**Testimony of Pierre F. Harter**
**Director of Research and Development**
**National Institute for Aviation Research**
**AVP Industry and Defense Programs, Research Operations**
**Wichita State University**

**U.S. House of Representatives Transportation and Infrastructure Committee**
**Subcommittee on Aviation**
**"The Leading Edge: Innovation in U.S. Aerospace"**

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## Thank You

Mr. Chairman and Members of the Subcommittee, I would like to thank you for the opportunity to testify today. My name is Pierre Harter, and I am Director of Research and Development for the National Institute for Aviation Research and Associate VP for Industry and Defense Programs, Research Operations at Wichita State University.

## Background

After dominating in the 20th century, the U.S. aerospace industry continues to be the world leader in this century as well. The gap has closed significantly in the commercial aviation sector, hastened by the pandemic and the MAX grounding. Significant competition remains and is growing, with major world powers (e.g. China, Russia, Japan, India, Brazil) working to introduce new indigenous commercial platforms (with some being nationalized) to capture the economic and trade benefits associated with this industry and its products.

U.S. general aviation continues to slowly recover from the shock of the 2009 financial crisis, with significant consolidation in the sector and continued pressure from international competition.

In the defense industry, the U.S. continues to maintain air dominance in traditional manned aircraft, although the competition is stiff. Widely reported cybersecurity/espionage threats in the 21st century have tightened the gap. The global arms race for unmanned aerial systems (both autonomously and remotely flown) and hypersonics is well underway, spurring innovation that will impact the aerospace industry for years to come – and in some cases, the military relies on innovation coming from commercial industry sectors like aerospace.

The U.S. (and international) aerospace supply chain is still in a precarious position recovering from multiple recent global shocks[1]. The aerospace supply chain is an essential component of the U.S. economy that provides a competitive edge. It must remain a strategic asset as well as national defense priority, as much of it serves the civil, commercial, and military sectors.

[1] Robin Lineberger, John Coykendall, Alan D. Faber, Steve Shepley. Deloitte. "2021 aerospace and defense industry outlook". https://www2.deloitte.com/us/en/pages/manufacturing/articles/global-aerospace-and-defense-industry-outlook.html

In the aerospace supply chain (civil, commercial and defense), as well as the original equipment manufacturers (OEMs), transformation was well underway and will accelerate as we emerge from the pandemic. This transformation has been both physical and digital across existing production lines as well as sustainment of legacy fleets - incorporating new technologies and innovations in areas such as robotics, automation, digital engineering, additive manufacturing, Industrial Internet of Things (IIoT), data science, artificial intelligence and other technologies (aka "Industry 4.0" and "Advanced Manufacturing).

Technological advances in hardware, software, composites, and other advanced materials have spurred innovation in recent years in several new areas that are within the focus of this hearing:

- Unmanned Aerial Systems (UAS), also referred to as "drones" or unmanned aerial vehicles (UAV) with some nuances
- Advanced Aerial Mobility (AAM), also referred to as Urban Air Mobility (UAM)
- Supersonic (Mach 1 – 5) and hypersonic (greater than Mach 5) transportation
- Electric propulsion

## Innovation

Aviation has always been a source of innovation and inspiration going back to the Wright Brother's first flight in 1903. In many ways, the next two decades hold the promise to transform our daily lives as significantly as that event did for the twentieth century.

Advanced aerial mobility (AAM) and supersonic flight will create new travel paradigms and provide us with unprecedented global and local connectivity. Unmanned aerial systems (UAS) technology will provide new and faster methods for delivering goods, transforming business-to-business and business-to-consumer transactions, similar to how ecommerce has transformed our daily lives. Electric technologies will provide cleaner, quieter, and more efficient propulsion systems that will drive a variety of these new air vehicle platforms. Continued advancements in composite materials, additive manufacturing, and production system technologies will increase efficiency and reduce costs for these new entrants, as well as the "traditional" general aviation and commercial aircraft designs of the future.

I would also like to highlight the importance of advanced air mobility as an emerging sector of the aviation industry. We need broader thinking to facilitate industry growth within this realm, and we are pleased to see both House and Senate legislation working to address this important topic through the *Advanced Air Mobility (AAM) Coordination and Leadership Act.* This legislation will facilitate collaboration between federal agencies and civil aviation industry leaders to develop policies regarding advanced air mobility, ensuring we advance United States global leadership and competitiveness within this growing sector.

It certainly is an exciting time in aviation history, with so much innovation underway and on the horizon. And the stakes are high – as these technologies will transform how we do business domestically and internationally, and even more fundamentally, how we live and interact with each other on a daily basis.

It is imperative that we recognize, as this hearing is, the promise that these new innovations will bring. Safety must of course remain at the core of all aviation-related innovations, but must be balanced by enabling new technologies to enter the market efficiently, which inherently

enhances safety. The United States must maintain its competitive advantage in aerospace, as it will continue to remain a dominate economic driver and a national defense imperative.

To remain the world leader in aerospace, the United States must develop and execute a strategic plan to create an environment that allows U.S.-based companies to innovate and be first to market with these new technologies, while maintaining safety and security[2]. To do this, we must continue to embrace strong public-private partnerships to help establish the strategic framework and shape the regulatory environment. In addition, we must invest in research and development that enables new designs/products, materials and manufacturing technologies that enable U.S. businesses to efficiently design, certify, and manufacture the most advanced air vehicles of the future.

Wichita State University's National Institute for Aviation Research has a proven track record for supporting industry and government agencies in developing, certifying and bringing new technologies to market. An excellent example of this is composite technology.

## Composites – Case Study

Composites have transformed aerospace since their introduction in the late 1970s and 1980s. Early on, adoption was limited to OEMs with deep pockets to invest in proprietary structural material databases and analytical tools for certification. In many cases, identical materials were used by multiple OEMs, each having to create their own database at their own cost. This created a barrier to entry, and hence stifled innovation.

Recognizing this barrier, a partnership was formed in the 1990s with the FAA, NASA, academia and industry. The partnership was successful in transforming the way new composite material databases were created and approved for use on aircraft utilizing a shared database methodology. This collaboration between the FAA, NASA, NIAR and industry reduced the "time required for certification of new composite materials by a factor of four and the cost of certification by a factor of ten" [3].

Over the last two decades, NIAR's relationship with government and industry has evolved significantly. NIAR is the world's only non-OEM entity that the FAA, and its counterpart in Europe (EASA), accept for developing new composite materials and specifications[4]. NIAR partners with OEMs, as well as sub-tiers and material suppliers, to test and create certified material databases. Adoption has been broad, starting with general aviation and quickly moving into commercial and defense applications. Recognizing this expertise and experience, NIAR now oversees the Composite Materials Handbook (CMH-17, formerly MIL-HDBK-17) and works with industry and government to continuously amend and add new content to this handbook that provides methods and guidance material for certifying composite structure. NIAR also provides

[2] Source: Robin Lineberger, Aijaz Hussain and David Silver. Deloitte Insights. "Advanced air mobility: Can the United States afford to lose the race?". https://www2.deloitte.com/us/en/insights/industry/aerospace-defense/advanced-air-mobility.html.
[3] Source: Statement of John Tomblin, Ph.D. before the U.S. Senate Commerce Committee Subcommittee on Science, Technology and Space. February 27th, 2003. https://www.globalsecurity.org/space/library/congress/2003_h/030227-tomblin.pdf
[4] Sources: AIR100-2010-120-003.pdf (faa.gov) and Certification Memorandum_v2 (europa.eu)

research and guidance to government agencies for policy and regulatory guidance material for composite structures as well as other certification areas (e.g. crash worthiness).

In recent years, this composite expertise has extended into the additive manufacturing field. In 2019, working with government and industry, NIAR provided new guidance for how to certify non-metallic additive manufacturing materials and added the first AM material system to its shared database – ULTEM 9085. NIAR is now working with government agencies (FAA and DoD) as well as respected industry advisory groups (America Makes, SAE International, ASTM International, Metallic Material Property Development and Standardization (MMPDS), and others) to create guidance material and create shared databases for metallic AM materials. The first effort is with a titanium alloy, which is a critical structural material for civil and military air vehicles.

New epoxy composite material systems continue to evolve, providing higher strength and stiffness, lower costs, and higher operating temperatures. Many companies are investigating and deploying new thermoplastic polymer matrix composite (TP PMC) materials into structure. These materials offer the ability to drastically reduce composite manufacturing times down to the automotive-like efficiencies, while offering higher temperature capabilities required for primary structure and supersonic applications where skin friction at supersonic speeds creates significant heat on the structure.

The hypersonic regime (speeds greater than Mach 5), creates a new challenge for materials and manufacturing based on the intense heat generated by skin friction at these speeds. Efforts are already underway at NIAR, and industry partner Spirit AeroSystems Inc., to build the infrastructure needed to create and test these new ultra-high temperature materials. See Figure 1 for more details on the evolving advanced material landscape applicable across all sonic speed zones.

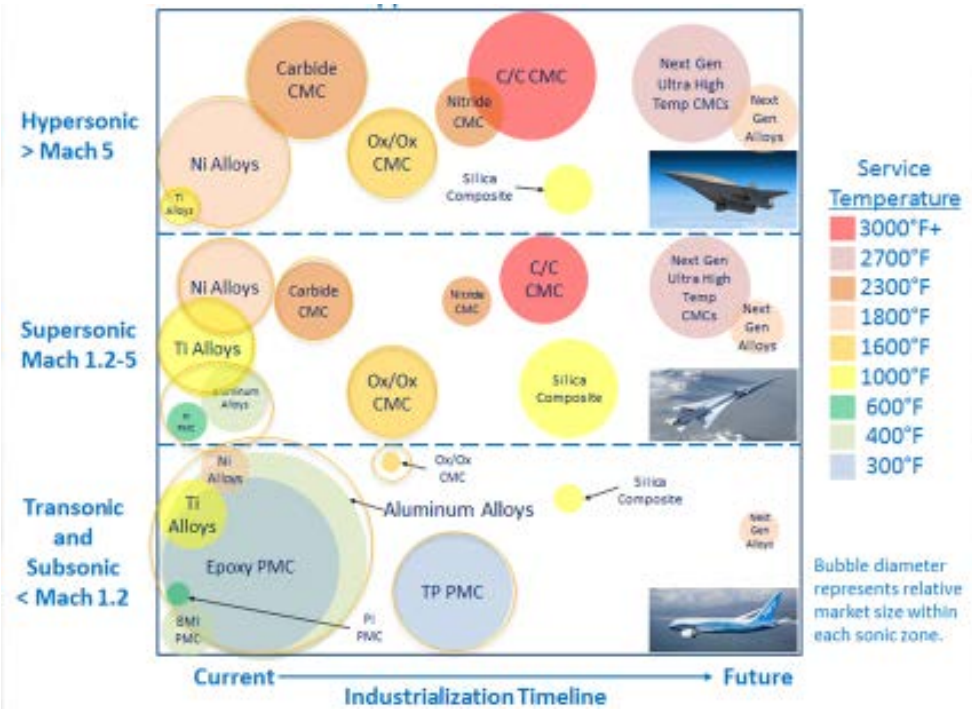


*Figure 1: Material Application in Aerostructures. Source: Spirit AeroSystems Inc.*

All of this was made possible via strategic decisions by the U.S. government in the 1990's to fund R&D efforts in this area and embrace public and private collaborations to create new policy, guidance and regulations to enable innovation that has carried through to present day. It is this successful model of investment in R&D and public-private collaboration that will continue to enable innovation in U.S. aerospace allowing U.S companies to be first-to-market and maintain the leading edge.

## Wichita State University and the National Institute for Aviation Research

Since its inception in 1985, National Institute for Aviation Research (NIAR) at Wichita State University has made a name for itself as the most capable university-based aviation research center in the United States, providing research, design, testing, certification and training to the aviation manufacturing industry, government agencies, educational entities and other clients that can benefit from our services. NIAR has a $125 million annual budget, a staff of over 875, and over one million square feet of laboratory and office space in six locations across the city of Wichita, the Air Capital of the World.

The Brookings Institution ranks:

- Wichita #1 in manufacturing jobs as a percentage of all jobs.
- South Central Kansas as the most manufacturing-specialized region in the United States with 17.7 percent of regional jobs in manufacturing, more than half of which are engaged in making some of the world's most sophisticated aircraft.
- Wichita has the highest concentration of aerospace manufacturing employment in the nation.
- Wichita is ranked #3 nationally as an advanced industry hotspot.
- Wichita ranks # 1 in percentage of jobs involving stem occupation.
- Wichita ranks #3 among metros for highest concentration of engineers per 1,000 employees (22.4 / 1000)

A key contributor to these rankings, the NIAR mission is to conduct research, transfer technology and enhance education for the purpose of advancing the nation's aviation industry, and to assist non-aviation industries that may benefit from aviation-related technologies. NIAR's areas of expertise are:

- Additive Manufacturing & Prototyping
- Advanced Coatings
- Advanced Manufacturing
- Aerodynamics
- Ballistic and Impact Dynamics
- Composites and Advanced Materials
- Crash Dynamics
- Digital Twin
- Engineering Design & Modification (WERX)
- Environmental and Electromagnetic Testing
- Extended Reality
- Flight Simulation
- Full-Scale Structural Testing
- Nondestructive Testing
- Sustainability
- Reverse Engineering
- Robotics and Automation
- Virtual Engineering
- Wind Tunnel Testing

NIAR also runs several centers and participates in initiatives that are strategically aligned with the institute's capabilities and mission. NIAR's centers promote the safety, research, manufacturing and design elements of today's aviation industry. They strengthen airworthiness assurance in the short and long term. They make the concerns of the general aviation industry their own. And they make dreams of a reality. This happens not only through NIAR's own research, but through the exchange of knowledge with researchers in other centers.

Those centers include:

*ATLAS Advanced Technologies Lab for Aerospace Systems (ATLAS)*

NIAR's ATLAS is a multi-disciplinary manufacturing environment and engineering education program to prepare engineers and educators for the Factory of the Future and to aid the current workforce in seamlessly adapting to advancements in the workplace. ATLAS's mission is to provide a neutral ground for advanced manufacturing research and development with state-of-the-art machines, software and processing options.

*Aircraft Structural Test & Evaluation Center (ASTEC)*

NIAR's ASTEC encompasses 130,000 square feet (39,000 square meters). The facility features include a 30x70-foot hangar door, a clear span of 265 feet (80 meters) and ceiling height of 48 feet (14 meters). ASTEC is a secure site designed to perform proprietary client research and testing. The facility is currently home to the institute's Full-Scale Structural Test Lab, Aging Aircraft Lab, Mechanical Test Lab and Ballistics Lab.

*3DEXPERIENCE Center*

The 3DEXPERIENCE® Center, a partnership with Dassault Systemes, involves an interconnected community of top researchers, corporations and laboratories to accelerate innovation. The 22,000 sq. ft. facility at Wichita State University offers the expertise and technology for companies to accelerate their innovation. Aerospace and other industries can target improvements from concept to production and extend to operations - all while facilitating certification. The 3DEXPERIENCE Center enables companies to engage in advanced product development and the manufacturing of next-generation materials and technologies.

*Jerry Moran Center for Advanced Virtual Engineering & Testing*

The Advanced Virtual Engineering and Testing Lab (AVET) was opened in 2019. It was dedicated to Kansas Senator Jerry Moran in 2020 as tribute to Moran's commitment to helping WSU fulfill its vision and mission to provide impactful student experiences that drive prosperity in our region. AVET is home to NIAR's Virtual Engineering and Crash Dynamics Labs. The facility features additional client prep bays, which will allow multiple clients to be in the lab at the same time, while maintaining privacy during testing. It also includes workspace for 40+ virtual engineering staff, three collaboration rooms and secured areas for restricted projects; and a space for related technologies such as material/component testing and virtual reality.

*National Center for Advanced Materials Performance (NCAMP)*

The National Center for Advanced Materials Performance (NCAMP), located at WSU-NIAR provides the nation's commercial and military aviation industry with a center for the validation and quality assurance of composites and advanced materials.

*Composite Materials Handbook-17 (CMH-17)*

The CMH-17 organization, administered by Wichita State University, provides information and guidance necessary to design and fabricate end items from composite materials. Its primary purpose is the standardization of engineering data development methodologies related to testing, data reduction, and data reporting of property data for current and emerging composite materials. In support of this objective, the handbook includes composite materials properties that meet specific data requirements. CMH-17 works closely with NCAMP to approve composite specification and design values.

*FAA Center of Excellence for Composites and Advanced Materials (CECAM)*

CECAM is an FAA-sponsored consortium of universities competent in advanced materials research. CECAM is led by Wichita State University, which interacts directly with the FAA to support its advanced materials safety programs.

*FAA ASSURE Center of Excellence for UAS Research*

WSU is one of 24 core research institutions within the FAA's Alliance for System Safety of UAS through Research Excellence (ASSURE). ASSURE's mission is to provide high-quality research and support to autonomy stakeholders both within the US and beyond to safely and efficiently integrate autonomous systems into the national and international infrastructure, thereby increasing commerce and overall public safety and benefit

*Kansas Aviation Research & Technology Growth Initiative (KART)*

The Kansas Aviation Research & Technology Growth Initiative uses funds provided by the Department of Commerce and the Kansas Legislature with the goal of strengthening a variety of aircraft industry technologies and marketing them to other areas outside the State of Kansas and the United States. The Kansas Aviation Research & Technology Growth Initiative will help retain and grow the aviation cluster in Kansas and help Kansas aviation companies remain competitive throughout the 21st century.

*FirePoint Innovations Center*

Established in 2018, FirePoint partners with the U.S. Army's Combat Capabilities Development Command, Aviation and Missile Center (DEVCOM AvMC) to accelerate the delivery of innovative capabilities to the warfighter. FirePoint creates a collaborative and networked environment of national scope to investigate, collaborate and produce courses of action to solve technology and equipment challenges identified by the Army.

*National Institute for Research and Digital Transformation (NIRDT)*

The newly created (2019) National Institute for Research and Digital Transformation at Wichita State focuses on diversifying and growing the economy while providing an important platform for creating new academic and applied learning programs for students. NIRDT is based on the model and strengths of NIAR, but focused on

developing technology that can transform other industries, including aviation, to drive economic development and support new ventures in Kansas and the United States.

Kansas's leadership in aerospace research and development and its strong aerospace manufacturing presence is reflected in Wichita State University. Because of NIAR's research efforts, Wichita State University currently ranks fourth among all U.S. universities in aeronautical R&D expenditures according to the National Science Foundation. WSU ranks first in industry funding for aeronautical expenditures. See Figure 2. WSU and NIARs R&D expenditures have steadily increased over the last two decades, a testament to its unique capabilities and ability to collaborate successfully with government and industry as shown in Figure 3.

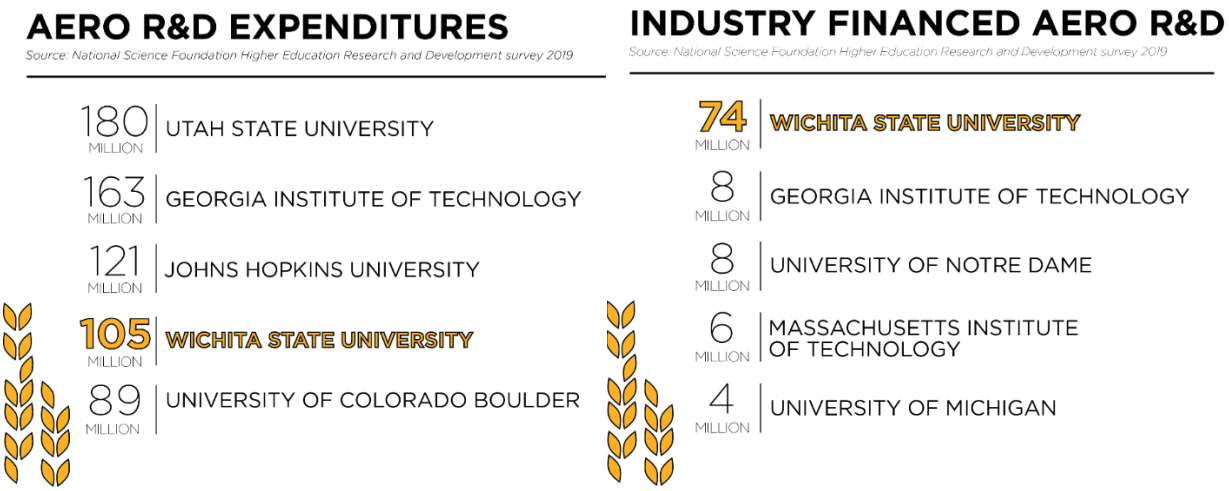


*Figure 2: WSU aeronautical R&D expenditures 2019 rankings (Source: National Science Foundation survey 2019)*

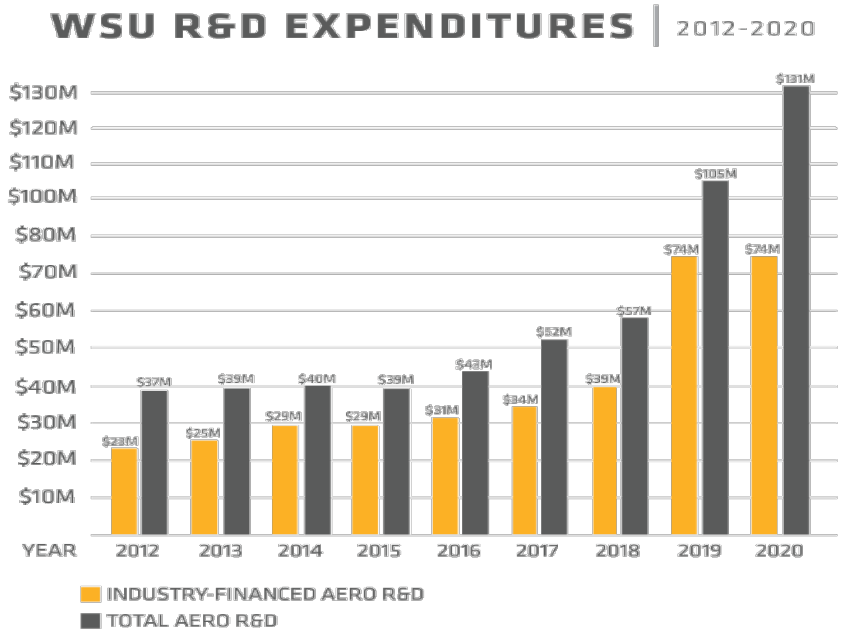


*Figure 3: WSU aeronautical historical R&D expenditures (Source: National Science Foundation Surveys 2012-2020)*

## Summary

In conclusion, it is apparent that U.S. dominance in aerospace is a critical economic driver and national security imperative. The next two decades promise exciting new aerospace innovations and products that will transform the way we live and work – enhancing the quality of life for Americans and the rest of the world. As in the past, the government must continue to support innovation by incorporating these new technologies into its strategic framework. Investment in R&D and capitalizing on industry/academia/government partnerships will enable safe, secure and efficient introduction of these new technologies and products. WSU and NIAR look forward to continue working with industry and government to conduct research, transfer technology and enhance education for the purpose of advancing the nation's aviation industry.

I appreciate the opportunity to testify today and would be happy to answer any questions you may have.