

2021 AIAA STATE OF THE INDUSTRY REPORT

The Health and Future Outlook of the Aerospace Industry

FULL REPORT

This report summarizes the findings from a survey of approximately 1,000 people conducted by Edge Research on behalf of AIAA in April 2021. Respondents were from across the United States and 37 other countries. Respondents included AIAA members – current aerospace professionals, academics, students (master's and Ph.D.) – and nonmembers.

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INTRODUCTION

Commissioned by the American Institute of Aeronautics and Astronautics (AIAA), the “2021 AIAA State of the Industry Report” captures insights from a survey of AIAA members and stakeholders across the global aerospace industry. AIAA is the world’s largest technical society dedicated to the aerospace profession. AIAA membership comprises nearly 30,000 professional and student members from 91 countries and 100 corporate members who are shaping the future of aerospace.

The findings reveal top-line perspectives on the future outlook of the aerospace industry overall, which sectors are promising and which are challenged, the impact of COVID-19, where policymakers should focus, and how employers are demonstrating a commitment to diversity, equity, and inclusion. The data spans the three AIAA domains – Aeronautics, Aerospace Research and Development (R&D), and Space.

This full report is provided as a membership benefit to all AIAA members. The Executive Summary of the initial insights from the report is available for download by the public at aiaa.org/stateofindustry.

“The advances in aerospace technology and the capabilities over the last century have been essential to economic growth. The sector is integral to accelerate innovation in the 21st century.”

DAN DUMBACHER, Executive Director, AIAA

KEY FINDINGS



Industry outlook cautiously optimistic

The outlook on the aerospace industry is cautiously optimistic. The mood varies widely between professionals in the United States versus those in other countries. The mood in the space sector is 82% positive, while it is only 75% positive in the aviation sector.



Career outlook promising

Current professionals in the industry would recommend a career in aerospace to a young person right now — with a net promoter score (NPS) of 29.



Promising sectors

There are many areas of opportunity in space, artificial intelligence, advanced manufacturing, and autonomous flight, but space has the momentum at this time.



Challenged sectors

Cybersecurity stands out among the most significant challenges – those in the United States place it as one of the top two priorities for their organizations.



Public policy priorities are clear

Stable funding, research investments, technology infrastructure, and an educated workforce pipeline are seen as priorities for congressional and executive branch action, cutting across industry sectors.



Diversity, equity, and inclusion (DEI)

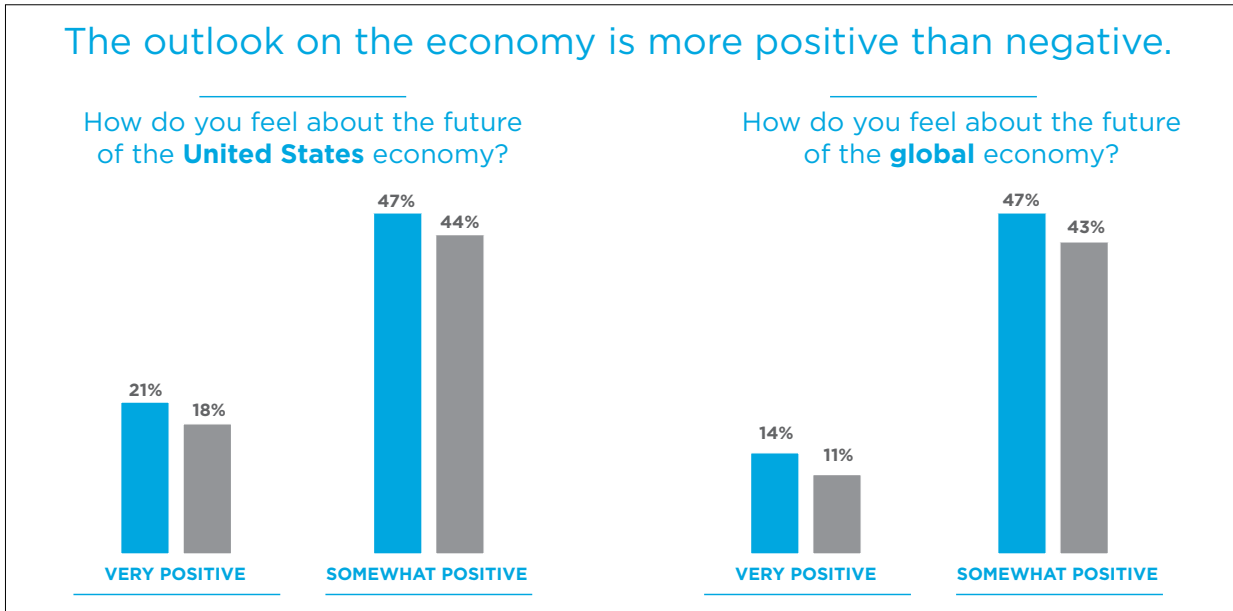
DEI is revealed as a priority and is tied to workforce development. Despite the focus, workers are not sure employers are making the most meaningful changes.

THE ECONOMY AND THE AEROSPACE INDUSTRY

The multi-trillion-dollar aerospace enterprise in the United States includes major corporations, small businesses, federally-funded laboratories, and research universities, as well as airports and military installations. Its extensive presence includes a vast global supply chain. All these stakeholders are focused on innovation and implementation to stay on the cutting edge of research and development, production, and operations.

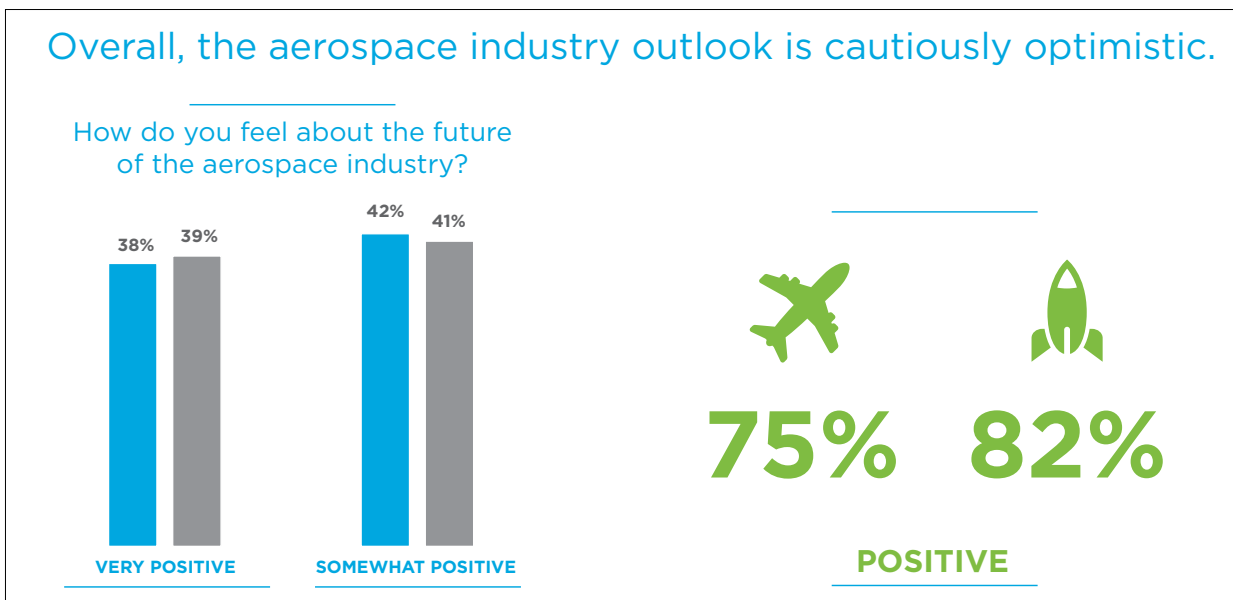
The overall mood from respondents shows they believe the U.S. economy is moving in the right direction, with only slightly lower expectations

about the global economy. Respondents from the United States are more optimistic in general, with international colleagues less optimistic.



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When asked how they felt about the future of the aerospace industry, not surprisingly, members of the aviation sector are more subdued than those in the space sector.



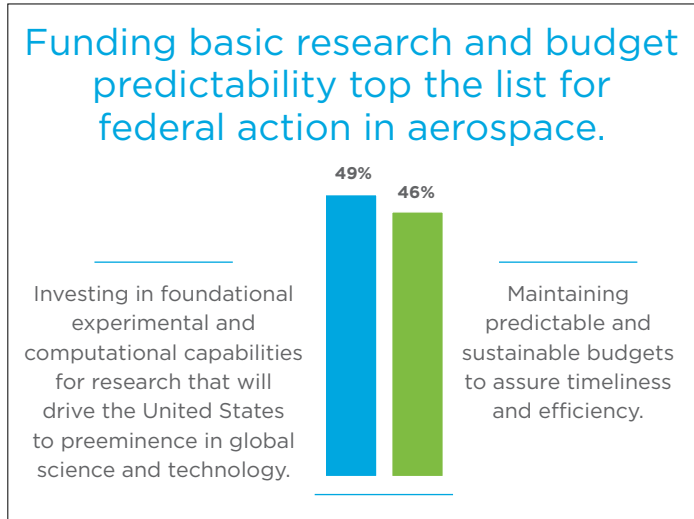
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PUBLIC POLICY PRIORITIES

AIAA is the voice of the aerospace profession, giving its members an effective say in policy decisions affecting aerospace. Since 1972, AIAA has contributed technical expertise to Congress and the executive branch, providing accurate information to decision makers and highlighting the crucial role aerospace plays in economic and national security and in our technological future.

Based on this survey, the top priorities for attention by the current U.S. Congress and administration must be:

- › Investment in foundational experimental and computational capabilities for research
- › Maintaining predictable and sustainable budgets to assure timeliness and efficiency
- › Enhancing the pipeline of STEM-competent workers from within the United States



“It is imperative that Congress make investments in U.S. aerospace R&D. The result will be innovation that leads to new and better products that will create additional jobs, while providing economic and physical security. The Institute’s members agree.”

DAN DUMBACHER, Executive Director, AIAA

Making the Case for R&D Investment

While there has been a recent uptick in federal R&D funding and the United States still represents nearly half of global aerospace R&D spending, other nations continue to close the gap by investing significantly in technologies critical to aerospace and defense. According to analysis from the American Association for the Advancement of Science, federal R&D spending as a percentage of gross domestic product (GDP) had dropped from 1.9% in the mid-1960s, at the height of the Apollo program, to less than 0.7% in 2018. In comparison, China’s research intensity has increased sharply, with spending climbing 10.3% to 2.44 trillion Chinese yuan (\$378 billion) and accounting for 2.4% of its GDP in 2020.

AIAA established funding stability and competitiveness as one of its 2021 Key Issues because a predictable funding environment and long-term authorizations ensure stability and are foundational for successful research and development. The technologies and products developed for aerospace and defense applications have been at the heart of the technology boom and will continue to be at the forefront of rebuilding and growing the economy while providing security from global economic, military, and health threats. Maintaining near-term business health, coupled with a long-term perspective, will drive the difficult choices needed so the nation can best plan for and execute initiatives critical to a secure and economically robust future.

Maintaining Stable Funding

The aerospace industry has experienced growth in recent years because of a strong commercial market and increased government investment, but major challenges have emerged that have been compounded by the pandemic. These challenges include mounting budget deficits, trade policy uncertainties, supply chain disruptions, and global competitors investing heavily in military modernization, commercial development, and scientific research.

This study confirms what the Institute already advocates for – the need for lawmakers to continue funding stability, the need for continued investments in R&D, and legislation that will continue to enhance diversity in the workforce and educate the next generation of aerospace engineers. Across academia, government, military, and the space and aviation sectors, stable funding is critical to the work they are doing, and this budget predictability is key for all three of the AIAA domains – Aeronautics, Aerospace R&D, and Space.

AIAA encourages stable and dependable government budgets that align with clear and achievable goals to provide the means to conquer the technological challenges we face across the industry. This is particularly important as government budgets are stressed with the pandemic response and addressing the needed public health and economic priorities. The technologies and products developed for aerospace and defense applications have been at the heart of the American technology boom and will continue to be at the forefront of rebuilding and growing the economy while providing security from global economic, military, and health threats.

“We face a skills gap in this future group of dreamers and leaders. AIAA believes we must enable a diverse and robust STEM workforce pipeline, and support workforce development for all skill types and career stages to advance learning commensurate with technology and product advancement. It is essential to continue attracting and retaining the skilled, diverse 21st-century workforce who will lead our industry into the future.”

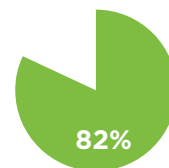
DAN DUMBACHER,
Executive Director, AIAA

Ensuring a STEM Workforce Pipeline

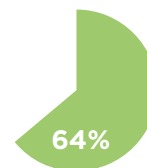
All sectors agreed that enhancing the pipeline of STEM-competent workers from within the United States is extremely important to the health and well-being of the aerospace industry.

AIAA established workforce development as one of its 2021 Key Issues because the United States faces a skills gap in this future workforce due to significant hiring and retention challenges. These include achieving greater workforce participation by women and ethnic minorities, retaining qualified and trained personnel because of recruitment by other industries, processing background checks without long delays for classified work, losing knowledge from early retirements, and hiring well-qualified international workers without impediment. A sizeable percentage of the workforce is approaching retirement eligibility, and the skills gap will be exacerbated by mass layoffs and career switches as a result of the pandemic. AIAA believes industry leaders and policymakers must work together on an urgent basis to address the forecasted demand for highly skilled workers.

Academia expressed strong beliefs about how to increase the talent pool



Enhancing the pipeline of STEM-competent workers from within the United States



Developing a more diverse talent pool of candidates interested in aerospace careers



Prioritizing visas for skilled workers from outside the United States and retaining highly educated international professionals



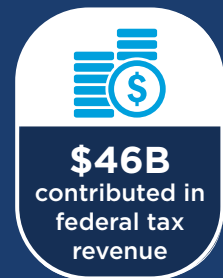
2021 AIAA Key Issues

AIAA urges decision makers to enact and support policies that will allow sustainment of the vital aerospace and defense (A&D) industry each year and result in a robust and world-leading A&D sector. Actions taken (or missed) now for the industry will affect it for many years to come. More specifically, the Institute recommends:

- › Providing stable and sustained funding for the entire A&D sector (DoD, NASA, FAA, other applied research and development, small businesses) to ensure the United States emerges from the pandemic with its global leadership in this area intact.¹
- › Supporting initiatives for national and global cooperation to enable the commercial aviation market to return to full operation – such as standardized health management measures and tasking the FAA to lead the harmonization of regulations and policy.²
- › Continuing to invest in A&D research and development – this is the source of new technologies and products that will ensure future job growth, address climate change, provide needed opportunities for young people of all backgrounds, address evolving threats, and global leadership.^{3,4}
- › Developing public/private partnerships at national, state, and local levels to dramatically improve (in quality and quantity) the STEM pipeline – our future workforce.⁵

Policy papers on each subject can be read and downloaded at [aiaa.org/advocacy/Policy-Papers](https://www.aiaa.org/advocacy/Policy-Papers)

A&D INDUSTRY OVERVIEW



Source: Aerospace Industries Association 2020 Facts and Figures

1 "Addressing COVID-19 Challenges to U.S. Aerospace and Defense." [https://www.aiaa.org/docs/default-source/uploadedfiles/issues-and-advocacy/policy-papers/addressing-covid-19-challenges-to-the-u-s-aerospace-industry-\(june-2020\).pdf?sfvrsn=cb1a3467_2](https://www.aiaa.org/docs/default-source/uploadedfiles/issues-and-advocacy/policy-papers/addressing-covid-19-challenges-to-the-u-s-aerospace-industry-(june-2020).pdf?sfvrsn=cb1a3467_2).

2 "FAA Certification: Accelerating Innovation in Civil Aviation." https://www.aiaa.org/docs/default-source/uploadedfiles/issues-and-advocacy/policy-papers/aircraft-certification-background-paper-2021_2.pdf?sfvrsn=8b626757_2.

3 "Aeronautics R&D Policy Platform Paper." [https://www.aiaa.org/docs/default-source/uploadedfiles/issues-and-advocacy/policy-papers/aeronautics-r-d-policy-platform-paper-\(october-2020\)_final.pdf?sfvrsn=54c3957c_2](https://www.aiaa.org/docs/default-source/uploadedfiles/issues-and-advocacy/policy-papers/aeronautics-r-d-policy-platform-paper-(october-2020)_final.pdf?sfvrsn=54c3957c_2).

4 "Aeronautics R&D: A Key to Economic Prosperity." https://www.aiaa.org/docs/default-source/uploadedfiles/issues-and-advocacy/policy-papers/information-papers/aeronautics-research-and-development-2018.pdf?sfvrsn=3a57eac8_0.

5 "STEM Pipeline." https://www.aiaa.org/docs/default-source/uploadedfiles/issues-and-advocacy/policy-papers/workforce-pipeline-background-paper2021_2.pdf?sfvrsn=e2fb4e9f_2, n.d.

COVID-19 IMPACT REPORT

Looking Back, Leading Forward

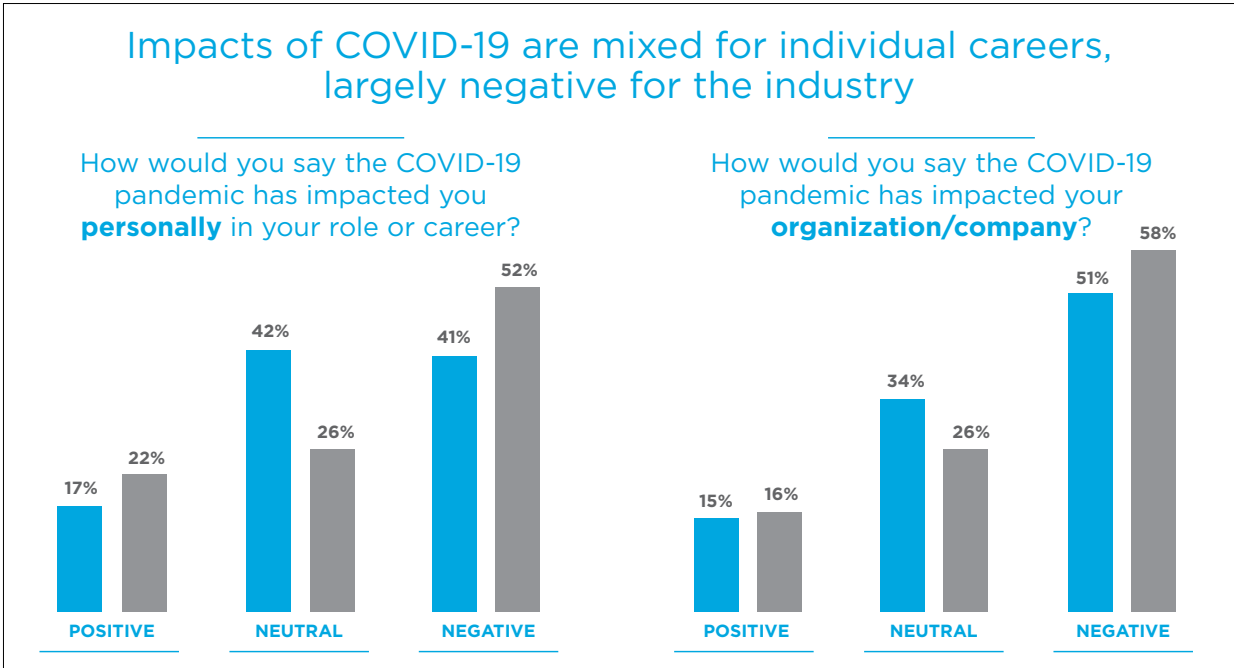
Well over a year into the pandemic, the challenges of COVID-19 need little introduction. As one of the areas most directly and dramatically affected by its economic impacts, the aerospace industry has quickly pivoted to change how it operates, while simultaneously leveraging the talents of its community — to make and transport PPE for medical personnel, rapidly design new ventilator solutions and donate component parts to ventilator manufacturers, assist with supply chain and global sourcing needs, donate meals to help combat food insecurity, and accelerate hundreds of millions of dollars’ worth of payments to small business suppliers.

While the commercial air travel industry dropped significantly in 2020, innovation in mobility did not. The data show how those challenges impacted business operations across sectors, the industry’s recovery since the pandemic’s onset in the United States, future projections, and opportunity ahead.

- › Aviation industry recovery will first occur within domestic markets and eventually spread to international travel. While domestic travel within the United States and within China have nearly recovered to pre-pandemic levels, recovery of this magnitude is a long way off in other parts of the world. The reasons are varied, but access to the vaccine is key.
- › The aviation industry has or will regain the trust of the flying public because of numerous risk mitigation initiatives introduced into airport operations and in airplane cabins. A large-scale shift away from physical air travel driven by permanent telework and shrinking travel budgets is unlikely,

as customer-facing business will eventually drive increased demand. However, the sector should prepare for some degree of structural change in travel within companies.

- › Sustainability, the transition to carbon neutral aviation, and the electrification of aircraft propulsion systems are high priorities for the industry — and should be. However, new levels of interdisciplinary collaboration are required for long-term success. If we are to make the needed progress, we must shorten product development cycles and make full use of tools such as model-based systems engineering.
- › Over 40% of U.S. aviation and aeronautics professionals surveyed said COVID-19 had a negative impact on their careers and them personally, while more than half said the pandemic negatively impacted their organization. Drilling down into the numbers we see that COVID-19’s level of impact on industry professionals varies by individual career.



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Transforming Business Operations

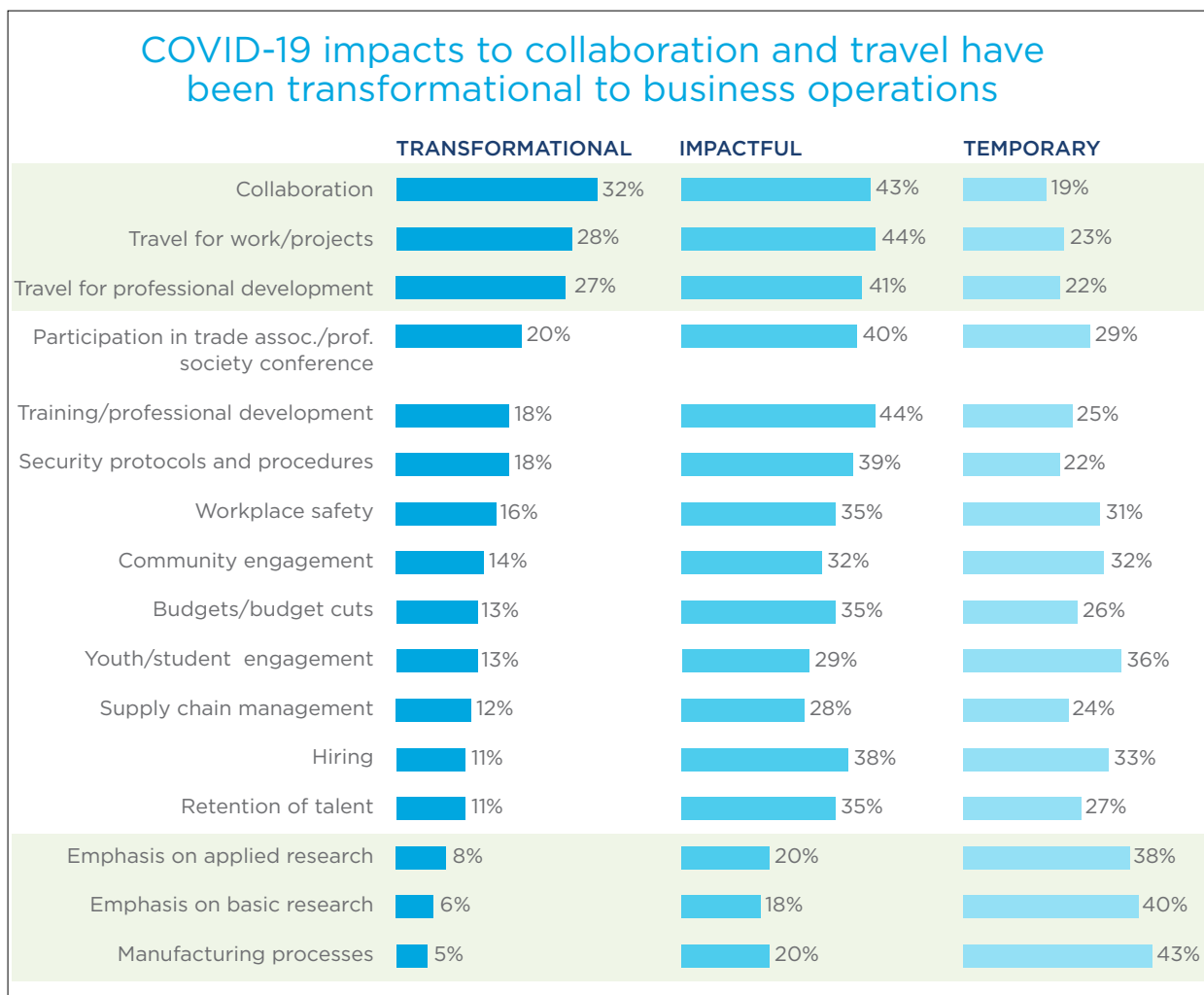
Nearly 30% of aerospace professionals across all sectors reported seeing changes in travel due to COVID-19 as transformational to their business operations. This is perhaps unsurprising given the drop-off in demand for commercial air travel and its domino effect on employment, all levels of the supply chain, and research funding.

Although passenger travel is just now showing signs of recovery, air cargo proved to be a bright spot in the industry. In fact, Kevin Michaels, managing director of AeroDynamic Advisory — a specialty consulting firm focused on the global aerospace and aviation industries — said that while air cargo took a dip in the beginning of 2020, it now exceeds pre-pandemic levels. Air cargo is benefiting from the period's growth in e-commerce and changes in global supply chains that favor its speed over the less expensive option of maritime transport. Air cargo

accounted for 30% of airline revenue in 2020 — up from just 12% in 2019.⁶

Over 40% of U.S. aviation and aeronautics professionals surveyed said COVID-19 had a negative impact on their careers and them personally, while more than half said the pandemic negatively impacted their organization. Drill down into the numbers, and we see that COVID-19's level of impact on industry professionals varies by individual career.

In the United States, those working in academic settings and aviation reported more negative impact from COVID-19 than those working in the space sector. In the aviation sector, we attribute this to the unprecedented decline in commercial air travel in 2020. On the academic side, this sentiment stems from increased difficulty in accessing grant funding and labs to conduct research with tightened budgets from private donors.



In the US, those working in academic settings and aviation report more negative impact from COVID-19

		AIAA MEMBER	NON-MEMBER	ACADEMIA	SPACE	AVIATION
PERSONAL IMPACT	Extremely/very positive	6%	10%	8%	7%	8%
	Somewhat positive	10%	16%	3%	15%	10%
	Neutral	43%	39%	41%	43%	36%
	Somewhat negative	32%	27%	39%	28%	34%
	Extremely/very negative	9%	8%	9%	6%	12%
IMPACT TO ORGANIZATION	Extremely/very positive	2%	5%	0%	4%	3%
	Somewhat positive	13%	11%	6%	13%	10%
	Neutral	33%	40%	18%	42%	22%
	Somewhat negative	35%	34%	55%	29%	20%
	Extremely/very negative	16%	11%	21%	12%	35%

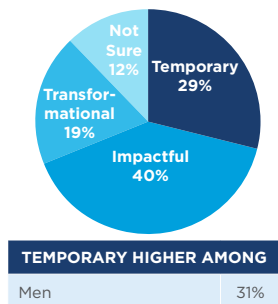
During the 2021 AIAA AVIATION Forum, Chief Operating Officer of American Airlines David Seymour said that while last year was “monumentally challenging,” it also presented a unique opportunity to reset, retool, and cut the proverbial fat. “We really overhauled our network,” Seymour noted. “It was an enormous opportunity for us to put the airline through a real microscope to understand what we can change and how can we change it.”

American Airlines was able to reduce some of the complexity in its operation by accelerating fleet retirements and working to decrease duplication across the organization seven years post-merger

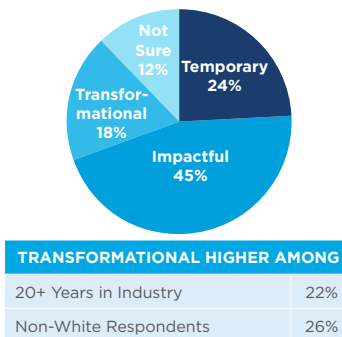
with US Airways. The “pause” also afforded the opportunity to upgrade technology to enhance the customer experience and make team members’ jobs easier — although American also made “the difficult decision” to reduce management support staff by 30%, eliminating organizational layers that Seymour believes made decision making faster against a rapidly evolving pandemic landscape. However, American plans to add more than 3,500 new team members this year, and “be very deliberate” as they look at diversity, equity, and inclusion in advancement, particularly in technical fields.⁶

U.S. respondents expect changes to professional development and association participation to be impactful

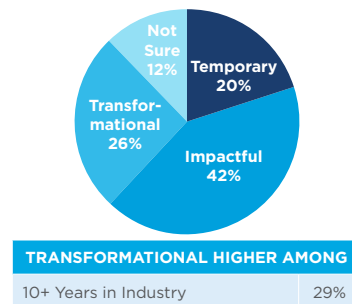
Participation in Trade Association/ Professional Society Conference



Training/Professional Development



Travel for Professional Development



6 Michaels, K., Schirmer, P. J., & Seymour, D. (2021, August 2). Plenary session: Aviation Recovery, Transition, and New Horizons [Conference presentation]. 2021 AIAA AVIATION Forum, virtual.

The Reality of the Virtual Shift

A large-scale transition away from physical air travel would affect the health of the entire air transport industry. However, during the 2021 AIAA AVIATION Forum, Michaels told attendees he doubts predictions of a “tech utopia” stemming from permanent telework and slashed travel budgets, saying customer-facing business, which his firm estimates represents about two-thirds of business air travel, will drive increased demand. However, the sector should expect some structural change in travel for company purposes, such as trainings and sales meetings, where digital conferencing may become the new normal.

We can see evidence of this in the survey. The industry anticipates changes to professional development and association participation, with over 40% of U.S. respondents saying they expect changes to travel for professional development to be impactful and more than 25% of respondents saying it will be transformational.

Sustainability and Opportunity on the Horizon

Given the industry’s unprecedented downturn, it would have been tempting for the air transportation sector to think only of short-term survival and put discussions of environmental sustainability on the back burner. Yet, according to Netherlands-based aviation innovation strategist Asteris Apostolidis,⁷ sustainability in aviation is more relevant than ever. Significant improvements to atmospheric quality occurred in just weeks as air travel waned, demonstrating the positive impact industrywide change and innovation could have on the environment. A year-and-a-half later, with about 6,300 aircraft still parked, Michaels said airlines have had the opportunity to put only their newer generation, more fuel-efficient models into service, like the Boeing 787 and Airbus A320neo.⁶

Seymour pointed to the strides American Airlines has made amid the pandemic, including announcing a net-zero carbon emission target by 2050 and a science-based target to reduce emissions by 2035. Sustainability, he said, is always top of mind at American, which is showing gains in terms of overall carbon emissions from an extensive fleet renewal program and has received its first delivery of sustainable aviation fuel from Neste — with another 10 million gallons in carbon neutral sustainable aviation fuel committed.⁶

What’s next? Apostolidis said his peers in the air transport industry were considering “the figurative day after the crisis.”⁷ For Seymour, it’s working with policymakers in Washington, D.C., on credits for sustainable fuel to close the gap in fuel prices — and continuing investments to advance sustainable aviation so that innovations like electric flight may develop into technologies that are adopted by the larger commercial aviation market.⁶ For a truly sustainable future to be successful, significant interdisciplinary collaboration will be required — as well as widespread agreement across sectors on the value of sustainability policies. When asked whether addressing sustainability and reaching carbon neutrality by 2050 was “extremely or very important to health and well-being of the aerospace industry” as part of the AIAA State of the Industry Survey, just under half (47%) of total U.S. respondents agreed. Those in academia and space showed the most agreement with the statement, at 52% and 51%, respectively.

WHAT IS KNOWN:

Aerospace never stops innovating. COVID-19 accelerated investment into cleaner technologies that put aviation on a new trajectory for a more sustainable future. Aerospace is also resilient. Regulators, original equipment manufacturers (OEMs), and operators are all looking at lessons learned to better prepare for crises and future downturns, regardless of the cause.

7 Apostolidis, A. (2020, June). “Don’t sideline environmental sustainability.” Aerospace America, 20-21.

“[It’s] a phenomenal time to get into the industry.”

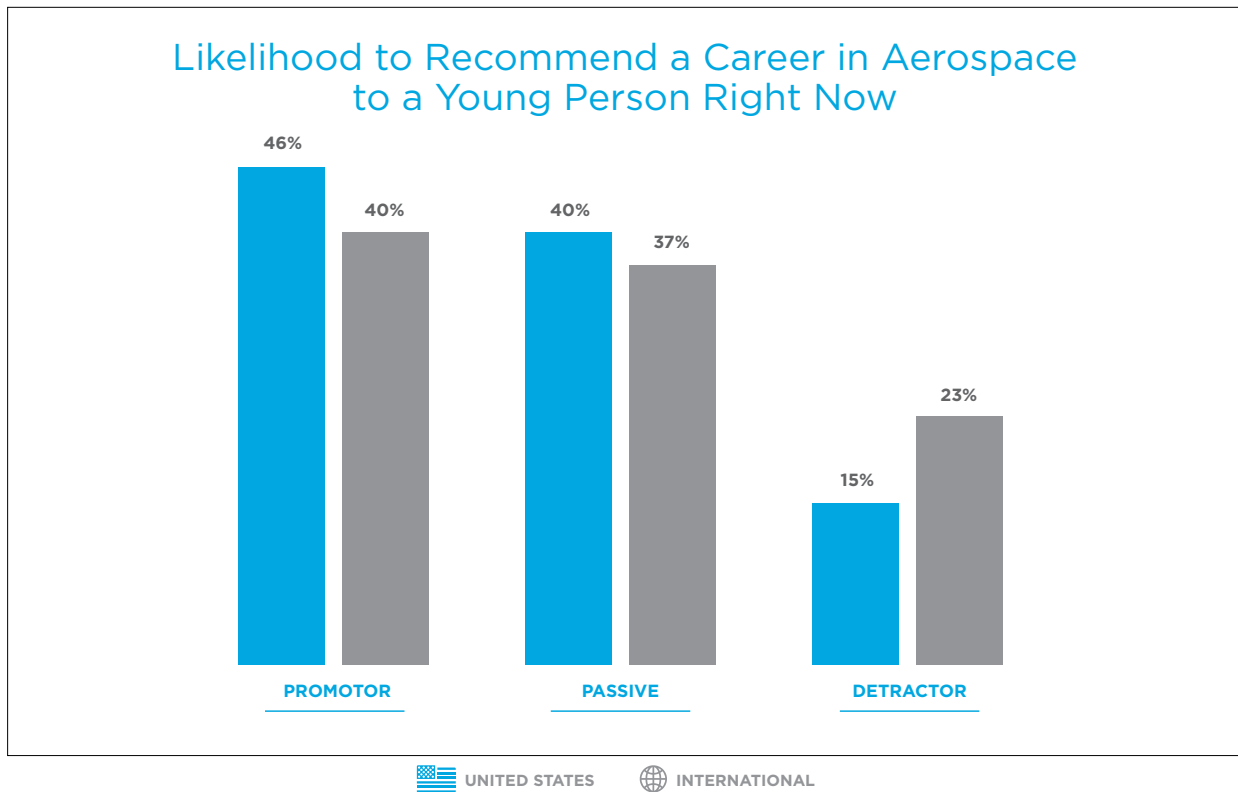
DAVID SEYMOUR, Chief Operating Officer of American Airlines

Advancements in electrification, hydrogen, and other sustainable technologies are precisely why Seymour said it’s “a phenomenal time to get into the industry,” particularly on the engineering side.⁶ This report shows that Americans working in academia and space agree, as respondents demonstrated a high likelihood of recommending a career in aerospace to young people right now.

AIAA Executive Director Dan Dumbacher noted that as the U.S. aerospace industry works to address an aging workforce, gender gap, lack of diversity, and hiring retention challenges, investing in education focused on tomorrow is imperative. The current U.S. administration has made intensive investment in the workforce of the future one of the most important elements in The American Jobs Plan — including

initiatives like assisting underserved and underutilized groups, funding apprenticeship programs for middle and high school students, and creating job training programs at community colleges — to cultivate a STEM-literate generation capable of responding to technologies and challenges as they evolve.⁸

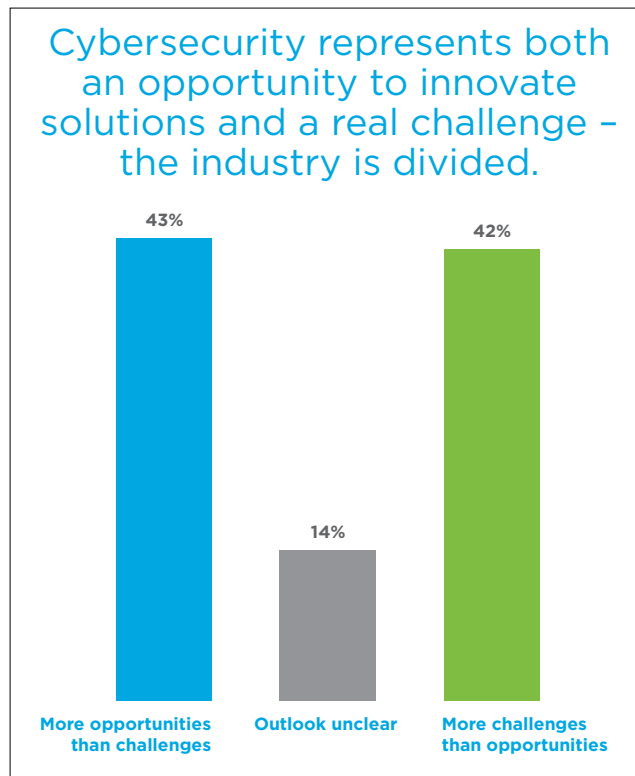
Despite the pandemic’s impact on aerospace overall, certain pockets of the industry, from cargo transport to defense, stayed insulated and even thrived. Over a year later, signs of recovery are strong in the United States. However, aerospace is a global industry, and full-scale recovery relies on the health of our international community. Coronavirus variants also continue to create unknowns.



8 Dumbacher, D. (2021, June 1). “Opinion: Congress Should Consider Aerospace As Infrastructure.” aviationweek.com

AEROSPACE CYBERSECURITY CHALLENGES AND OPPORTUNITIES

This survey affirms the concerns of the aerospace community around cybersecurity. In fact, cybersecurity was viewed as an increasing concern with 18% of respondents saying cybersecurity was the most concerning area of emerging technologies. Many respondents feel cybersecurity threats are difficult to understand.



The Voice of the Community

“WE’RE BEHIND, AND IT WILL BE HARD TO CATCH UP.”

“CENTRAL TO MOST AEROSPACE SYSTEMS GLOBALLY.”

“THIS CHALLENGE TRANSCENDS THE UNDERSTANDING OF MANY OF US BUT CONTINUES TO EVOLVE/ADVANCE BY THE ACTIVE FEW. THIS THREAT IS NOT REGIONALIZED NOR IS IT RESTRICTED BY RESOURCES MAKING IT THE MOST UNPREDICTABLE.”

AIAA has made a long-term commitment to bringing aerospace cybersecurity front and center. During 2020, AIAA hosted events, technical talks and presentations, and educational opportunities around the topic. Also in 2020, AIAA published a white paper

entitled “Aerospace Cybersecurity: Enduring Challenges, Enduring Solutions, Bringing Cyber Protection to the Heart of the Aerospace Industry,” describing the findings and insights from the 2020 AIAA Aerospace Cybersecurity Market Study.

“It is becoming more and more essential to address cybersecurity on an ongoing basis in the mainstream of our core processes - from the design and development of new space systems to manufacturing and production to operations.”

DAN DUMBACHER, Executive Director, AIAA



Cybersecurity = Safety

Cybersecurity needs to become as important and overarching as safety. Unsafe practices were evident in the early stages of the aerospace industry, but no longer. Today, the industry thinks of safety as a paramount value. Now it needs to make progress with cybersecurity.

AIAA is building cybersecurity capabilities in the aerospace workforce and cultivating cybersecurity awareness among current and future aerospace leaders. The Institute is specifically working toward a “cyber smart” aerospace workforce at all levels, with three major areas of activity:

- › Leadership engagement on cybersecurity is absolutely necessary in any industry or enterprise, particularly in aerospace. Aerospace leaders — no matter where they are in their career journeys — to know and own cybersecurity. Leaders need to cultivate a “cyber hygiene mindset.”
- › The aerospace community needs more learning opportunities in cybersecurity.
- › Changes are needed to aerospace education at the university level to create a professional aerospace workforce that is grounded in cybersecurity and digital practices.

Cultivating Leaders’ Cyber Hygiene Mindset

Over the past year, AIAA has provided experiences and information on aerospace cybersecurity focused on leaders, including senior industry executives and government officials. High-profile talks on cybersecurity are being included in AIAA forums, as well as the customary technical papers and presentations. Interactive cybersecurity programming has been added, specifically aimed at leaders, such as, aerospace cybersecurity tabletop exercises designed specifically to engage participants and emphasize the wholistic leadership challenges of cybersecurity.

AIAA also has hosted Capture the Flag exercises to cultivate technical excellence. Tabletop exercises like the “Breached!” event at the 2021 AIAA AVIATION Forum in August are a vital element of AIAA programming to engage leaders.

AIAA also has established a steady cadence of aerospace cybersecurity content in its daily and monthly publications for all members. Cybersecurity news content is now curated for the Daily Launch, our aerospace newsletter. In addition, *Aerospace America* has also featured original reporting on aerospace cybersecurity matters.

Industry professionals responded to this survey with their concerns about education around cybersecurity. They admit a lack of knowledge on where to begin gaining knowledge. New aerospace engineers and scientists assigned to product security or digital projects can take up to year to get up to speed on cybersecurity and digital — because they often are not getting the coursework and preparation they need for the new normal of digital aerospace. Students and young professionals themselves have shared they want more exposure to digital and cybersecurity subjects to be more successful in their careers. Cybersecurity challenges for the aerospace workforce seem daunting, but AIAA has short-term and long-term approaches to help meet those challenges.

Courses Available Now to Get Cyber Smart

AIAA is offering continuing education programming aimed directly at shoring up individual cybersecurity knowledge among aerospace professionals. Insights from non-aerospace industries suggest that special cybersecurity courses like those AIAA is fielding would be more impactful than promoting, for example, conventional enterprise cybersecurity certifications like the CISSP, Security+, or Certified Ethical Hacker.

Two courses are scheduled during October 2021, which is also known as Cybersecurity Month. The courses will cover the essentials of cybersecurity in the current information technology ecosystems of the aviation and space industries, blending cybersecurity principles with industry-specific practical knowledge and insights. The space course will examine the practical issues of developing and sustaining a secure cyber environment through all phases of the space mission lifecycle. The aviation course will cover the needs and developments of cybersecurity, and the techniques to minimize or eliminate threats.



Understanding Cybersecurity in the Space Domain

The space domain and the cyber domain are mutually dependent. The Space Domain Cybersecurity Framework provides a comprehensive and systematic model for understanding and tackling cybersecurity in the space domain. This virtual course examines the practical issues of developing and sustaining a secure cyber environment through all phases of the space mission lifecycle.

Students will examine the space domain layer by layer from enterprise, through mission, system, development, security, and operations, learning the threats and vulnerabilities at each layer. Cybersecurity first principles are taught through practical application pushing students to develop plans for action to address the cybersecurity issues exposed by this course through cybersecurity assessment plans.

This course is designed for space professionals who want to understand the cyber domain as it applies to their missions/programs, and cybersecurity professionals who want to understand the space domain.

SURVEY DATA THEMES ON CYBERSECURITY

- › There is a confluence of the move to cyber/digital space in aerospace operations, communications, and data storage — as well as the prevalence and skill of bad actors.
- › There is a sense this has not received the attention it deserves.
- › The skill level of the threat transcends the understanding and capabilities of the defense at the moment.

Aviation Cybersecurity

This course covers Aviation Cybersecurity Management, a discipline that is fast becoming one of the most important aspects of the aviation industry. Aircraft systems integrity, airport security, security of the passengers, cargo, and the myriad systems that support aviation are a few areas where the reliance on computer networks is significant and the consequences of cyber breaches are great. Students will learn the needs and developments of cybersecurity and techniques to minimize or eliminate threats. The course treats aviation cybersecurity management within the context of rapid technological changes.

This course is designed for any and all aviation professionals and students, as cybersecurity is an essential skill that all engineers, researchers, and managers will need in their jobs and for their careers.

Register for these courses at aiaa.org.

Longer Term Education Changes: University-Level Curriculum on Cybersecurity

AIAA's long-term approach to addressing cyber workforce needs is to engage with higher education. There is growing recognition that university-level aerospace education needs more coverage of cybersecurity and digital topics. This recognition is vital, yet it does not represent consensus around this need. The process of changing aerospace curriculum and learning expectations will take years. However, AIAA and its members are aware of what it takes to implement changes in academia. AIAA is involved in key groups that influence aerospace curriculum and standards, such as the Accreditation Board for Engineering and Technology (ABET) and the Aerospace Department Chairs Association (ADCA).

EMERGING TECHNOLOGY TRENDS

Looking ahead, the aerospace community sees a number of exciting technology developments that will be transformational to the industry. While all new technologies come with challenges, four are viewed as having opportunities that far outweigh these challenges: advanced or additive manufacturing, artificial intelligence (AI)/machine learning, space exploration, and autonomous aircraft. These areas strongly align with the AIAA Domain approach, focusing its efforts, activities, and programming around the following three domains:



Aeronautics Domain

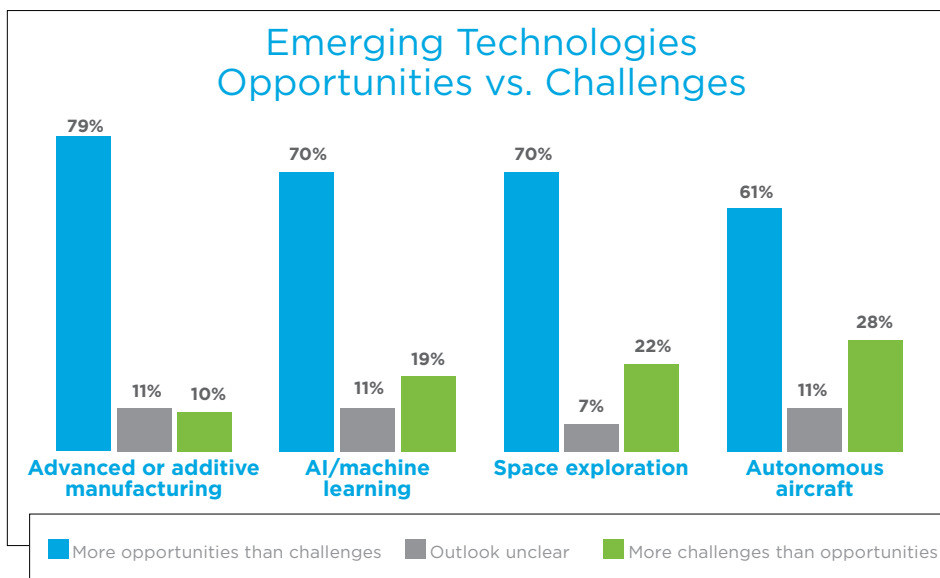
Supersonic and hypersonic flight are viewed by the respondents with a mixture of optimism and pessimism. On the one hand, professionals view it in the context of advancements and building on strong knowledge foundation where both the past experience of the Concorde and new learning from hypersonic weapons development can come into play. Challenges in this area center on a combination of perceived technological hurdles and inadequate funding/market support, at least as this time.

Aerospace R&D Domain

Advanced manufacturing is seen as transformational to current production practices for the aerospace industry and beyond. This view aligns with AIAA's focus on R&D investment, with an emphasis on advanced manufacturing, artificial intelligence, and machine learning to stay on the cutting edge. Excitement about this new technology is not only driven by the possibilities of new products or faster production cycles. Respondents are enthusiastic because of what advanced manufacturing can mean for space exploration and the ability to expand the space economy.

Space Domain

AIAA believes the space sector needs strong support for developing the technologies and operations for humanity's return to the moon for the long term, and continuing exploration of the solar system and beyond, among which advanced manufacturing will be foundational. Not surprisingly, aerospace professionals are extremely excited by space exploration and the intersection between growing commercial investment.

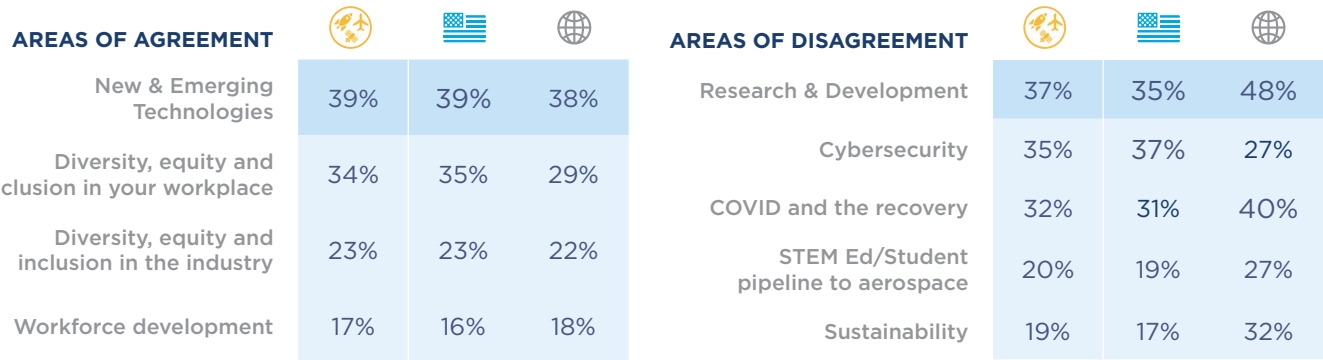


“AIAA is committed to solving the problems, developing new ideas, and applying technology in creative ways to shape the future of aerospace and build a better future for everyone. AIAA will address key needs and priorities to make progress at the pace required to accelerate innovation in three domains – Aeronautics, Aerospace R&D, and Space.”

DAN DUMBACHER,
Executive Director, AIAA

Priorities Differ Between U.S. and International Colleagues

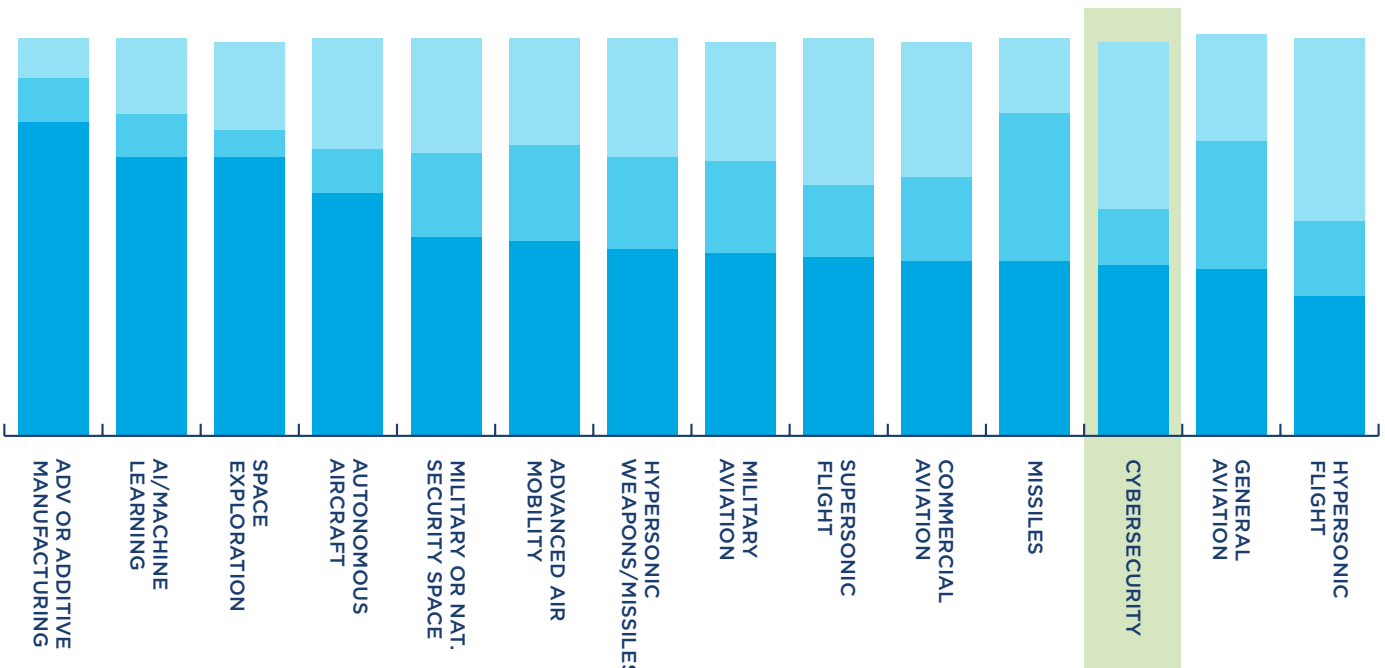
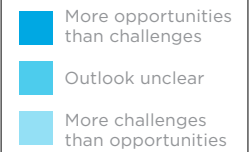
Close alignment seen on new and emerging tech and DEI in the workplace; views differ on cybersecurity and sustainability



 INDUSTRY  UNITED STATES  INTERNATIONAL

Most Opportunities Seen in Advanced Manufacturing, AI/Machine Learning, and Space Exploration

Cybersecurity represents both an opportunity to innovate solutions and a challenge – the industry is evenly divided.





Emerging Technology Trend: Autonomous Aircraft

Autonomy will drive new missions and capabilities otherwise unimaginable, as well as improve performance and lower cost and/or risk for aerospace systems and their missions. More than 60% of industry professionals ranked autonomous aircraft as an emerging technology with more opportunities than challenges.

The AIAA Autonomous Vehicles and Systems Task Force agrees and has recommended that United States needs a national research and development (R&D) plan for autonomous capability for aerospace. Autonomous systems and technology will impact the programs and influence many other government organizations. Autonomy drives new missions and capabilities otherwise unimaginable, as well as improves performance, lowers cost, and/or lowers risk for aerospace systems and their missions. We must think beyond the immediate and envision what will make a difference for aerospace now and in the future.

Given the rapid science and technology advancement in autonomous aerospace systems, we are seeing a global race to integrate autonomous components, especially in Advanced Air Mobility (AAM) systems. The U.S. aerospace industry looks to the government to understand these innovations and approve such systems in a timely manner so they can compete in this emerging global market. Just as the Biden Administration has set a visionary goal for electric cars, autonomous space and aviation systems, including AAM aircraft, should soon follow a similar visionary path.

Autonomy is certainly going to be part of America's transportation and off-world future. It is imperative we clear the way for American industry to flourish in the evolving aviation and space markets. The benefits of autonomy will enhance safety for all Americans and enable capabilities we are only just imagining.



Emerging Technology Trend: Hypersonic Flight

Hypersonics has been a technology in development for more than 75 years. The industry continues its pursuit of hypersonic flight for applications in high-speed weapons and aircraft, learning from the challenges of the past. Nearly 50% of respondents to this survey identified hypersonics as one of the technologies with the most opportunities. Developments in recent years have taken hypersonics from the fringes of defense science and technology to front and center of the mainstream defense research and engineering.

The United States has long been the clear global leader in hypersonics research, development, and testing. That lead has now diminished, if not been lost. While the United States was pursuing hypersonic technologies intermittently, starting and stopping programs and, in so doing, failing to achieve continual progress, other nations have steadily made investments that have enabled them to reach parity or even to surpass us, while largely building upon U.S. government-funded R&D work. This is consequential to national security because hypersonic vehicles can be effective weapons that are difficult to defend against due to their speed and maneuverability.

Hypersonic weapons can be launched from land, sea, and air where they are used to rapidly attack targets hundreds to thousands of miles away in a matter of minutes. Hypersonic missiles will be hard to detect, hard to stop, and offer little time for an effective defensive response. In response to these developments, the United States has initiated a number of programs to rapidly field hypersonic weapons and defensive systems.⁹

Beyond the ongoing activities, there are remaining challenges to hypersonic system development in the United States.

9 "Hypersonics: A Game-Changing Technology." https://www.aiaa.org/docs/default-source/uploadedfiles/issues-and-advocacy/policy-papers/information-papers/hypersonics_update-2019.pdf

- › The current investment in systems to defend against hypersonic weapons is a small fraction of the resources expended on offense weapons development, putting at risk the ability of the United States to keep pace with the weapons that will be fielded by other nations.
- › While resources are being expended on rapid fielding of first-generation hypersonic weapons, support of fundamental science and technology is needed to yield second-generation capabilities.
- › Hypersonic system work requires unique skills, and past university programs in these areas were dropped due to lack of national interest, reducing workforce entrants. Strengthening and rebuilding our workforce with expertise in all areas of hypersonic technology, from basic research to design and testing will fill these gaps.
- › Current U.S. hypersonic ground test facilities are few and decades old, with limited test capacity, workforce, and equipment maintenance challenges that can only be addressed through national investments.



AIAA is promoting specific content around hypersonics to increase the professional knowledge base. Hypersonics appears in numerous technical sessions during forums and conferences, dedicated webinars throughout the year, continuing education courses, and Institute-published books and journals. AIAA is focused on promoting dialogue around the underlying question of why hypersonics today is different than how it has been viewed in the past.

“We must advance new technologies, secure necessary funding for R&D, ensure workforce readiness, and gain the support of policymakers to reach this bold goal [of carbon neutrality by 2050].”

DAN DUMBACHER, Executive Director, AIAA

Emerging Technology Trend: Sustainability and Carbon Neutrality

Addressing sustainability and reaching carbon neutrality by 2050 was viewed as extremely or very important to the health and well-being of the aerospace industry by all audience segments. Nearly 50% of respondents agreed that policies are needed to drive innovation and technology development supporting the pursuit of sustainability.



AIAA has recommended steps for the aeronautics community to reach its 2050 goal in an information paper. These steps include government support, deployment of SAF for current airline fleets, adoption of hydrogen fuel cells and other clean, renewable energy sources, focus on achieving new solutions by researchers, and developing the workforce in the vital technical disciplines.¹⁰ AIAA is committed to ongoing advocacy for these efforts, building upon the momentum during AIAA forums and other events throughout this year. Outcomes from these events will help drive the much-needed progress to assure a long-term human future.

¹⁰ “Sustainability in Flight: Our Journey to Decarbonization.” https://www.aiaa.org/docs/default-source/uploadedfiles/issues-and-advocacy/policy-papers/information-papers/sustainability-in-flight-our-journey-to-decarbonization.pdf?sfvrsn=7b52fb00_2.

WORKFORCE INSIGHTS

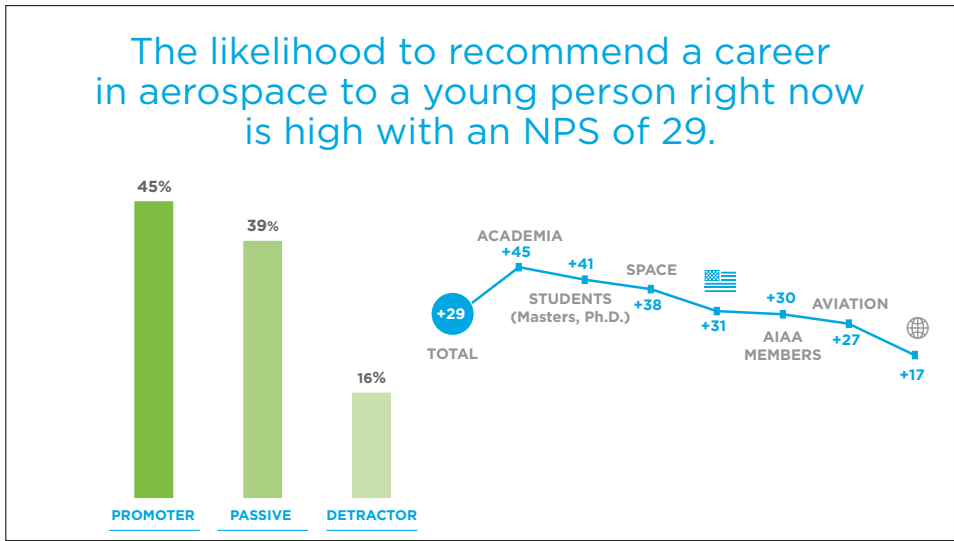
Respondents gave the aerospace industry a net promoter score (NPS) of 29. As the world’s leading metric on loyalty, an NPS score of 29 demonstrates solid confidence and commitment to the aerospace industry by today’s aerospace workforce — current aerospace professionals would recommend a career in aerospace to a young person right now. AIAA members scored another point higher. The overall outlook is closely tied to one’s perspectives on job security and career advancement.

However, a wide gulf exists between U.S. respondents and international respondents. With responses coming from professionals in 37 countries outside the United States, it’s difficult to gauge where the reticence is based.

Among those promoting careers in the aerospace industry, they believe current space headlines will keep people engaged and interested and because of that there will be job growth. They believe the growing STEM focus in education will create more

jobs as well, not only because of NASA’s programs, but because of the rise of private sector companies working in commercial space.

Others see less opportunity for jobs. Their focus was on the likelihood of cuts to government spending creating cuts in the aerospace job market. They shared skepticism based on the cyclical nature of government funding to contractors that must constantly adjust staffing levels.



CALCULATING NPS

On a 10-point scale where 10 means “extremely likely” to recommend:

- Promoters= 9, 10
- Passives= 7, 8
- Detractors= 0-6

Net promoter is calculated by subtracting the percentage “detractors” from the percentage “promoters” to obtain an overall “health” score.

What is NPS and why does it matter?

NPS has become the world’s leading metric on customer loyalty in the 21st century. Calculating the score is only the first part of why NPS is so valuable. The second part is how an organization uses its score to help refine and target marketing and outreach strategies. It’s about improved relationship building with customers and prospects. Organizations can use NPS data to create a customer-driven culture that:

- Focuses on customer service to boost satisfaction and build retention
- Drives continuous improvement within the organization
- Understands changing customer needs leading to new product development
- Creates a responsive feedback loop to communicate with customers

Diversity, Equity, and Inclusion (DEI) is a Priority

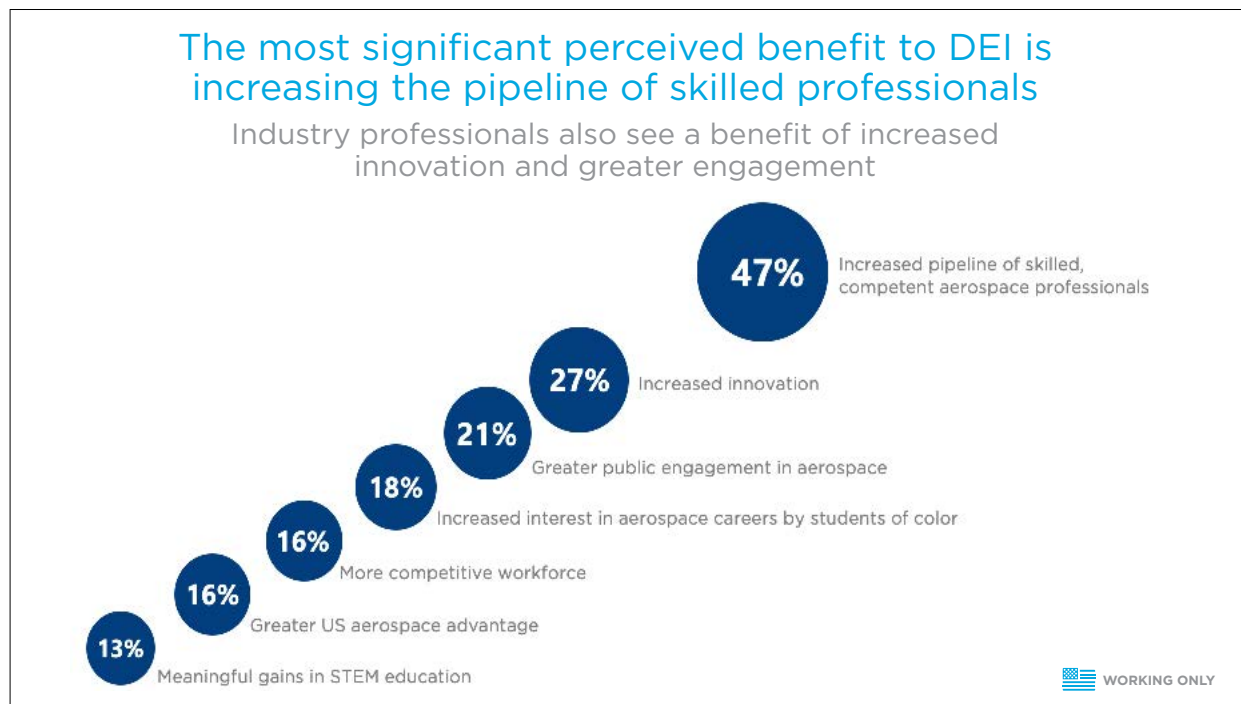
The survey responses strongly linked DEI to workforce development. Nearly 50% of the respondents agreed that the most significant perceived benefit to promoting DEI is increasing the pipeline of skilled professionals in the aerospace industry. Industry professionals also see a benefit to promoting DEI in increased innovation and greater public engagement with the field of aerospace.

Based on responses to the survey, employees expect a demonstrated commitment to DEI from their employers — which they feel is not always being met. Respondents were asked to rank the characteristics that demonstrate an employer’s commitment to DEI. The top five characteristics that demonstrate an employer’s commitment to DEI include:

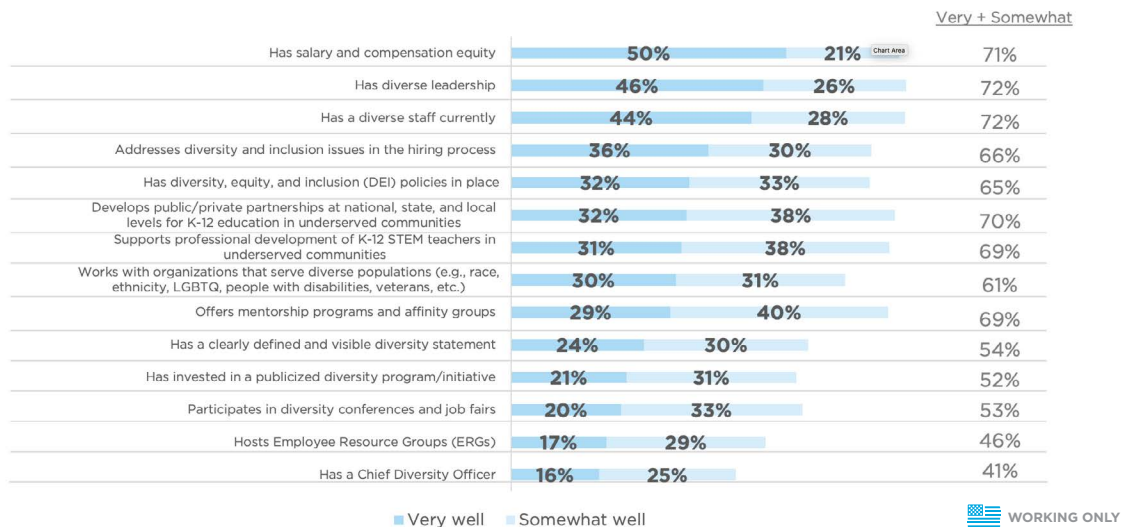
- › Salary and compensation equity (50%)
- › Diverse leadership (46%)
- › Diverse staff currently (44%)
- › Addresses diversity and inclusion issues in the hiring process (36%)
- › DEI policies in place (32%)

“Today’s students will make up the teams that will become the most technically proficient, professionally equipped, and culturally diverse workforce on the planet.”

DAN DUMBACHER, Executive Director, AIAA



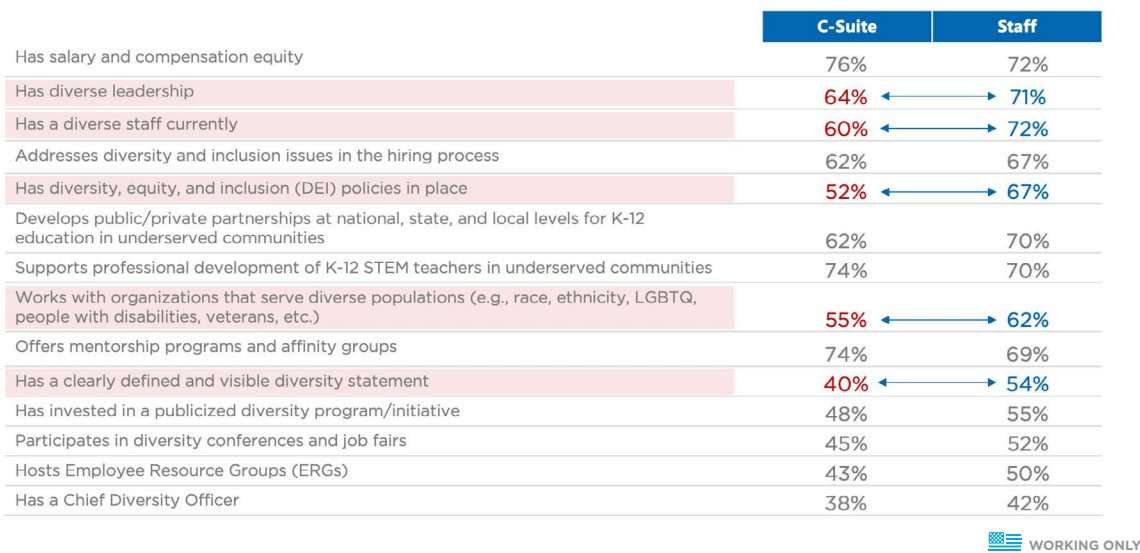
Characteristics that Demonstrate Employer Commitment to DEI



Yet, the scores between C-Suite respondents and other levels of employees showed a disconnect on which areas were of highest importance. The five areas where C-Suite did not rank as highly as other levels of employees by a substantial difference include:

- › Diverse leadership
- › Diverse staff currently
- › DEI policies in place
- › Works with organizations that serve diverse populations
- › Clearly defined and visible diversity statement

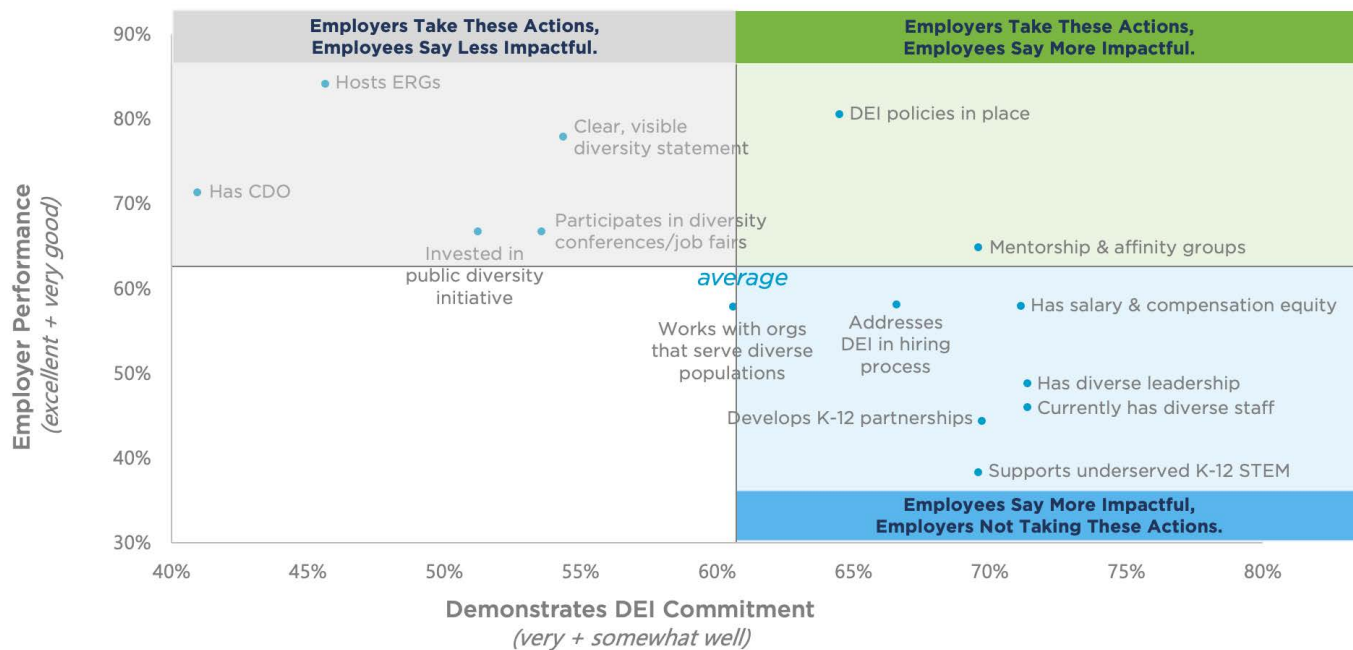
Disconnect on DEI Between C-Suite and Staff



Of the steps employers are taking to demonstrate their commitment to DEI, the more public facing efforts are the most prevalent — yet demonstrate an employer’s commitment the least (as seen in gray). The actions that matter the most to employees are not being taken by enough employers (as seen in blue).

Comparing perceptions of performance on indicators of DEI shows lower scores on the items that matter most to employees

More public facing efforts are seen as least demonstrative, but are the ones companies are doing most



WORKING ONLY



AIAA Commitment to DEI

AIAA established DEI as a priority area in 2016, creating the Diversity and Inclusion Working Group (DWG) focused on improving DEI across the AIAA community. Since then, the group has raised awareness of the importance of diversity and inclusion, conducting a reliable, representative, and continues assessment of AIAA’s membership diversity, and facilitated improvement in the diversity of AIAA members and its groups. After reporting its progress in 2021, the DWG affirms there is more work to be done and established the 2021-2023 AIAA

Diversity and Inclusion Plan that builds on the past accomplishments and creates new opportunities to solve future challenges. The DWG goals include:

- › Diversity and inclusion are widely recognized within the AIAA community as essential to the mission and vision of the Institute.
- › Provide a welcoming environment and cultivate an inclusive culture that supports the success of every AIAA member.
- › AIAA embraces and fulfills its role as a leader in promoting diversity and inclusion in the aerospace community.

During a recent presentation, the AIAA DWG chair shared definitions and an analogy that resonated with attendees. The following ideas were coined by The Extension Foundation at dei.extension.org.



Diversity

The presence of differences that may include race, gender, religion, sexual orientation, ethnicity, nationality, socioeconomic status, language, (dis)ability, age, religious commitment, or political perspective. Populations that have been — and remain — underrepresented among practitioners in the field and marginalized in the broader society.

Diversity is where everyone is invited to the party.

Equity

Promoting justice, impartiality, and fairness within the procedures, processes, and distribution of resources by institutions or systems. Tackling equity issues requires an understanding of the root causes of outcome disparities within our society.

Equity means that everyone gets to contribute to the playlist.

Inclusion

An outcome to ensure those that are diverse actually feel and/or are welcomed. Inclusion outcomes are met when you, your institution, and your program are truly inviting to all. To the degree to which diverse individuals are able to participate fully in the decision-making processes and development opportunities within an organization or group.

Inclusion means that everyone has the opportunity to dance.

“AIAA is working every day to increase the diversity of the aerospace workforce. We know we have a long way to go. The aerospace community simply does not yet reflect society in terms of race and gender.”

DAN DUMBACHER, Executive Director, AIAA



The AIAA Diversity Scholars Program seeks to provide opportunities for underrepresented university students who have an interest in or are pursuing a degree in aerospace to attend an AIAA forum or event.

ABOUT AIAA

The American Institute of Aeronautics and Astronautics (AIAA) is the world’s largest aerospace technical society. With nearly 30,000 individual members from 91 countries, and 100 corporate members, AIAA brings together industry, academia, and government to advance engineering and science in aviation, space, and defense. For more information, visit www.aiaa.org, or follow AIAA on Twitter, Facebook, LinkedIn, and Instagram.