



A STRATEGIC ROADMAP:

ANALYSIS OF NASA GLENN'S POTENTIAL AS AN ENGINE FOR NORTHEAST OHIO'S ECONOMIC DEVELOPMENT

PREPARED FOR:
Ohio Aerospace Council

PREPARED BY:
Technology Partnership Practice
Battelle Memorial Institute
Cleveland, Ohio

February 2003

Battelle Memorial Institute (Battelle) does not endorse or recommend particular companies, products, services, or technologies, nor does it endorse or recommend financial investments and/or the purchase or sale of securities. Battelle makes no warranty or guarantee, express or implied, including without limitation, warranties of fitness for a particular purpose or merchantability, for any report, service, data, or other information provided herein.

Copyright 2003 Battelle Memorial Institute. Use, duplication, or distribution of this document or any part thereof is prohibited without the written permission of Battelle Memorial Institute. Unauthorized use may violate the copyright laws and result in civil and/or criminal penalties.

**A Strategic Roadmap:
Analysis of NASA Glenn's Potential as an Engine
for Northeast Ohio's Economic Development**

Prepared For:

OHIO AEROSPACE COUNCIL

Prepared by:

BATTELLE TECHNOLOGY PARTNERSHIP PRACTICE

February 2003

Executive Summary

INTRODUCTION

The Northeast Ohio region is fortunate to be home to the John H. Glenn Research Center at Lewis Field, one of 10 NASA field centers. Since 1941, NASA Glenn has conducted cutting-edge research in aeronautics, aerospace, and space technologies. Originally one of three national aeronautics centers, NASA Glenn began with a focus on developing aircraft engines as the United States ramped up its war efforts, later becoming a worldwide leader in propulsion research. Today, NASA Glenn's mission is to "work as a diverse team in partnership with government, industry, and academia to increase national wealth, safety, and security, protect the environment, and explore the universe."¹ NASA Glenn is a significant source of technological innovation and talent for Northeast Ohio, but it is not the only technology driver in the region. Other technology anchors include Case Western Reserve University (CWRU), the Cleveland Clinic, Cleveland State University (CSU), Kent State University (KSU), the University of Akron, and University Hospitals.

Despite the presence of these research and technology drivers, the Northeast Ohio region has not yet achieved the level of technology-based development that community leaders believe is possible. An analysis of Ohio's technology economy conducted by Battelle for the State of Ohio found that Ohio's technology sector is composed of older traditional industries and firms that are not designing, developing, and making new products in the state.² This is also true of Northeast Ohio, which has a heavy concentration of traditional manufacturing companies.

NASA Glenn has the potential to play an important role in contributing to the building of Northeast Ohio's economic future by becoming

A leading-edge research and development center whose talent and research knowledge contribute significantly to NASA's mission requirements in both the aerospace and space arenas and whose partnerships with higher education and industry contribute to national research excellence and industrial commercial adaptation and use.

The Ohio Aerospace Council (OAC), an independent organization that seeks to increase the positive impact of the NASA Glenn Research Center on the State of Ohio, decided to commission a study that would

- Analyze Northeast Ohio's current competitive situation as it relates to effectively leveraging the NASA Glenn Research Center and its technology strengths to promote economic development
- Identify ways in which the Northeast Ohio community can help NASA Glenn to achieve research excellence in support of NASA's mission
- Define opportunities to create new and emerging technology sectors in Northeast Ohio

¹ <http://www.grc.nasa.gov/Doc/aboutgrc.htm>, October 29, 2002.

² Battelle Memorial Institute, *Tomorrow Through Technology: An Economic Analysis of Ohio's Technology Sector*. Cleveland, January 2002.

- Develop a detailed, action-oriented strategy to position NASA Glenn and Northeast Ohio research organizations to grow the region’s technology base.

PROJECT METHODOLOGY

OAC engaged the Battelle Memorial Institute’s Technology Partnership Practice to undertake this analysis, develop the strategy, and prepare an implementation plan. The Center for Regional Economic Issues at CWRU assisted Battelle in conducting the study, focusing particularly on the role of OAC in strategy implementation and analyzing the region’s technology intermediaries.

To answer the question of how to make NASA Glenn a leading world-class research center and a technology anchor for the region, the Battelle team

- Assessed NASA Glenn’s existing core competencies and industry and university linkages, and identified emerging areas with potential for future growth
- Prepared an economic analysis of Northeast Ohio’s industry base relative to the research strengths of NASA Glenn
- Benchmarked NASA Glenn against other federal laboratories in regions that have or are seeking to leverage the presence of a federal laboratory to spur regional development
- Identified barriers to and gaps in private and public investments, policies, programs, and activities that might hinder Northeast Ohio’s ability to leverage the strengths of NASA Glenn
- Proposed a set of strategies and actions that could be undertaken to position NASA Glenn to be a stronger economic driver for Northeast Ohio.

This report summarizes the findings from these analyses and lays out a bold, yet achievable, strategy designed to make NASA Glenn, working in partnership with the region’s research institutions, a world-class research center in key technology areas that will benefit, first and foremost, NASA and the nation, but also Northeast Ohio.

NASA GLENN RESEARCH AND TECHNOLOGY STRENGTHS

NASA Glenn Research Center’s research mission is to ***“ . . . develop and transfer critical technologies that address national priorities through research, technology development, and systems development for safe and reliable aeronautics, aerospace, and space applications.”*** NASA Glenn continues to execute its support of the aircraft industry through research aimed at developing advances in aeropropulsion technologies—providing faster, safer, quieter, and cleaner propulsion systems for U.S. civil and military aircraft. Additionally, NASA Glenn has leveraged its aeronautics expertise into strengths in both aerospace and space power and propulsion research and technology development in support of NASA’s mission. Currently, programmatic research activities at NASA Glenn are organized around five main mission areas ranging from aeropropulsion to microgravity science. These five mission areas constitute the primary, milestone-oriented research and technology development efforts of NASA Glenn across both aeronautics and space applications, with NASA Glenn having primary NASA organizational responsibility for aeropropulsion.

To understand how NASA Glenn can impact both research excellence and emerging and future industries, the Battelle team analyzed the Center’s capabilities across three technology areas: Mission-Related Technology Development, Cross-Cutting Enabling Capabilities, and Emerging Technology Development Niches.

Mission-Related Technology Development

Today, and throughout its history, NASA Glenn is at the forefront of developing breakthrough and emerging technologies in support of the NASA mission, national priorities, and the needs of the aeronautics and space industries. Many of these research projects are often beyond the requirements or cost constraints of even the most technology-intensive industries in Northeast Ohio. However, it is important to recognize some of the key mission-related research endeavors that NASA Glenn is currently engaged in—as these areas may provide the seeds for future technological innovations and industries in Northeast Ohio.

Cross-Cutting Enabling Capabilities

To support its core NASA research, NASA Glenn has developed cross-cutting enabling capabilities that distinguish NASA Glenn from other centers, agencies, and groups. Four enabling capabilities were identified. They include harsh environment analysis and technologies, integrated communications and remote device control, surface and thin-film technologies, and computational modeling and simulation. These capabilities are important to understanding how NASA Glenn’s research can address industrial/commercial issues because all four are used by the Center’s scientists and engineers in some combination as a supporting expertise or frame of reference for developing scientific approaches, testing and evaluating devices, or exploiting new technology platforms.

Emerging Technology Development Niches

In examining the role that NASA Glenn’s research and technology strengths and assets can play in building the Northeast Ohio technology economy, the Battelle team focused on emerging areas that can build on both existing regional industrial strengths and assets and also areas where NASA Glenn has the strong capacity to be a source for unique innovations. Battelle identified the following four technology development niches:

Microsystems and Nanotechnology. Microsystems and nanotechnology are becoming a foundational building block for developing new technologies across a variety of applications. The continuing search for mechanisms to sense and control a variety of aerospace functions led NASA Glenn scientists and researchers into MEMS and nanotechnology efforts. These efforts

NASA Glenn’s Thematic Areas

Mission-Related Technology Development

- Aeronautics Projects
- Space Projects

Cross-Cutting Enabling Capabilities

- Harsh Environment Analysis and Technologies
- Integrated Communications and Remote Device Control
- Surface and Thin-Film Technologies
- Computational Modeling and Simulation

Emerging Technology Development Niches

- Microsystems and Nanotechnology
- Biomedicine and Bioengineering
- Advanced Energy Generation and Storage Technologies
- Smart Products and Systems

were provided a new impetus and vehicle for collaborative technology development with the launching of the Glenn Microsystems Initiative (GMI) in 1998 by NASA Glenn, CWRU, and the State of Ohio. GMI has a two-fold purpose: (1) nurture and strengthen its strategic alliance to create initiative-owned or initiative-controlled intellectual property of use to the membership and (2) accelerate the commercialization of this intellectual property.

Biomedicine and Bioengineering Applications.

Biomedicine and bioengineering applications is emerging as an important research area for NASA Glenn—both in support of the health and safety of astronauts and as an often-unique mechanism to transfer technologies developed for fundamental aerospace applications into the commercial realm. These efforts are coordinated through the Bioscience and Engineering Glenn Initiative (BEGIN). While it includes internal research and Space Act-based development and testing at NASA Glenn, collaborative biomedicine and bioengineering efforts have been given an additional boost with the recent launch of the John Glenn Biomedical Engineering Consortium, which includes the Cleveland Clinic Foundation, CWRU, University Hospitals of Cleveland, and the National Center for Microgravity Research. The Consortium is currently conducting 10 NASA-funded research projects addressing crew health, safety, and performance.

Advanced Energy Generation and Storage Technologies. NASA Glenn has a long history of researching, developing, and testing energy-related technologies for NASA’s space missions. Increasingly, due to both environmental and fuel availability concerns, a number of these technologies are being examined as alternative sources for generating and storing energy for home, vehicle, and device power. The advanced energy generation and storage technologies developed by NASA Glenn are seen as commercially viable, albeit early-stage research, by a variety of small and large firms.

Smart Products and Systems. Smart products and systems refer to those devices and technologies that sense changes in their operating environment and ultimately adapt to these changes to optimize their performance. The development of smart materials and systems at NASA Glenn is the ultimate blending of existing technological strengths and cutting edge research. Much of the work in this area is focused on developing “smart aircraft engines.” This effort is primarily funded out of the Ultra Efficient Engine Technology’s (UEET’s) Intelligent Propulsion Control initiative. The region’s strengths in sensors, instrumentation, controls, and materials stemming from both industry and higher education, when combined with NASA Glenn’s research strengths in these same areas, provide Northeast Ohio with a competitive advantage in the emerging smart products and systems arena.

Figure ES-1 provides a more detailed picture of the interconnections among the research areas of NASA Glenn and how they relate to the three thematic areas (mission-related, cross-cutting

Northeast Ohio Interest in Biomedicine and Bioengineering Applications

Companies

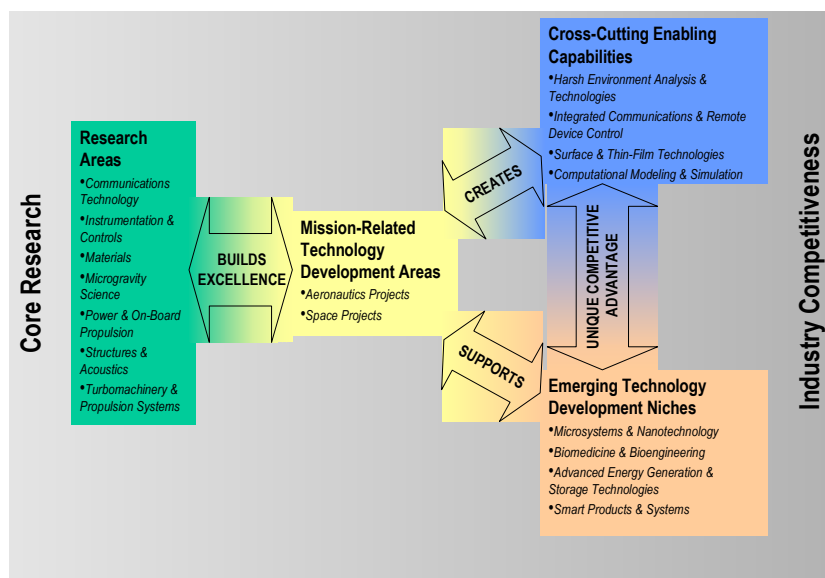
- Analiza, Inc.
- Applied Medical Technology, Inc.
- BIOMECH
- Cleveland Medical Devices
- Invacare
- Micronix Surgical Corporation
- Philips Medical Systems
- STERIS Corp.

Institutions

- The Cleveland Clinic Foundation
- Case Western Reserve University
- University Hospitals of Cleveland/Rainbow
- MetroHealth
- Cleveland State University
- Kent State University
- University of Akron
- BioEnterprise

enabling, and emerging technology development niches) as a potential driver for technology, industry, and regional economic development in Northeast Ohio.

Figure ES-1: Interconnections Among NASA Glenn Research Areas and Thematic Areas



INDUSTRY AND REGIONAL POTENTIAL FOR NASA GLENN COLLABORATION: AN ECONOMIC ANALYSIS

In addition to an understanding of the research areas in which NASA Glenn and the region’s research institutions have strength, an understanding of Northeast Ohio’s industrial base is needed to identify those industry sectors most likely to benefit from collaboration with NASA Glenn. The Battelle project team identified 13 industry sectors that appear to have the most potential to benefit from the expertise found at NASA Glenn and then examined the size and composition of these sectors in Northeast Ohio. The industry sectors include

- Aerospace Parts and Assemblies
- Communications and Digital Equipment
- Electronic and Photonic Components
- Energy Conversion and Storage
- Engineering, Research, and Testing Services
- Life Sciences
- Materials—Coatings
- Materials—Nonferrous Metals
- Materials—Nonmetallic
- Pumps and Fluid Power Devices
- Sensors and Analytic/Control Devices
- Software and Computer Programming Services
- Turbomachinery, Propulsion, and Related Equipment.

Among these sectors, Northeast Ohio has existing strengths in materials; engineering, research, and testing; and energy conservation and storage. The fact that all three materials-based industry sectors show evidence of regional strength bodes well for potential NASA Glenn collaboration. In many respects, this collaboration may be critical to the future of these sectors in the region as they face the choice of either pursuing technological advances in process and product to remain competitive or becoming a commodity-oriented player. The potential for these sectors to remain at the cutting edge given the resources of NASA Glenn is strong and should be a focus of regional efforts.

Opportunities for development also exist in areas in which NASA Glenn is strong but the regional industry base is weak. These areas include sensors and analytic/control devices, communications, turbomachinery, and electronics and photonics. Expertise in fuel cell development also exists at NASA Glenn. Leveraging the competencies and capabilities of NASA Glenn can go a long way toward ensuring that some aspect (perhaps the development of niche fuel cells or systems integration/control applications) of this emerging fuel cell industry is developed in Northeast Ohio. The engineering, research, and testing industry sector has been growing and offers potential as these types of services continue to be outsourced by both the nation's larger firms as well as federal agencies. This sector warrants further development attention in the region, especially given the competencies and facilities potentially available at NASA Glenn.

Within these broadly defined clusters are specific core and integrative industry sectors that, based on NASA Glenn's research and technology strengths, assets, and capabilities, can potentially engage in a variety of collaborative efforts with the Center. Efforts to foster and develop such collaborations should necessarily be part of the efforts of these regionally focused development programs.

FEDERAL LABS AS ECONOMIC DEVELOPMENT DRIVERS: COMPARING NASA GLENN AND NORTHEAST OHIO WITH OTHER LABS AND REGIONS

Regions of the country with strong technology-based economies usually have one or more research drivers playing a critical role in producing innovation and new knowledge. These can include research universities, major medical research centers, and public and private research organizations. In some regions, a federal laboratory or laboratories can serve as the region's research anchor.

Federal laboratories provide positive economic benefits to the regions where they are located by virtue of the employment and income that they generate. Federal research laboratories tend to employ highly skilled and educated workers; they generate regional economic activity by purchasing goods and services from local companies. In addition, federal labs can help local companies solve technical problems and provide access to unique facilities and equipment. In

Our federal labs offer unique and hard-to-duplicate facilities, long-standing relationships with top innovators, and a congressional mandate to promote technology transfer—the diffusion of knowledge and inventions created with federal funds. By partnering with industry, federal labs create new competencies and capabilities to help achieve their missions, ensure their work generates maximum benefit for our nation, and better compete for future resources.

Bruce Melman
Secretary for Technology Policy
*Recent Trends in Federal Lab
Technology Transfer: FY 1999–2000
Biennial Report*

some instances, technology developed in a federal laboratory may be commercialized within the region, leading to firm start-up and growth.

The project steering committee selected seven federal labs that are often cited as ones with a strong record of collaboration, partnership, and economic development to use as benchmarks for NASA Glenn. The seven benchmarks were examined to identify best practices.

Based on its review of the benchmark labs and interviews with industry and federal lab officials, Battelle identified the following factors as key to creating successful partnerships and collaborations that enable federal laboratories to contribute significantly to technology-based state and regional economic development.

Benchmark Labs

- Argonne National Lab
- Jet Propulsion Lab
- Lincoln Laboratory
- Marshall Space Flight Center
- Sandia National Lab
- Walter Reed Army Institute of Research
- Wright Research Site

Recognized area or areas of research and technical excellence. A company's greatest benefit from working with a federal laboratory is access to smart people, new ideas, and state-of-the-art technical expertise. Those labs with strong collaborative relationships are recognized as having deep and well-recognized research excellence in specific technology areas. In certain instances, federal labs have made the decision to develop research excellence in areas of interest to particular industry sectors.

Laboratory leadership committed to collaboration. Of the labs in the benchmark set, Argonne National Lab has been very effective in creating partnerships with industry, other federal labs, academia, and the private sector. In FY 2001, Argonne had approximately 5,000 faculty, student, and industry users throughout the United States, with more than 100 of these located in Ohio. Argonne officials report that this would not be possible without strong leadership at the lab committed to collaboration.

Unique facilities and equipment that are actively marketed for university and industry usage. Federal laboratories can provide companies with access to unique and specialized facilities and equipment that are either unavailable elsewhere or cost prohibitive for smaller firms. Except for Lincoln and the Wright Site, the other labs in the benchmark set (including Glenn) all make their specialized user facilities available to industry.

Facilities and mechanisms that allow federal lab, academic, and industry researchers to work side by side. NASA Glenn recognized early on the importance of collaborating with industry and higher education and joined with the Air Force Research Lab, 10 Ohio universities, and industry to form the Ohio Aerospace Institute (OAI) in 1989. OAI is a nonprofit corporation that facilitates industry/university/government collaborations to advance aerospace-related capabilities. Additional partnerships in which Glenn participates include the National Center for Microgravity Research on Fluids and Combustion, the Glennan Microsystems Initiative, and the John Glenn Biomedical Engineering Consortium.

Several labs in the benchmark set recently have formed R&D consortia that deepen their regional ties, particularly to universities. Marshall Space Flight Center, for example, has entered into a unique partnership with the University of Alabama-Huntsville and five other state universities to create the National Space Science and Technology Center (see description in box).

National Space Science and Technology Center

Marshall Space Flight Center and the University of Alabama-Huntsville (UAH) along with five other state universities (Alabama A&M, Auburn, UA-Tuscaloosa, UA-Birmingham, and the University of South Alabama in Mobile) have established the National Space Science and Technology Center (NSSTC). Located in the Cummings Research Park, NSSTC provides a venue in which NASA can station up to 450 scientists from four programmatic directorates in closer proximity to potential research partners at UAH and among the aerospace contractors populating Cummings Research Park. NSSTC is conceived as a way of bridging the gap between the low TRLs that prevail in academia and the high TRLs of Marshall and its large-company partners. It includes seven “centers” or clusters of common research interest. NSSTC is housed in a \$27 million pair of off-site buildings, paid for mainly by the state and owned by UAH. NSSTC will house joint teams of researchers from NASA, university partners, and industry partners. The joint goals are to give UAH higher prominence in national space-related research programs, to attract more industry-funded Space Act Agreements, and to allow support from non-NASA federal agencies flowing through UAH to support NASA scientists off the base budget, as priorities for the Center shift, while retaining the expertise. This positions Marshall in several ways: it (1) enables Marshall to maintain research excellence in areas in which NASA may have determined that Marshall no longer has a role; (2) enables Marshall to indirectly obtain other federal agency funds that may be used partially to support research Marshall is also funding, making its NASA dollars go further; and (3) links the education/talent function with the research function, ensuring the latest talent and graduates flow into Marshall and to the university.

Successful engagement with intermediary organizations. Those laboratories that have been successful in commercializing technology and spinning off new companies often accomplish these goals by working in close partnership with intermediary organizations. The TVC at Sandia, for example, is a commercialization company, taking “handoffs” from the lab’s internal entrepreneur-development programs and making sure business plans get written, pre-seed capital is found, and the company is exposed to later-stage, formal venture capital.

Selected metrics from Technology Ventures Corp., which works with Sandia

- 46 start-ups established 1993–2001, more than half from Sandia
- Brought \$306 million in private-sector venture investment into these start-ups and their expansions
- Staff of <12 employees in three areas: technology sourcing, business-case development, and equity-capital match-up

Strong state support. Recognizing that a region can benefit from having federal funding flowing into a national laboratory, some states have made significant investments to attract federal facilities and dollars. For example, in Illinois, the Governor’s VentureTECH program is allocating \$17 million to help induce DOE to locate at Argonne the next-generation “Rare Isotope Accelerator.” While the State of Ohio does not provide any direct funding to NASA Glenn, it provides significant funding to several of Glenn’s commercialization partners including GLITeC, OAI, Glennan, and the Lewis Incubator for Technology (LIFT). Ohio is generally considered a leader in its support of federal laboratory commercialization.

Discretionary federal dollars. One lesson learned in looking across the United States at factors contributing to the development of technology-clustered regions is the presence of federal

laboratories and/or attracting significant or extraordinary amounts of federal research and development dollars. Obviously, Marshall’s leaders insisted on a major university presence in Huntsville that is an integral part of and increasingly more of the strategic advantage for the Space Flight Center as well. Others of the benchmark set have regions that do well in attracting federal research dollars, including New Mexico and California. Table ES-1 compares NASA Glenn with the best practice federal labs.

Table ES-1: Comparison of NASA Glenn to Best Practice Federal Labs on Key Success Factors

Best Practice Factors of Success	NASA Glenn Situation
Are recognized by industry and academia as conducting world-class research and providing access to unique expertise and resources in selected technology areas	NASA Glenn is recognized as having world-class capabilities in a variety of research areas including microgravity science and microsystems for harsh environments, an area in which partnerships with academia and industry have developed.
Leadership committed to collaboration	A number of collaborative relationships including OAI, the National Center for Microgravity Research on Fluids and Combustion, Glennan Microsystems Initiative, and the recently established John Glenn Biomedical Engineering Consortium have been established; however, NASA Glenn is not as active in this area as many of the labs in the benchmark set, especially as compared with Argonne and Sandia. NASA Glenn throughout its history has relied primarily on its internal staff capabilities.
Unique facilities and equipment that are actively marketed for university and industry use	NASA Glenn is known for its wind tunnels, icing research facilities, microgravity simulators, and other specialized facilities. While these are used in mission-oriented partnerships and have formed the basis for many Space Act Agreements, they do not appear to be heavily marketed for non-mission-related work, as is done in leading-edge labs.
Mechanisms and facilities that allow researchers to work side by side	Joint research projects between GRC, industry, and universities are conducted at OAI, which is located adjacent to NASA Glenn.
Engagement with intermediary organizations	NASA Glenn works closely with the Great Lakes Industrial Technology Center, the Regional Technology Transfer Center for the Midwest. A number of other economic development intermediary organizations in Northeast Ohio have relationships with NASA Glenn, including EDI for two incubators and OAI for workforce and industry consortium building.
Strong state and regional support	The State of Ohio does not provide any direct funding to Glenn, but does provide significant funding for several of its commercialization partners including GLITeC, OAI, Glennan, and LIFT. Ohio has been generally considered a leader in its support of federal lab commercialization.
Discretionary federal dollars	Compared with other regions, limited federal dollars have come into Northeast Ohio; although \$150 million in non-NASA federal dollars have come to OAI consortia from sources such as the NIST Advanced Technology Program (ATP).

Key Tools Used by Federal Labs to Promote Regional Technology-Based Economic Development

Review of the benchmark laboratories reveals several distinct mechanisms used to promote engagement with industry in general and regional industry in particular. Mechanisms observed include

- **Technical assistance programs.** Both Sandia and Argonne have engaged in efforts to convince the regional community of small manufacturers that their future competitiveness will depend in part on the degree to which they embrace advanced materials, short design cycles, low production runs, and customization to produce highest value.
- **Technology development funds.** Recognizing that additional, non-mission funding is often needed to develop a technology enough to attract industrial interest or venture investment, both JPL and Marshall have internally managed discretionary funds aimed at speculative research and advancing discoveries toward commercialization (analogous to the Glenn Commercial Technology Fund). Marshall's Technology Innovation Program is funded at about \$1 million to \$1.2 million annually. Awards range from \$20,000 to \$100,000.
- **Commercialization centers/companies.** Both DOE labs in the benchmark set are paired with external entities charged not only with licensing outreach, but with creating locally based businesses around either IP or personnel leaving a laboratory. At Sandia, this organization is the Technology Ventures Corporation. TVC's job is to take the "handoff" when an entrepreneur decides to leave the employment of the laboratory and tries to create a business based on know-how or formal license from the lab. Through a yearlong mentoring process, TVC prepares these entrepreneurs for an annual venture symposium that it sponsors.
- **Early-stage capital programs.** At a slightly later stage in their existence, lab spinouts require more than technology-development funds; eventually, they need a seed-stage investor. In Maryland, the Technology Development Corporation operates a Technology Transfer Fund that makes equity or near-equity investments specifically in companies pulling technology from Johns Hopkins University, Morgan State University, or federal laboratories in the state. The program provides up to a maximum of \$50,000 in non-equity investment.
- **Research parks.** Two of the labs in the benchmark set participate indirectly in the operation of a regional research and technology park. Although it does not serve in any governance role, Marshall is the de facto *catalyst* of the Cummings Research Park, which serves the aerospace contractor community. The park began in the early 1960s and, after several waves of expansion, is now billed as the nation's largest technology park. The park has some 22,000 employees who work for 229 companies, occupying 8.5 million square feet spread over 175 separate buildings.
- **Incubators.** Analogous to Glenn's association with LIFT, several other NASA Centers work with designated incubators.
- **Entrepreneurial leave programs.** Two of the labs surveyed offer formal entrepreneurial leave programs. At JPL, a staff member may take leave for two years and return assured of continuation status in Caltech's pension and benefit program, but not necessarily of the same or even a similar job. At Sandia, a two-year leave guarantees the right to return at a similar though not identical job. NASA Glenn also allows entrepreneurial leave, but the program has

not been heavily used. NASA Glenn estimates that one to two people leave to start companies annually.

NASA Glenn employs many of the same mechanisms to promote technology transfer and commercialization and is considered a leader among the NASA labs (see box below). However, some of the benchmark labs—most notably the Department of Defense (DoD) and DOE labs—have been somewhat more aggressive in their attempts to collaborate with the private sector. These agencies have historically worked closely with the defense industry and, comparatively speaking, have larger R&D budgets than other federal agencies, including NASA. Also, most DOE labs and some DoD labs are government-owned/contractor-operated (GOCO) facilities rather than government-owned and -operated facilities. GOCOs in general have more flexibility; and those managed by universities also have access to the university's technology transfer and commercialization offices, which in some cases are a substantial resource. But, as NASA as an agency and NASA Glenn seek greater collaborative partnerships with universities and industry, lessons can be learned from the federal laboratories that have been successful in promoting collaboration and contributing to the regional economic growth.

NASA Glenn's Commercialization Activities

Efforts to commercialize NASA technology are managed by NASA Glenn's Commercial Technology Office (CTO) with assistance from the Great Lakes Industrial Technology Center (GLITeC), the Regional Technology Transfer Center managed by Battelle and co-funded by NASA and the State of Ohio, and the Lewis Incubator for Technology (LIFT) managed by EDI (an arm of Case Western Reserve University) and partially funded by the State of Ohio. The CTO works with these affiliates, NASA programs, and Glenn scientists and engineers to create innovative research through the Small Business Innovative Research and Small Business Technology Transfer (SBIR and SBTTR) programs, partner with industry and government, provide opportunities with small businesses, negotiate licenses, and manage export control.

During the past several years, NASA Glenn has created several innovative programs designed to facilitate the commercialization of NASA technology and to link companies to NASA expertise and resources. These initiatives include

- The **Garrett Morgan Commercialization Initiative (GMCI)**, which is aimed specifically at helping small, disadvantaged, or women-owned businesses to grow their companies using NASA technology and expertise.
- The **Glennan Microsystems Initiative**—funded by NASA and matched by the State of Ohio—which seeks to leverage NASA expertise in the area of microsystems for harsh environments in conjunction with selected companies with operations in Northeast Ohio.
- A **Commercial Technology Fund (CTF)**. The CTO has established a CTF to provide funding for projects that are not mission-related but that appear to have a commercial application. The fund typically provides up to \$70,000 for projects that have matching funds or support from a commercial partner.
- **LIFT**, a NASA-sponsored incubator with participation from the State of Ohio, which has two sites, one on the grounds of NASA Glenn. LIFT provides space and business assistance to start-up companies. Since its inception, LIFT has housed approximately 20 companies that now employ about 100 people.

In FY 2002, NASA Glenn entered into 144 Space Act Agreements that brought \$20 million in funding to the Center. Ten percent of these partnerships were with other government agencies, and 40 percent were with firms in the State of Ohio. NASA Glenn estimates that its commercialization activities, and those of its affiliates including GLITeC and LIFT, helped to

- Create 10 new start-ups since 1997 and incubated an additional eight companies.
- Introduce 27 new products
- Realize \$11.7 million in new sales and \$5.9 million in cost savings
- Facilitate \$5.4 million in investment and grant funding.

ASSESSING THE COMPETITIVE POSITION OF NASA GLENN AND NORTHEAST OHIO

The Battelle team prepared an analysis of the strengths, weaknesses, opportunities, and threats (SWOTs) facing Northeast Ohio in building a technology-driven economy by leveraging the resources of NASA Glenn and its physical presence in Northeast Ohio. It examined (1) strengths that could enable both the region to leverage the resources and expertise of NASA Glenn and NASA Glenn to leverage resources within the region, (2) weaknesses that would prevent these partnerships, (3) opportunities that could be capitalized on to build the region's technology economy in partnership with NASA Glenn, and (4) external threats that must be recognized and addressed in positioning Northeast Ohio and NASA Glenn to become a leading technology center.

To prepare this analysis, the Battelle project team interviewed NASA leadership and researchers, CEOs of leading technology companies, university representatives, entrepreneurs, and community leaders to determine

- The level of awareness within the community of NASA Glenn's resources and expertise
- The extent of existing partnerships and relationships
- Obstacles to working collaboratively to build the region's technology economy
- Factors that should be addressed to realize greater economic benefit from the technology resources, particularly NASA Glenn, present in Northeast Ohio.

It should be noted that, in some cases, perceptions are included in the SWOT analysis, whether accurate or not, that reflect the climate within which progress can be made in leveraging NASA Glenn and building Northeast Ohio's regional technology economy. Table ES-2 summarizes the findings from the SWOT analysis.

SITUATIONAL ANALYSIS

National Priorities and Directions for NASA

NASA Directions in Aeronautics. NASA's current Administrator has made addressing the challenges of the U.S. aviation system a priority for NASA. In February 2002, Administrator O'Keefe issued *The NASA Aeronautics Blueprint: Toward a Bold New Era of Aviation*. The Blueprint identifies a number of challenges facing the aeronautics industry:

- Aerospace R&D funding has fallen by more than 50 percent from a 25-year peak in 1987
- The U.S. aerospace workforce shows serious signs of erosion
- The U.S. global market dominance in aviation is rapidly declining.

Table ES-2: Strengths, Weaknesses, Opportunities, and Threats

Strengths

- NASA Glenn is a significant contributor to the Northeast Ohio economy, although its economic impact has decreased since the 1990s due to its declining budget.
- NASA Glenn researchers are a significant source of technological innovation and talent.
- Northeast Ohio has a strong university and government technology base.
- New leadership committed to collaboration has energized Northeast Ohio's research institutions.
- New and existing multi-institutional collaborations involve NASA Glenn, including OAI, the National Center for Microgravity Research, GMI, the John Glenn Biomedical Engineering Consortium, and ITI.
- Northeast Ohio has a diverse industry base of small- and medium-size manufacturers and a number of organized industry networks.
- Public recognition of the importance of technology-based businesses to Northeast Ohio's economy and a business climate supportive of technology companies is emerging.

Weaknesses

- The community lacks knowledge and understanding of NASA Glenn's resources and capabilities.
- Perception of the business community is that NASA Glenn is not open to working with companies.
- Decreased funding for NASA has placed increased demands on NASA researchers and limited their ability to partner with industry on non-NASA-mission work.
- Technology developed at NASA Glenn often is at an early stage of development and therefore requires significant additional investment prior to use in a commercial product or application.
- NASA Glenn has not been as competitive as some would desire in competing for program funding from NASA and other federal agencies.
- In-depth assistance to entrepreneurs wanting to commercialize a NASA technology is insufficient.
- Lack of scale and depth of expertise exists within and among various intermediary organizations.

Opportunities

- NASA Glenn could become nationally recognized in key R&D areas by establishing focused strategic relationships with higher education, research institutions, and companies in Northeast Ohio, the State of Ohio, and the nation.
- New leadership at NASA Headquarters presents an opportunity for NASA Glenn to compete for new program funding and initiatives.
- NASA Glenn could help strengthen Northeast Ohio companies and manufacturers by providing access to and marketing its cross-cutting enabling technologies.
- NASA Glenn's procurement base should be used to attract, build, and expand the NASA contractor base in Northeast Ohio.
- NASA Glenn and the region's companies and research institutions could take advantage of the State of Ohio's commitment to make Ohio a national leader in selected technology areas.

Threats

- Decreased funding for NASA agency-wide and the perceived lack of a strong program focus at NASA Glenn could lead to continued loss of funding.
- NASA Glenn's talent base may erode as scientists and engineers retire unless new positions offering competitive salaries are created.
- Lack of funding for non-mission work may limit the ability of NASA Glenn to do testing or undertake collaborative research with industry partners locally or nationally.
- NASA Glenn may be unable to compete successfully for funding against other Centers receiving significant support from state, regional, and local economic development agencies.

NASA, working in partnership with the Federal Aviation Administration, the Department of Transportation, DoD, and industry, is committed to developing technology solutions to address these challenges. NASA efforts will focus on four areas: the airspace system, revolutionary vehicles, aviation security and safety, and a state-of-the-art educated workforce. The Blueprint identifies the following areas that will be supported by NASA Glenn:

- Aerodynamics/Aerothermodynamics
- Aerospace Communications
- Aeropropulsion Systems.

NASA Glenn is already involved in a number of projects that directly address issues identified in the NASA Aeronautics Blueprint. These include UEET; Quiet Aircraft Technology; Green Efficient Aircraft Propulsion (Electric Aircraft); Integrated Communications, Navigation, and Surveillance; Weather Accident Prevention; Accident Mitigation; and Aircraft Icing.

The Aeronautics Blueprint acknowledges that aviation applications likely will be realized from the convergence of many technologies, rather than from progress in any single area of research, and therefore states:

We need to restructure our approach and portfolio for long-term research. To enhance our probability of success, we will

- *Establish new national technology competencies*
- *Expand our approach to University Research Center partnerships*
- *Continue to strengthen interagency partnerships to meet national needs.*⁴

NASA's renewed focus on the aeronautics industry is likely to offer additional opportunities for NASA Glenn.

NASA Directions in Space. NASA's Space Science Enterprise, one of five NASA enterprises, has identified the following key enabling technology capabilities as those that will be needed to advance the objectives of the space program:⁶

- Advanced power and on-board propulsion
- Sensor and instrument component technology
- Distributed spacecraft control
- High-rate data delivery
- Intelligent Space Systems
- Micro and nano sciencecraft, including MEMS
- Surface systems technology
- Ultra-lightweight space structures and observatories
- Atmospheric systems and in-space operations
- Next-generation infrastructure.

Some of these capabilities match well with the cross-cutting enabling technologies found at NASA Glenn, which include Harsh Environment Analysis and Technologies, Integrated Communications and Remote Device Control, Surface and Thin-Film Technologies, and

⁴ *The NASA Aeronautics Blueprint: Toward a Bold New Era of Aviation*, February 2002.

⁶ Space Science Enterprise, *Space Science Strategic Plan*, November 2000.

Computational Modeling and Simulation. Of particular interest to the space science program is instrument capability to perform in harsh environments, an area in which NASA Glenn is a world leader.

NASA Theme: Increased Focus on Partnerships and Education. Emphasizing partnerships is a key strategy being pursued across all of NASA. As stated in the NASA 2000 Strategic Plan:

A key NASA strategy is to establish and effectively utilize partnerships. We seek to partner with universities, other U.S. government agencies and industries where there are mutual benefits. We can significantly leverage our research by benefiting from the interests, skills and resources of others.⁷

In 2002, NASA's Office of Aerospace Technology, working in partnership with the DoD's Research and Engineering Office, competitively awarded funding for seven University Research, Engineering, and Technology Institutes (URETI). NASA Glenn's Aerospace Propulsion and Power program sponsored the URETI for the aerospace propulsion topic, which was awarded to the Georgia Institute of Technology. Both Ohio State University and Case Western Reserve University are participants in the Aerospace Propulsion and Power URETI. NASA Glenn is also responsible for two URETI's awarded under sponsorship of the Advanced Transportation Program.

The strategies and actions proposed in this report are designed to position NASA Glenn to respond to current and future opportunities within the Agency.

Assessing NASA Glenn

The analysis of NASA Glenn's capabilities in its current research and mission areas suggests that NASA Glenn may need to further build world-class research in appropriate areas to increase collaboration with Northeast Ohio's research universities and industry. Through collaboration, both NASA Glenn and these research universities will be stronger; and the foundations around which enabling and emerging technologies can emerge will be strengthened. As the benchmarking analysis shows, NASA Glenn is at a severe disadvantage when compared with other NASA Centers such as Marshall, Ames, and JPL because it lacks a deep, integrated, close research collaboration with nearby research universities. Fortunately, Northeast Ohio has a number of research universities with which NASA Glenn has partnered in the past and whose level, intensity, and scale of partnerships could be significantly increased in the future.

The proposed strategies and actions are designed to ensure that NASA Glenn becomes a recognized leader in key technology areas within the Agency and the world in areas that are critical to the Agency's mission and that also offer opportunities for future growth and development.

⁷ NASA 2000 Strategic Plan, p. 52.

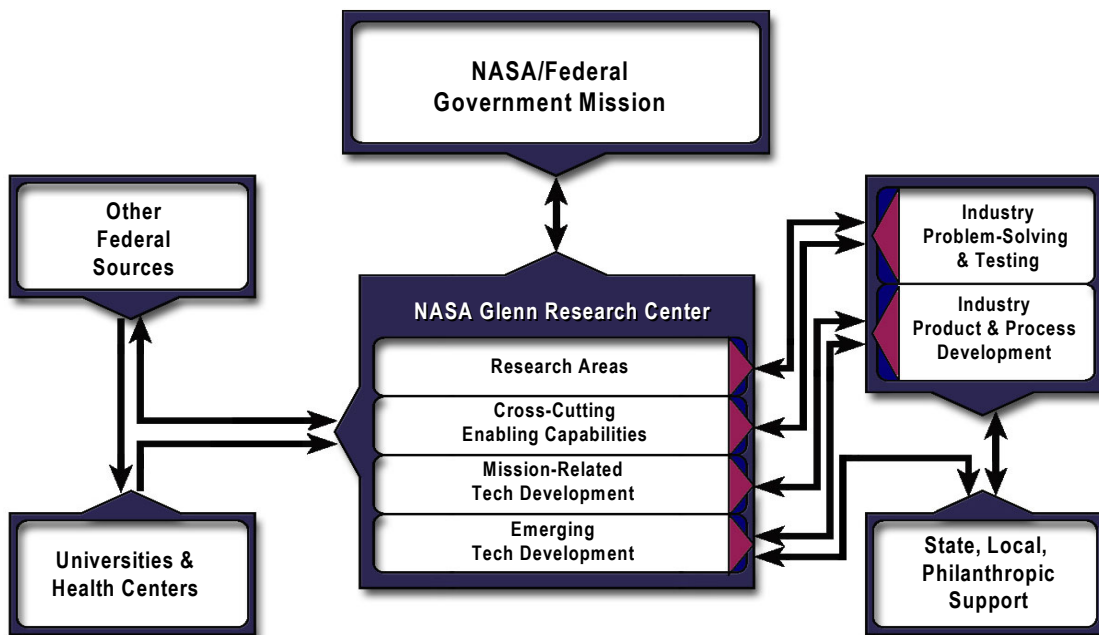
STRATEGIES AND ACTIONS TO POSITION NASA GLENN TO BE AN ECONOMIC ENGINE FOR THE REGION AND STATE

Proposed Approach

NASA Glenn, in partnership with Northeast Ohio research organizations and industries, can play a key role in supporting the growth of Northeast Ohio's technology economy. This can be accomplished while enhancing NASA Glenn's mission-oriented research capabilities. Figure ES-2 provides a vision of the role that NASA Glenn can play in the regional economy. Partnering with the region's universities and health centers will enable both the universities and NASA Glenn to increase their capabilities and attract additional R&D dollars. Meanwhile, NASA Glenn's research and technology capabilities can be accessed to support regional companies in problem solving and product development.

To enable NASA Glenn to effectively achieve this vision, four strategies and 16 actions are proposed.

Figure ES-2: Role of NASA Glenn



Strategies and Actions

The following four strategies are proposed for linking NASA Glenn and Northeast Ohio research organizations and industry to grow the region's technology-based economy:

Strategy One: Build a world-class R&D base in key technology areas and platforms by partnering NASA Glenn with higher education and other research institutions in Northeast Ohio and the nation.

Strategy Two: Build robust NASA Glenn/industry partnerships in Northeast Ohio and nationally in research, problem solving, testing and evaluation, and product development.

Strategy Three: Make NASA Glenn key to achieving NASA's vision for the future by reinvigorating NASA Glenn's technical talent base.

Strategy Four: Improve NASA Glenn's reputation within the region, state, and nation as a cutting-edge R&D anchor for technology-based economic development.

To accomplish these four strategies, 16 specific actions are proposed for implementation. Table ES-3 summarizes the proposed strategies and actions.

It is anticipated that these strategies would be implemented over a five-year period. *Immediate* priorities are those that should be undertaken in the first year, *short-term* priorities are those that should be undertaken in the one- to three-year period, and *mid-term* priorities are those to be implemented beginning in years three to five.

IMPLEMENTATION PLAN

This strategy proposes an aggressive agenda for Northeast Ohio and NASA Glenn. To make NASA Glenn a driving force in the region's technology economy, a two-fold approach must be followed:

- The region and its research institutions and industry must join with NASA Glenn to develop world-class excellence in key technology areas, which will form the basis for developing not only new companies but also new industries.
- NASA Glenn must reach out to and find ways to work closer with industry in the region, state, and nation.

Table ES-3: Summary of Proposed Strategies and Actions

Strategy	Action	Priority
<p>STRATEGY ONE:</p> <p>Build a world-class R&D base in key technology areas and platforms by partnering NASA Glenn with higher education and other research institutions in Northeast Ohio and the nation.</p>	<p>Create a NASA Glenn Research and Technology Innovation Center, a multi-institutional applied research, applications, education, and training center, at or in close proximity to NASA Glenn.</p>	<p>Mid-term</p>
	<p>Expand current NASA Glenn-assisted consortia and build additional research consortia around emerging Glenn strengths.</p>	<p>Short- to Mid-term</p>
	<p>Position NASA itself to secure R&D funding around key technology areas where NASA Glenn and associated research collaborators can further build world-class research stature and reputation.</p>	<p>Immediate</p>
	<p>Seek and secure multiyear federal investments to address the research and technology infrastructure for NASA Glenn and the region through the Ohio Congressional Delegation.</p>	<p>Immediate</p>
<p>STRATEGY TWO:</p> <p>Build robust NASA Glenn/industry partnerships in Northeast Ohio and nationally in research, problem solving, testing and evaluation, and product development.</p>	<p>Create an Industry Fellows program to allow industry and academic scientists and engineers to spend time at NASA and to allow NASA researchers to spend time in industry and/or academia.</p>	<p>Short-term</p>
	<p>Establish an Industry Support and Applications Program to enable NASA researchers to conduct research, develop products and processes, develop pre-prototypes, and undertake technical problem solving for industrial clients.</p>	<p>Short-term</p>
	<p>Expand and broaden NASA Glenn's Commercial Technology Fund to provide funding for additional research and proof-of-concept activities within NASA Glenn.</p>	<p>Short-term</p>
	<p>Form a comprehensive Glenn Technology Commercialization Center that provides expanded in-depth commercialization assistance to entrepreneurs seeking to form firms and to start-up and emerging companies seeking to commercialize NASA-developed technologies.</p>	<p>Short-term</p>
	<p>Establish a strong networking and connecting organization at sufficient scale and intensity among industry, higher education, and the public sector that permits increased knowledge and awareness of NASA Glenn and builds relationships and linkages.</p>	<p>Immediate</p>
<p>Use NASA Glenn's procurement base to attract, build and expand the NASA contractor base in Northeast Ohio and Ohio by building on its successes with 8(a) firms.</p>	<p>Immediate</p>	

Table ES-3: Summary of Proposed Strategies and Actions (continued)

Strategy	Action	Priority
STRATEGY THREE: Make NASA Glenn key to achieving NASA's vision for the future by reinvigorating NASA Glenn's technical talent base.	Build a strong co-op engineering program in conjunction with the region's engineering schools (Akron, Case, Cleveland State, and elsewhere) offering opportunities for students to work both at NASA Glenn and in regional firms.	Short-term
	Provide NASA Glenn with greater flexibility in recruiting entry-level engineers and other scientific, technical, and research personnel.	Short-term
STRATEGY FOUR: Improve NASA Glenn's reputation within the region, state, and nation as a cutting-edge R&D anchor for technology-based economic development.	Create a brand name for NASA Glenn for its 21st century direction—including its areas of excellence, its mode of operation, and its distinguishing features.	Short-term
	Use modern technology tools to identify, market to, and build sustained knowledge and awareness of NASA Glenn in both higher education and industry.	Short- to Mid-term
	Expand external relations function by establishing a "One-Stop Industry Liaison Office" at NASA Glenn offering a single access point that enables firms, entrepreneurs, and citizens to learn about and access the resources of NASA Glenn.	Immediate
	Encourage the State of Ohio to help expand NASA Glenn's technology and research infrastructure to world-class status in certain fields through NASA Glenn's participation in Ohio's Third Frontier Innovation Centers and encourage Ohio's universities and industries to use NASA Glenn as an important enabling partner.	Immediate

Critical Actions

Of the 16 proposed actions, the following seven are the most critical and important to the impact of these strategies on NASA Glenn and Northeast Ohio:

- Create a **NASA Glenn Research and Technology Innovation Center** as a multi-institutional applied research, applications, education and training center, at or in close proximity to NASA Glenn
- **Expand existing research consortia** (Glennan Microsystems, Glenn Biomedical Engineering) and **establish additional consortia** in the next five years
- **Position NASA Glenn as a cutting-edge research organization in several of the cross-cutting and emerging technology development areas** identified in this report with support and recognition from NASA itself
- Establish an **Industry Support and Applications Program** to cover partial costs of NASA researchers working on projects of interest to the region and state's industries
- **Form a comprehensive Technology Commercialization Center** to provide in-depth commercialization assistance to entrepreneurs

- Establish a **strong networking and connecting organization** at a sufficient scale and intensity to link Glenn, higher education, and industry through a reconstituted Ohio Aerospace Council or its successor organization
- Utilize this strategy to **seek and secure funds from the federal and state governments** for research and technology investments of strategic importance to NASA Glenn and Northeast Ohio’s economic future.

Immediate Work Plan Priorities

Immediate actions that must be addressed by Northeast Ohio leaders and NASA Glenn include the following:

- Begin planning for a NASA Glenn Research and Technology Innovation Center—initiate discussions with the City of Cleveland and NASA Glenn
- Identify opportunities for NASA Glenn to participate in Wright Centers for Innovation
- Reconstitute OAC to serve as a networking and connecting organization
- Convene a meeting of the vice-presidents for research of the region’s universities and NASA Glenn leadership to initiate discussion of areas for collaboration
- Seek additional support for GMI and the John Glenn Biomedical Engineering Consortium
- Brief NASA leadership and Congressional leaders on the strategy
- Develop implementation plan for NASA Glenn Commercialization Center
- Establish Industry Support and Applications Program
- Establish a one-stop industry liaison program.

Resource Requirements

Table ES-4 lays out the actions and annual and one-time costs and identifies potential funding sources. A number of items require reallocation and re-prioritization of existing resources. The largest single item is to create the NASA Glenn Research and Technology Innovation Center. All funds need not be provided at once, but are dependent on the priority of the action item.

ANALYSIS OF POTENTIAL ECONOMIC IMPACTS

Northeast Ohio can follow many options and paths to build its future economy. One approach is to build on the region’s assets, including a major federal laboratory as represented by NASA Glenn. The past and ongoing federal investments in NASA Glenn represent a major technology anchor for the region and state, now and in the future. By securing more outside funds for both NASA Glenn and the regional actions required to move this research toward commercialization, NASA Glenn can become an even stronger force in driving an increasingly technology-driven regional and state economy—offering good, well-paying jobs; creating new industries and new firms; and helping existing firms become more competitive.

This analysis conveys the potential economic impact of this strategy over the next 10 years. The number of firms created, innovations introduced, and sales from such innovations will exponentially grow far greater than the level projected at the end of 10 years. Even so, the

Table ES-4: NASA Glenn Strategy Resource Requirements

Action	Priority	Annual Cost	One-Time Cost	Funding Sources
Create a NASA Glenn Research and Technology Innovation Center	Mid-term		\$80 million to \$120 million	Federal, state
Scale up existing research consortia	Short-term	\$5 million per center for 1 to 3 years	Seed funding for GMI business accelerator, \$30 million over three years	Federal, state
Create two new research consortia	Mid-term	Seed funding of \$10 million to \$15 million per center	Seed funding for facilities, equipment, etc., of \$30 million to \$45 million per center	Federal, state
Seek to build joint efforts of NASA Glenn, in concert with other research organizations, to seek R&D funding in key technology areas	Immediate	No new resources required		NASA Glenn internal funds
Seek multiyear federal investments through efforts with Congressional Delegation	Immediate	No new resources required		Goal of \$100 million over five years secured
Create Industry Fellows Program	Short-term	\$150,000 seed funds to establish and \$300,000 annual funding		Industry and philanthropic
Establish Industry Support and Applications Program	Mid-term	\$500,000 to \$750,000		NASA reallocate internal funds (e.g., Director's Fund)
Expand and broaden NASA Glenn's Commercial Technology Fund	Short-term		\$10 million to \$12 million investment every five years	Philanthropic
Form Glenn Technology Commercialization Center	Short-term	\$1 million to \$1.5 million		Federal
Establish networking and connecting organization	Immediate	\$400,000 to \$600,000		Private, philanthropic, state

Table ES-4: NASA Glenn Strategy Resource Requirements (continued)

Action	Priority	Annual Cost	One-Time Cost	Funding Sources
Use Glenn procurement base to attract, build, and expand NASA contractor base in Northeast Ohio	Immediate	No new resources needed		NASA Glenn and existing economic development organizations
Build strong co-op engineering program	Short-term	\$200,000 to \$500,000	Redirect time of faculty	University, industry
Establish pilot program to establish own salary structure	Short-term	No new resources required		Federal funds
Create brand name for NASA Glenn	Mid-term	To be determined		NASA reallocate internal funds
Identify, market to, and build sustained knowledge and awareness of NASA Glenn	Short- to Mid-term	\$500,000 to \$750,000		NASA reallocate internal funds
Establish a One-Stop Industry Liaison Office	Immediate	\$150,000 to \$300,000		NASA reallocate internal funds
Encourage NASA Glenn participation in Ohio's Third Frontier Innovation Centers	Immediate	No new resources required		

investments described in this Roadmap are estimated to create more than 12,000 direct and indirect jobs and leverage significant new additional federal R&D investment into the region, amounting cumulatively to more than \$12.5 billion in the next 10 years with \$4.8 billion of this investment occurring in the region's institutions and firms.

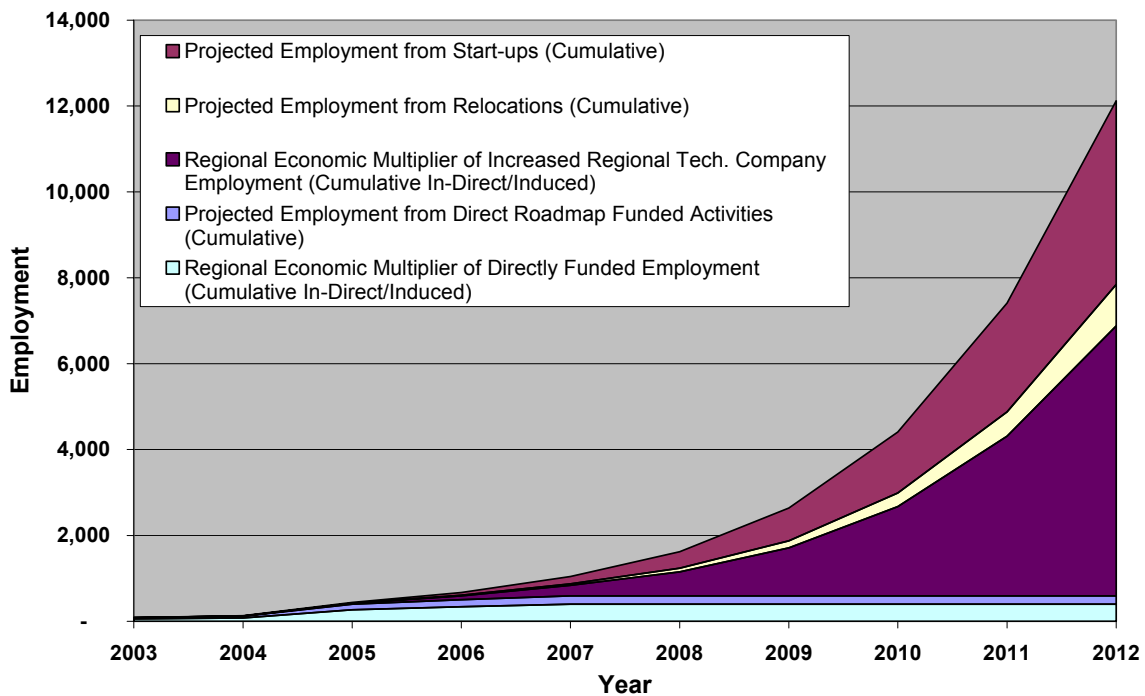
While the region could make other choices, taking advantage of NASA Glenn to further build its research stature in collaboration with the region's higher education institutions, increasing the focus and resources available to NASA Glenn to increase its applications work in conjunction with the proposed Research and Technology Innovation Center, and investing in other technology commercialization vehicles at a scale considerably greater than NASA and the community invest today can enable the region to further grow and prosper.

Battelle's analysis indicates that the investments recommended in the Roadmap can result in the following (Figure ES-3):

- 78 new technology firms, 68 start-ups and 10 companies attracted to the region
- 5,400 direct new jobs and 6,300 indirect new jobs
- 190 new research positions that will generate another 400 additional jobs.

Due to the need for specific infrastructure requirements, the NASA Glenn/Northeast Ohio Roadmap will require investments of approximately \$325 million in its first five years and an

Figure ES-3: Forecast Employment Impacts of NASA Glenn Roadmap
(Including Regional Economic Multipliers)



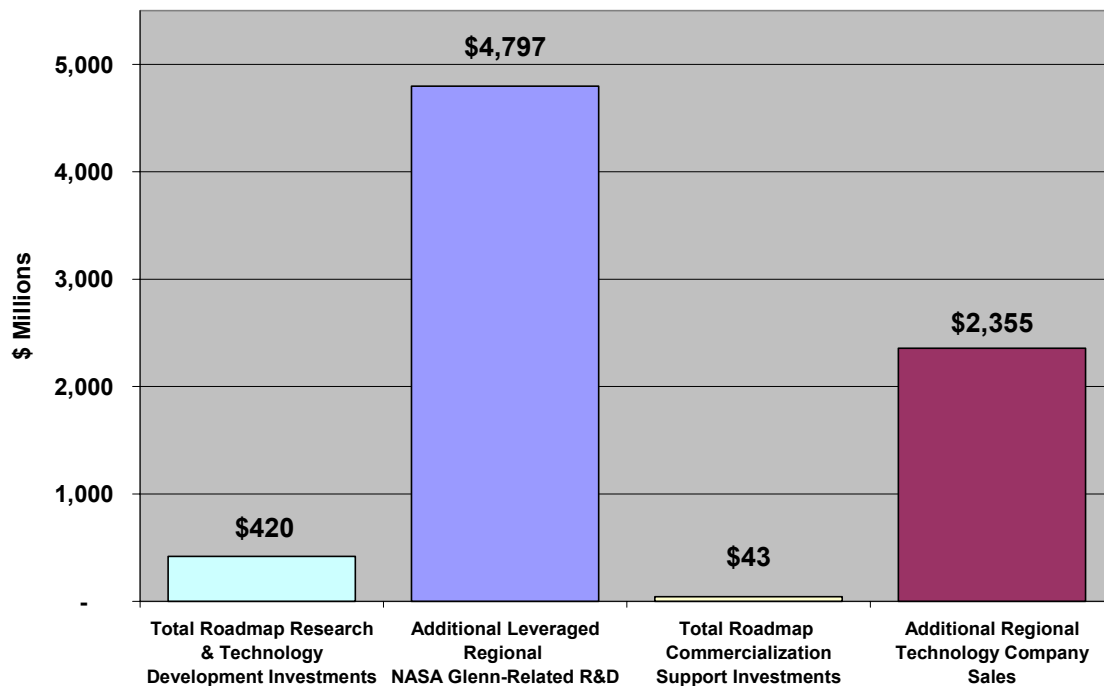
additional \$160 million in the second five years from private, philanthropic, state, and federal sources. Of this approximately \$485 million total, \$420 million is for direct funding of the technology development efforts of the Research and Technology Innovation Center and consortia (and associated technical infrastructure), \$43 million for the Commercialization Center and funding, and \$23 million in related support, educational, and marketing investments.

These investments in research, innovation, and commercialization infrastructure will ultimately support an annual increase of R&D resources directly to NASA Glenn of approximately \$250 million by 2012 and will yield an additional \$750 million in annual NASA Glenn-related research and development being performed by regional partners and collaborators (both institutional and private sector).

This additional increase in the research and development base of Northeast Ohio, combined with the supporting development and commercialization infrastructure, will lead new regional technology-based start-ups and relocated firms to generate, over time, annual sales that reach more than \$1.045 billion by 2012 with a cumulative total of \$2.355 billion over the 10-year period. As these start-up and relocated firms continue to grow, they are forecast to reach combined annual sales of approximately \$5.5 billion by 2017.

Over the next decade, these investments in the NASA Glenn/Northeast Ohio Roadmap are designed to foster, catalyze, and leverage other financial investments in the region's NASA Glenn-related research base. Over the 10-year period, 2003–2012, for every **\$1 of Roadmap-initiated investment in research and technology development, an additional \$11.42 in other research and development expenditures will occur in the region's firms and institutions (not including NASA Glenn)** (Figure ES-4).

Figure ES-4: Cumulative Leveraging of Roadmap Investments: 2003–2012



Additionally, these Roadmap investments will foster the development of new technology-based start-ups and relocated firms that will ultimately generate sales. **Every \$1 of Roadmap-initiated investments in research, technology development, and commercialization support is estimated to leverage \$10.36 in sales from new regional technology companies by 2012, growing to a level of \$1 of investment per \$32.02 in sales by 2017.**

Organization and Structure

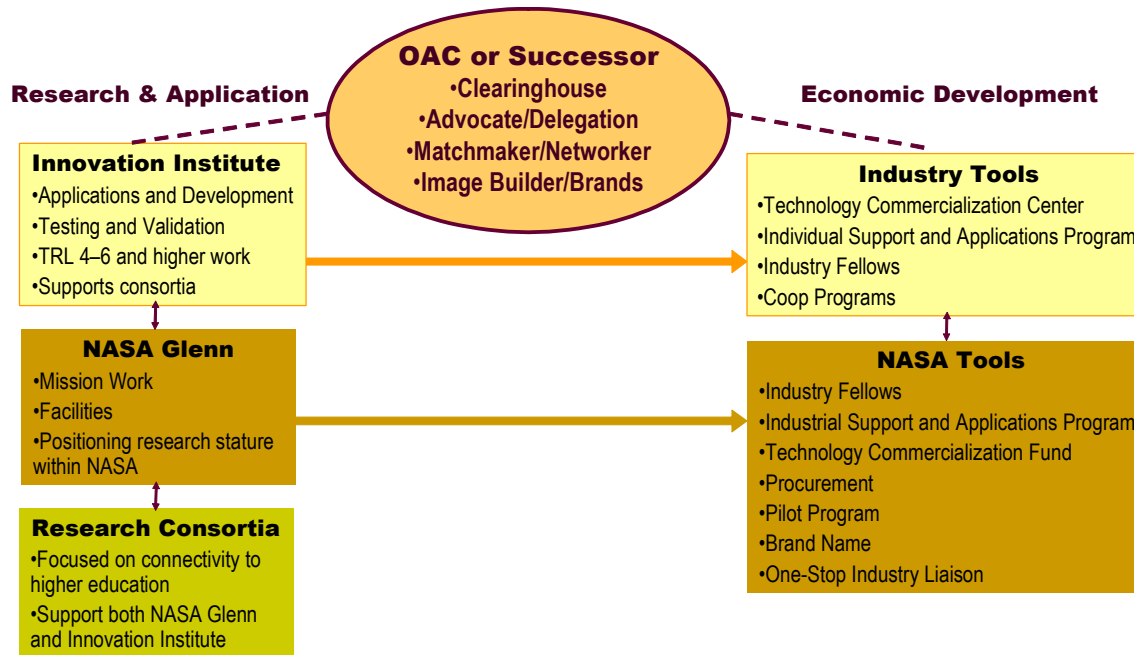
Two issues need to be addressed in moving this set of strategies forward:

- How NASA Glenn organizes itself
- How the external business community organizes itself to support and work with NASA Glenn.

Several actions are suggested to increase NASA Glenn’s focus on building stronger linkages with the external community. NASA Glenn must reconstitute its “tool kit” to work with industry around such new tools as technology commercialization support, prototype development, and testing and validation access and support. Other actions include an industry liaison office; internal resources to address and partially pay for the costs of working with industry under full cost recovery; a complementary Research and Technology Innovation Center to conduct applications-oriented research, undertake test bed and other support, and secure other federal and other funding sources; a Glenn Technology Commercialization Center; and a commercial technology fund to move NASA research forward. NASA Glenn must connect and collaborate more with higher education institutions, particularly those close to it, as do other NASA Centers (e.g., Ames, Langley, Marshall).

There is a need for an umbrella intermediary organization, not part of NASA Glenn itself, which plays the role of advocate, networker, matchmaker, and problem solver. While OAC, OAI, and CAPRA at various times have taken responsibility for part or parcel of these roles, the fragmentation of these responsibilities has neither served the region nor NASA Glenn well, compared with the roles of similar organizations in benchmark labs examined in this study, such as Sandia and Marshall. Figure ES-5 depicts the structure and organization that is proposed to accomplish the goals of this strategy.

Figure ES-5: Structure and Organization for Making NASA Glenn an Economic Engine for Northeast Ohio



The Center for Regional Economic Issues (REI) at Case Western Reserve University has completed a review of the capabilities of the OAC and the various Northeast Ohio intermediary organizations that play a role in supporting GRC and facilitating economic development within the region. Based on this review, REI recommends that OAC reposition itself within the local landscape and establish new relationships that will allow it to better access and leverage current capacity within existing institutions. Specifically, REI recommends that

- **OAC should remain a stand-alone organization with its own board of directors.** Gaps continue to exist within the local technology and economic development landscape. A properly restructured OAC could address these gaps and better support the region’s efforts to leverage GRC’s assets into economic growth for the region and the state.
- **OAC should achieve greater alignment with NorTech.** Proper alignment with NorTech could allow OAC to benefit more directly from NorTech’s ability to shape economic policy and to better position itself as an important organizational component in advancing the region’s technology agenda.

- OAC should continue to work with the Growth Association on the legislative aspects of the federal budget; however, **OAC should retain advocacy and lobbying as part of its core operations and should expand its budgetary advocacy activities to include state, local, and private sources, particularly foundations and the NASA agency in Washington.**
- **If implementing the strategies is not consolidated within a single organization, OAC could unite with several organizations to take responsibility for various components.** Leveraging the capacity and experience within several local intermediaries including OAI, NorTech, GLITeC, and potentially ITI could greatly enhance the efficiency and effectiveness of the implementation of the strategies.

To manage these responsibilities, OAC will need to expand and diversify its funding base, increase staffing, and restructure its board to include representatives of both the industry and research communities, including local universities.

Measures of Success

The following goals measure performance, with actual monitoring to be undertaken by OAC (or its successor organization) and NASA Glenn to determine the degree to which performance objectives are being accomplished. Key measures that could be used to monitor progress include the following:

- Increase the amount of federal R&D resources (including R&D funding and support for Glenn technical staff) flowing to the region involving NASA Glenn, including consortia, Innovation Center, and NASA directly from \$618 million today to \$1.2 billion by 2007 and \$1.6 billion by 2012
- Establish Northeast Ohio as a recognized national research center in at least two of the eight cross-cutting and emerging technology development areas as measured by citation analysis, federal funding flows, and reputation rankings (include both higher education and NASA Glenn combined numbers)
- Increase both the number and size of Space Act Agreements involving NASA Glenn and Ohio-based industry partnerships
- Increase the number of start-up firms formed around NASA technologies equal to or greater than the best practice federal laboratories
- Leverage federal and other dollars 3:1 for every \$1 invested by the State of Ohio and the region
- Increase the number of networking events and participants at least 25 percent per year over the next three years
- Dollars of venture capital invested in targeted technology platform areas
- Implement actions laid out in the strategy at least 70 percent within three years and 90 percent within five years.

In addition to these outcome and impact measures, OAC should work with and encourage NASA Glenn working with OAC to update this strategy every three to five years to adjust to changing economic conditions.

COMMUNITY ROLES AND NASA ROLES

Community and regional roles and responsibilities include

- Helping form an applications-focused Glenn Research and Technology Innovation Center
- Encouraging university and industry collaboration with NASA Glenn
- Utilizing NASA Glenn as a more important enabler and stakeholder in the state's Third Frontier efforts and proposals
- Supporting and helping to expand the depth of NASA Glenn niches and technology areas working with the Ohio Congressional Delegation and others
- Building strong, scaled-up networks and helping to fund technology commercialization tools to move NASA Glenn research into existing firms and new firms.

NASA Glenn roles and responsibilities include

- Taking on greater responsibility for its destiny within NASA's set of centers and taking advantage of NASA directions to build cutting-edge national excellence in key research and technology areas identified in this report
- Helping to form an applications-focused Glenn Research and Technology Innovation Center to complement NASA Glenn's internal research efforts
- Increasing collaboration with the region's higher education institutions
- Adopting internal changes and putting in place technology commercialization tools that will enable research to move into markets and industry to become more engaged with the institution
- Improving access to and ways for industry to interact closer with NASA Glenn.

CONCLUSION

Not only states but also countries around the world desire to have a federal or national laboratory located in their region. These laboratories serve as “anchors” for building a climate of knowledge, talent, and creative thinking, which both directly and indirectly contributes to developing new industries, new products, and more competitive economic bases. But these laboratories also contribute by offering good, well-paying jobs; employing scientific and technical talent; and offering good career opportunities for the region's citizens and the potential for their talented offspring to remain in the region.

Northeast Ohio, for many reasons, has either taken for granted or generally ignored a major federal laboratory in its midst; although, in the immediate post-WWII period, the region's business leadership actively courted NASA Glenn to locate in Cleveland rather than in another region of Ohio or another state. In recent years, however, positive progress has been made in seeking to support NASA Glenn's mission and to better link NASA Glenn to research institutions and firms in the region.

Yet, more needs to be done; some of which will require NASA Glenn to chart new directions for itself and to position itself in the cutting-edge technologies that will propel NASA forward in the

21st century. It also requires that the community's research institutions and industries be willing to develop stronger partnerships and to make the investments that will be needed to position NASA Glenn and the region as a leading technology center. While some of these investments may come from the federal government, experience demonstrates that business and philanthropic leadership also must do their part. The time to act is now.