Testimony before the Committee on Science, Space, and Technology
U.S. House of Representatives

Hearing on NASA's Aeronautics Mission: Enabling the Transformation of Aviation
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Madam Chair, Ranking Member Babin, and distinguished Members of the Committee, thank you for the opportunity to testify today. I will focus my remarks on NASA's role in hypersonics research, a field that holds the potential for truly transformative accomplishments in aeronautics.

As I am sure you know, hypersonics is a broad area of inquiry that generally refers to flight in excess of Mach five, or five times the speed of sound – about a mile per second. An airplane flying at hypersonic speeds could travel from Dulles Airport to London Heathrow in less than an hour. Talk about transformative!

We have been flying hypersonic vehicles of one sort or another since the late 1940's, but there are still many fundamental problems left to be solved, especially for vehicles that remain in our atmosphere instead of passing through it on the way to space or back. Propulsion is one – conventional jet engines will not work at hypersonic speeds, and so rockets or "airbreathing" engines such as *scramjets* must be used. At high speeds, friction with the air makes surface temperatures high, stressing the limits of materials. Control of a hypersonic vehicle is also an issue, as is the overall design of an optimized, fully-integrated configuration. NASA has significant expertise in each of these areas.

Historically, NASA aeronautics and even its precursor, the NACA, have made notable contributions to the evolution of hypersonic flight, including our understanding of the physics of reentering spacecraft, traveling in some cases more than 40 times the speed of sound. That work continues today as NASA engineers study the problems associated with decelerating large spacecraft in the thin atmosphere of Mars, and develop new high temperature materials, including the material that will shield SpaceX's Dragon capsule, invented by a team at NASA Ames.

That scramjet engine that I mentioned was invented by NACA researchers working at what is now the NASA Glenn Research Center in the late 1950's. Forty-six years after their work, engineers at NASA Langley and NASA Dryden (now Armstrong) flew the first operational scramjets on the X-43 unmanned aircraft, once at nearly Mach 7, and again at Mach 10. NASA also did key computational and experimental work in support of the Air Force's unmanned X-51 flights between 2010 and 2013. NASA even provided the chase planes that monitored the X-51 craft and gathered essential flight data.

NASA propulsion engineers and materials experts are today playing key roles in several DARPA hypersonic programs, as well as the joint U.S.-Australia HIFiRE flight program. And when engineers at the U.S. Air Force's Hypervelocity Tunnel Number 9 – the nation's premiere high-speed wind tunnel located in nearby White Oak Maryland – recently needed a new way to measure model temperatures, they turned to their colleagues at NASA Langley.

NASA has developed many of our standard hypersonic aerodynamics models. The agency also operates hypersonic test facilities, including the Langley 8-Foot High Temperature Tunnel, that has gathered data on nearly every significant airbreathing hypersonic engine, including those that powered X-43, X-51, and the upcoming DARPA HAWC designs. The 8-Foot is an irreplaceable national asset – not just the tunnel itself, but the resident knowledge of the NASA test engineers and technicians.

Research in hypersonic flight may someday lead to ultra-fast commercial craft, and maybe even new ways to reach earth orbit with airplane-like launch vehicles; these are wholly appropriate areas for NASA aeronautics research. The proverbial elephant in the room is the likely military use of hypersonics, including ultra-fast, nearly-unstoppable missiles and reconnaissance craft. In 2016 I chaired a National Academies panel that reported that both Russia and China were advancing quickly in the field, and moving to operational deployment. We are in a race, and I believe that NASA *must* help our nation address this threat. I further believe that role is completely consistent with NASA's mission as codified under the Space Act. With knowledge of all aspects of hypersonic flight, from basic physics to test and design, as well as ties to the broader research community, NASA has capabilities in hypersonics that no other federal agency can deploy.

NASA's hypersonics investments began to languish starting in 2012, when a roughly $60M portfolio was allowed to drop to less than $10M within two years. More recently NASA's hypersonics funding levels have been on the rise, just as our national programs are hitting limits of capacity and workforce, though they are still at only about half their 2012 levels. NASA's reinvestment has included much-needed maintenance on the Langley 8-foot Tunnel, without which some of our national programs would come to a screeching halt.

That's a promising start, but for our nation to lead the world in hypersonics, we must first create a challenging future vision. The future success of hypersonics ultimately hinges on our ability to integrate computational and experimental capabilities, and NASA is the ideal agency to lead such an effort. World-class research requires world-class research*ers* who must have access to affordable, flexible world-class modeling and test capabilities. To do this we need to sustain and expand NASA's hypersonic test infrastructure, including the possible recommissioning of the Hypersonic Test Facility at NASA's Ohio Plum Brook campus. And of course, we cannot relinquish our investments in fundamental research, both inside NASA and in the university community that NASA sponsors. With the promise of flying higher and faster, hypersonics is a great way to attract the best and brightest to careers in aerospace.

In conclusion, I am convinced that NASA Aeronautics has a critical role to play in pursuing hypersonics research that will transform our civil, commercial, and national security activities and inspire the next generation. In its mission to transform aviation, I know of no worthier investment in the NASA Aeronautics portfolio.

Mark J. Lewis

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Dr. Mark J. Lewis is the Director of the IDA Science and Technology Policy Institute (STPI), a federally funded research and development center. He leads more than 40 researchers providing analysis of national and international science and technology issues for the Office of Science and Technology Policy in the White House, the National Science Foundation, and the National Institutes of Health, among others.

Prior to taking charge of STPI, Dr. Lewis served as the Willis Young, Jr. Professor and Chair of the Department of Aerospace Engineering at the University of Maryland. A faculty member at Maryland for 24 years, Dr. Lewis taught and conducted basic and applied research. From 2004 to 2008, he was the Chief Scientist of the U.S. Air Force. From 2010 to 2011, he was President of the American Institute of Aeronautics and Astronautics (AIAA). Dr. Lewis also served as a member of the Air Staff and principal scientific adviser to the Chief of Staff and Secretary of the Air Force. He provided assessments on a wide range of scientific and technical issues affecting the Air Force mission.

Dr. Lewis attended the Massachusetts Institute of Technology, where he received a Bachelor of Science degree in aeronautics and astronautics, Bachelor of Science degree in earth and planetary science (1984), and both a Master of Science degree (1985) and a Doctor of Science degree (1988) in aeronautics and astronautics.

Dr. Lewis is the author of more than 300 technical publications and has been an adviser to more than 60 graduate students. He has also served on various advisory boards for NASA, the Defense Department, and the Air Force, including two terms on the Air Force Scientific Advisory Board.

Dr. Lewis is a Fellow of the Royal Aeronautical Society, a Fellow of the American Society of Mechanical Engineers, and an Honorary Fellow of the AIAA. His awards include the DOD Exemplary Civilian Service Award, Meritorious Civilian Service Award, Exceptional Civilian Service Award, the IECEC/AIAA Lifetime Achievement Award, and the Air Force Association's Theodore Von Karman Award. He was also recognized as an AIAA National Capital Young Scientist/Engineer of the Year (1994) and an Aviation Week Laureate (2007).

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