



Technologies Transforming Aerospace

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Overview

- BryceTech worked with AIAA to forecast the top 10 technologies impacting aerospace in the next 20 years
 - Surveyed members of the AIAA community to help identify future technologies; **700+** responses
 - Interviewed **22** technology leaders from across air and space domains
 - Results downselected, combined with desk research and subject matter expertise
- **Report published 18 February**
 - Full 39-page report available at [aiaa.org](https://www.aiaa.org)
 - Recording of this presentation to be shared



Methodology



Gather Data

- Respondents asked to identify three techs having biggest impact (free-form text, not predetermined list)
- Four impact dimensions: economic, disruption, societal, and strategic



Assess Responses

- Group responses into relevant transformative technologies
- Assess based on impact, technology category (e.g., space vs aeronautics), number of mentions



Produce Results

- Using assessment, arrive at top 10 technologies
- Additionally, produce list of technologies that just missed the cut

Technologies Selected

1,300+ unique responses

Grouped into 50 technologies

Top 10 selected



Technologies Across Domains

Aeronautics



Alternative Aviation Fuels



Electric Aircraft



Pilotless Aircraft



Hypersonic Propulsion

Space



Fully Reusable Launch



In-Space Manufacturing



Space Nuclear Power and Propulsion

R&D



AI-Aided Advanced Design and Engineering



High-Temperature Materials



Quantum Computing and Sensing

AI-Aided Advanced Design and Engineering



What is it?

AI-aided advanced design and engineering applies artificial intelligence (AI) and machine learning to enhance the design and engineering process for complex systems such as aircraft, spacecraft, and associated infrastructure. These technologies enable engineers to quickly explore innovative design trade spaces and identify more efficient or effective designs.

What are the impacts?

- **Economic:** Reduce development time and cost, increasing innovation
- **Disruptive:** Shift engineering from a slower iterative process to a more rapid one
- **Societal:** Change the role of an engineer as AI develops to be a partner
- **Strategic:** Shorten technology development timelines to maintain edge

Alternative Aviation Fuels



What is it?

Sustainable aviation fuels (SAFs) are the alternative fuels set to transform the emissions impact of air travel in the next decades. SAFs are jet fuel's more eco-friendly twin: they look the same, act the same, but come from renewable sources like biomass, waste, or even captured carbon instead of crude oil.

What are the impacts?

- **Economic:** More eco-friendly aviation without redesigning aircraft
- **Disruptive:** “Drop-in” quality of SAF allows for smooth transition to new fuels
- **Societal:** Potential to reduce environmental impact of air travel
- **Strategic:** Allows for transition to domestically produced biofuels

Electric Aircraft



What is it?

The flight path for zero emission aviation includes clean fuels and electric aircraft. Electrification efforts are occurring on two fronts: vertical take-off and landing (VTOL) advanced air mobility (AAM) concepts and modernization of current conventional take-off and landing aircraft. Hybrid-electric aircraft (HEA) use a mix of fuel combustion and electric power for propulsion, while electric aircraft use batteries, fuel cells, or other energy storage exclusively for all phases of flight.

What are the impacts?

- **Economic:** Reducing jet fuel cost for short-haul flights
- **Disruptive:** Initial strong impact on regional aviation
- **Societal:** Cleaner and quieter operations
- **Strategic:** Improved flexibility, logistics, and operational energy resilience

Fully Reusable Launch



What is it?

Historically, launch vehicles have used multiple expendable stages, each consisting of engines and tanks (i.e., boosters), to shed empty mass as fuel is consumed. Since 2015, reuse of first stage boosters has been demonstrated, lowering launch costs, and moving forward, fully-reusable second stages and payload fairings (the aerodynamic shell that protects the spacecraft during launch) aim to lower launch costs further.

What are the impacts?

- **Economic:** Dramatically lower launch costs and payload return capability
- **Disruptive:** Could revolutionize constellation design and deployment strategies
- **Societal:** Lower launch cost could enable growth of new consumer services
- **Strategic:** Opens new possibilities for responsive space and exploration missions

High-Temperature Materials



What is it?

High-temperature materials solve a common problem for hypersonic flight, space nuclear power, atmospheric reentry from space, and next-generation high-performance engines: management of temperatures that push the physical limits of existing materials, typically well above 2,000°F. This puts ever-increasing demands on scientists to come up with new materials that combine heat tolerance with ultralightweight and high strength, attributes which are often at odds.

What are the impacts?

- **Economic:** Components made of these materials will lower operating costs
- **Disruptive:** Enables reusable spacecraft, faster and more frequent access
- **Societal:** Helps increase aviation accessibility and sustainability
- **Strategic:** Importance for precision strike and lower cost reusable launch

Hypersonic Propulsion



What is it?

Hypersonic propulsion enables vehicles to fly at speeds exceeding Mach 5. Historically, rockets have been the primary form of hypersonic propulsion, used in ballistic missiles, interceptors, and space launch. But these are inefficient for sustained hypersonic flight, driving the development of new air-breathing systems. Of these systems, scramjets are used in existing hypersonic weapons, and the rotating detonation engine (RDE) is the most promising future technology.

What are the impacts?

- **Economic:** Maximized efficiency could enable lower operating costs
- **Disruptive:** Enables hard-to-intercept weapons and ultra-fast global transport
- **Societal:** Sustained hypersonic flight could revolutionize air travel
- **Strategic:** Enable new strike capabilities for a country's defense

In-Space Manufacturing



What is it?

In-space manufacturing is the production of goods, structures, components, and systems in orbit or on planetary surfaces for customers in space and on Earth, using a combination of people, autonomous robotics, and digitally-driven processes. Building things in space can shift space systems from being launch-limited products to adaptable, upgradable elements, supporting commercial platforms, national security missions, and long-duration human exploration.

What are the impacts?

- **Economic:** Shift to in-space production of high-performance systems, materials
- **Disruptive:** Enables entirely new systems, materials, and biological products
- **Societal:** Lays foundation for sustained human presence in space
- **Strategic:** Extends industrial capacity beyond Earth

Pilotless Aircraft



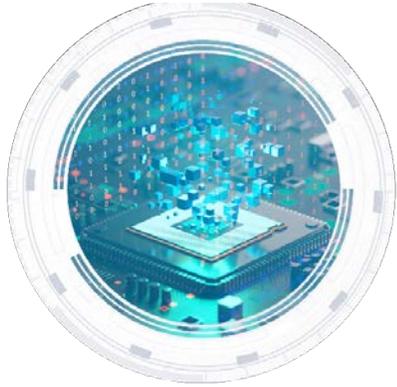
What is it?

Pilotless aircraft operate without a human pilot onboard and are controlled either remotely or autonomously. Pilotless passenger and cargo aircraft potentially offer significant advantages by enabling highly reliable autonomous flight operations that can allow continuous real-time system monitoring. Pilotless operation is a feature of many advanced air mobility (AAM) concepts, which feature electric or hybrid-electric, vertical take-off and landing (VTOL) aircraft.

What are the impacts?

- **Economic:** Contribute to reduction in operating costs
- **Disruptive:** Reshape labor needs, and enable new operating models
- **Societal:** Enable potentially safer, more affordable, and accessible air travel
- **Strategic:** Enhance transportation resilience and improve scalability

Quantum Computing and Sensing



What is it?

Quantum technologies leverage unique behavior of quantum systems to enable applications that are intractable or cost prohibitive with classical systems. Applications for quantum technology include quantum computing: utilizing superposition, entanglement, and interference to enable novel computing algorithms and quantum sensing: devices that use quantum phenomena to collect and measure physical properties.

What are the impacts?

- **Economic:** Gains in computing power and capabilities could reduce costs
- **Disruptive:** Could solve currently intractable problems
- **Societal:** Potential to transform day-to-day life (e.g., drug design, transportation)
- **Strategic:** Countries with quantum capabilities can become tech leaders

Space Nuclear Power and Propulsion



What is it?

Reaching other planets demands propulsion systems that are faster, safer, and more efficient while living or mining off Earth will require reliable, high-power energy sources that do not depend on sunlight. Nuclear fission reactors can meet both needs, supplying robust power and propulsion for deep-space travel and off-world operations.

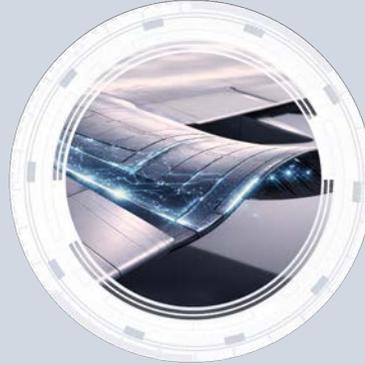
What are the impacts?

- **Economic:** Can impact the terrestrial market for small nuclear reactors
- **Disruptive:** Support wider ranging deep space exploration and exploitation
- **Societal:** Could spark public enthusiasm through bold accomplishments
- **Strategic:** Helps enable space domain superiority

Just Missed the Cut



**Collaborative
autonomous
aircraft**



**Functional
materials**



**Novel
aerodynamic
designs**



**Direct-to-device
communications**



**Large structure
additive
manufacturing**



**On-orbit
refueling**

Next Steps



Report available at: <https://aiaa.org/resources/technologies-transforming-aerospace-report>



Thank You

About BryceTech

- Delivers data-driven solutions in aerospace, biosecurity, and defense
- Clients across national security, civil, and commercial domains
- Systems engineering, advanced analytics, and strategic advisory services
 - Objective, non-advocate, data-driven analysis
 - Comprehensive industry databases
 - Strategy, competitive intelligence, forecasting, diligence, forecasting, program management

BryceTech publishes authoritative reports for public use, providing foundational data across aerospace



<https://brycotech.com/reports>

Carissa Christensen Bio

Carissa Bryce Christensen is an internationally-recognized expert on commercial space and industrial trends, advising senior government and industry decision-makers. She is the CEO and founder of BryceTech, LLC, an award-winning analytics and engineering firm and co-founder of other firms including a UK consultancy, US government contractor The Tauri Group, and quantum computing software company QxBranch.

Christensen serves as Senior Advisor to the USSF Schriever Wargame, on commercial and civil space. She previously sat on the Defense Innovation Board Space Committee and is currently a member of the Aerospace Corporation CSPA Senior Advisory Group and Co-Chair of the World Economic Forum Global Futures Council on Space. Christensen has testified before Congressional and Parliamentary committees on the space industry and has authored dozens of papers and book chapters. She guest lectures at universities internationally, including Harvard and the Eisenhower School of National Security, and is an Entrepreneur-in-Residence at Harvard Business School.

Christensen is a graduate of Harvard University's Kennedy School, where she specialized in science and technology policy. She attended the London School of Economics and was a Douglass Scholar at Rutgers University. She is a Fellow of the American Institute of Aeronautics and Astronautics and of the Royal Aeronautical Society.

