Johnson Space Center; and Henry Tang, Jacobs Technology, Senior Materials Research Engineer and Advanced Materials Laboratory Manager, Johnson Space Center. Fire-Dex representatives learned that NASA measures metabolic rate as one way to test the impact of various materials on astronaut performance. Since consulting with NASA, the firm has taken a more holistic approach to their design and material research.

**SUCCESS**
Fire-Dex recently launched a new product that is significantly lighter than any other product in fire protective gear. The growing company broke ground in 2017 for a 29,000-square-foot addition and expects to add 30 new full-time jobs by 2021.

“*We have lots of data at the material level but we are now striving to understand the true physiological impact through ensemble level testing. Understanding the science NASA uses helps us make a difference in the health and safety of firefighters and first responders across the world.*”

— Todd Herring
Director of Marketing and Product Development, Fire-Dex

Emergency Products + Research (EP+R) designs and manufactures emergency medical products. In 2014, the company began development of AMBUstat™, a portable device designed to decontaminate and sterilize ambulance interiors between patients.

**CHALLENGE**
The company needed expert advice on using oxidizers to decontaminate surfaces without damaging sensitive equipment inside the ambulance.

**NASA RED CONNECTION**
EP+R connected with the Manufacturing Advocacy and Growth Network (MAGNET), the regional Manufacturing Extension Partnership, at a NASA Glenn Roadshow in Akron.

**SOLUTION**
RED Midwest Manager Laurie Stauber connected EP+R with Sharon Miller, a subject matter expert in atomic oxygen plasma who works in NASA’s Environmental Effects and Coatings Branch. (NASA uses atomic oxygen plasmas to test durability of spacecraft materials for use in low Earth orbit and Mars orbit.) Miller advised EP+R on oxidation-sensitive surfaces and reactions and guided company representatives in setting up a test plan for the products.

**SUCCESS**
EP+R has implemented the AMBUstat™ system in public health agencies around the country. Through its pilot programs in key regions, the firm continues to identify best practices to achieve the effective decontamination of spaces while minimizing downtime and optimizing safety.

“We have met with public health officials and academics from around the world and we believe that our system will be adopted as the global standard for ensuring protection from pathogens in spaces that should be free of infective microorganisms.”

— Vice President Jason Thompson, EP+R
PRODUCT
Pile Dynamics, Inc. (PDI) is the world’s largest manufacturer of foundation dynamic testing equipment. PDI specializes in developing pile testing systems for quality control and integrity testing of deep foundations. PDI’s Thermal Integrity Profiler (TIP) measures the heat generated by curing cement to assess concrete quality in foundation piles.

CHALLENGE
The thermal sensors embedded in the piles to measure concrete temperatures were subject to damage from moisture ingression. The adhesive line bond between the sensor lead wires and the epoxy resin used to protect the sensors had an issue with moisture permeation that resulted in damage to the sensors. In addition, curing of the epoxy coating had been inconsistent. The challenge was to find a cost-effective method to consistently mass-produce the waterproofing technique and keep moisture from reaching the sensors.

NASA RED CONNECTION
PDI was selected to receive up to 40 hours of expert help through the Adopt-a-City program. PDI representatives met with materials researchers at Glenn to investigate low-cost, watertight materials that would make the thermal sensors resistant to the wet concrete environment.

SOLUTION
NASA surveyed epoxy resins for their ability to bond to PVC-class wire coatings. In parallel, PDI identified a polyacrylate material that passed their quality assurance tests but needed to understand how it prevented moisture permeation. NASA evaluated the bond formed by the adhesive material with the sensor leads to determine how the water sealing characteristics were achieved. Tests were also performed to determine the weakest link failure mechanism between the adhesive material and the sensor leads. Information about building foundation (pile) integrity is now available shortly after concrete pours are concluded. Improved sensor reliability reduces risk in assessing the integrity of cast-in-place concrete foundations.

SUCCESS
As a result of the success with this improvement to the sensor reliability, PDI opened a new manufacturing line and increased their workforce, and PDI’s new, more reliable sensor is being promoted to a wider health monitoring market for dams and levees in the United States and worldwide. Locally, thermal sensors incorporating NASA’s contribution were placed in the 150-foot-deep drilled shafts that support the eastbound George V. Voinovich Bridge, completed in 2016.

SUCCESS STORIES
Gotta Groove Records – Cleveland, OH

PRODUCT
Gotta Groove Records (GGR) is the only fully vertically integrated vinyl record manufacturing operation in the world. GGR is a one-stop source for lacquer mastering, record electroforming, record pressing, label/jacket/sleeve printing, download code hosting, crowdfunding, wholesale distribution, and consumer-direct fulfillment.

CHALLENGE
In 2012, this young company was seeking to increase production by modernizing their 1970s-era record presses. Three major issues needed addressing: (1) alignment between the two halves of the press, (2) temperature control and sensing, and (3) records sticking to the top of the press after pressing rather than falling onto the stack.

NASA RED CONNECTION
GGR was connected with electrical engineers at NASA Glenn through the Adopt-a-City program.

SOLUTION
NASA electrical engineers worked with the GGR team to design a new positioning system and provided a number of options for updating the control systems. They also grounded the release mechanism to the rest of the press, eliminating the static electricity buildup that was causing records to stick.

SUCCESS
As a result of the Adopt-a-City program and the support they received from NASA Glenn, GGR implemented technology and processes that had never been used on record-pressing equipment anywhere in the world, improving efficiency and productivity. The company is thinking, as of 2016, GGR had worked on over 8,000 individual vinyl releases.
**SUCCESS STORIES**

**Vadxx Energy – Cleveland and Akron, OH**

**PRODUCT**
Vadxx Energy manufactures synthetic crude oil using waste plastics and difficult-to-recycle industrial products.

**CHALLENGE**
To increase efficiency, Vadxx wanted to explore methods of maximizing petrochemical products output. They required assistance in modeling and optimizing their rotary kilns.

**NASA RED CONNECTION**
Vadxx was competitively selected to receive up to 40 hours of expert help from NASA through the Adopt-a-City program in 2013.

**SOLUTION**
NASA collaborated with Vadxx to develop analytical computer models for predicting throughput rates and provided efficiency improvements needed for additional energy production. NASA Glenn also helped the company’s technical team fine-tune their commercialization efforts.

**SUCCESS**
In 2016, Vadxx Energy opened its first commercial-scale plant to turn plastic waste into energy. Vadxx Energy anticipated that the regional operation, located in Akron, would recycle almost 60 tons of waste plastics per day, diverting them from landfill disposal.

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**SUCCESS STORIES**

**MegaJoule Storage, Inc. – Cleveland, OH**

**PRODUCT**
MegaJoule Storage, Inc., is an advanced battery and capacitor technology development company focused on the use of cells with power management and inversion.

**CHALLENGE**
MegaJoule was developing a lead acid battery in a capacitor for stationary power storage. The application life required a coating for the electrode that was flexible, very conductive, and able to withstand a wet sulfuric bath.

**NASA RED CONNECTION**
The company was competitively selected to receive up to 40 hours of expert help from NASA through the Adopt-a-City program in 2013.

**SOLUTION**
NASA subject matter experts from the Electrochemistry Branch worked with MegaJoule to investigate commercial suppliers of polymeric coatings and coating application techniques to uniformly coat the electrode and protect it against corrosion from the sulfuric acid electrolyte.

**SUCCESS**
NASA's assistance provided an initial overview of the design and analysis to bring MegaJoule's power management end product closer to market.

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**SUCCESS STORIES**

**Sensor Development Corporation – Cleveland, OH**

**PRODUCT**
Sensor Development Corporation designs, develops, and manufactures high-sensitivity devices for detecting the mold that produces aflatoxin.

**CHALLENGE**
The current design required operation of the sensor element at higher temperatures. The challenge was to provide a circuit board and sensor element package that would provide reliable operation for extended periods of time while minimizing power consumption.

**NASA RED CONNECTION**
Sensor Development Corporation was competitively selected to receive up to 40 hours of expert help from NASA through the Adopt-a-City program.

**SOLUTION**
NASA sensor engineers worked with Sensor Development Corporation engineers to develop effective, energy-efficient packaging for the sensor element and circuit board.

**SUCCESS**
As a result of the support from NASA Glenn, the company was ready to begin final development of a sensor system to provide real-time monitoring for early detection of molds to prevent a widespread outbreak.
Through the RED program, NASA engages in regional collaboration and partnership building in an effort to share its expertise with businesses and to participate in regional technology innovation clusters that are in place across the country.

**Aerozone Alliance:** Berea, Brook Park, Cleveland, Fairview Park, North Olmsted, and Cleveland Hopkins International Airport

**City of Cleveland**

**Catalyst Connection**

**Cleveland Engineering Society (CES)**

**Cleveland Water Alliance**

**Cuyahoga County**

**Jobs Ohio**

**Great Lakes Commission**

**JUMPSTART Inc.**

**MAGNENT (Manufacturing Advocacy and Growth Network)**

**Ohio Aerospace Institute (OAI)**

**Ohio Development Services Agency**

**Ohio Fuel Cell Coalition (OFCC)**

**Ohio Federal Research Network (OFRN)**

**Ohio Fuel Cell Coalition (OFCC)**

**Ohio Federal Research Network (OFRN)**

**Ohio Federal Research Network (OFRN)**

**State of Ohio**

**Team NEO**

**Society of Manufacturing Engineers (SME)**

**TechSolve**

**Tech Belt Energy Innovation Center (TBEIC)**

**U.S. Water Alliance**

**State of Ohio**

**University of Dayton Research Institute (UDRI)/FastLane**

**The Water Council (Milwaukee)**

Learn more about NASA Glenn's Regional Economic Development (RED) program at https://www.grc.nasa.gov/regecondev/