We aim beyond the sky we see.

www.aero.jaxa.jp

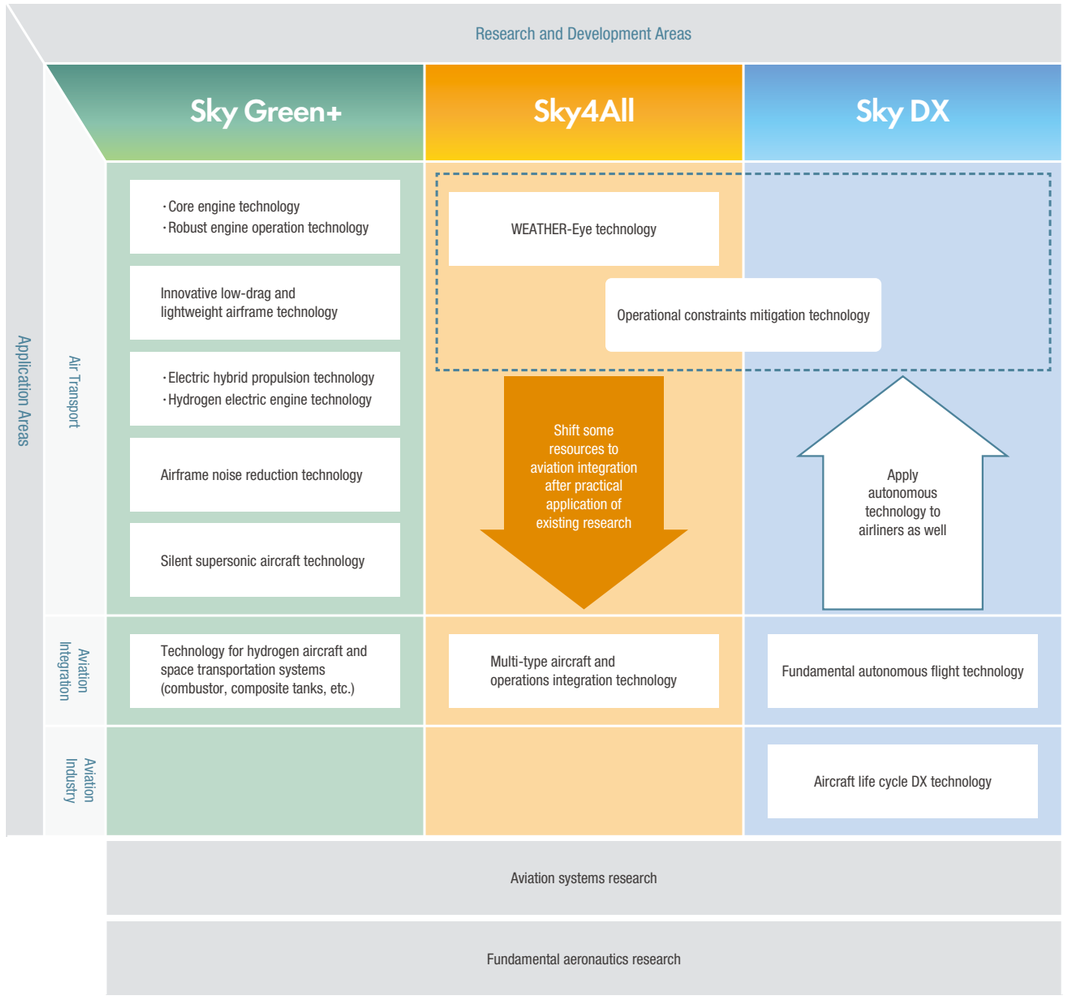
Aviation Technology Directorate
Japan Aerospace Exploration Agency

September 2024

Contributing to a sustainable aviation-integrated society that is people- and environment-friendly through aeronautical science and technology

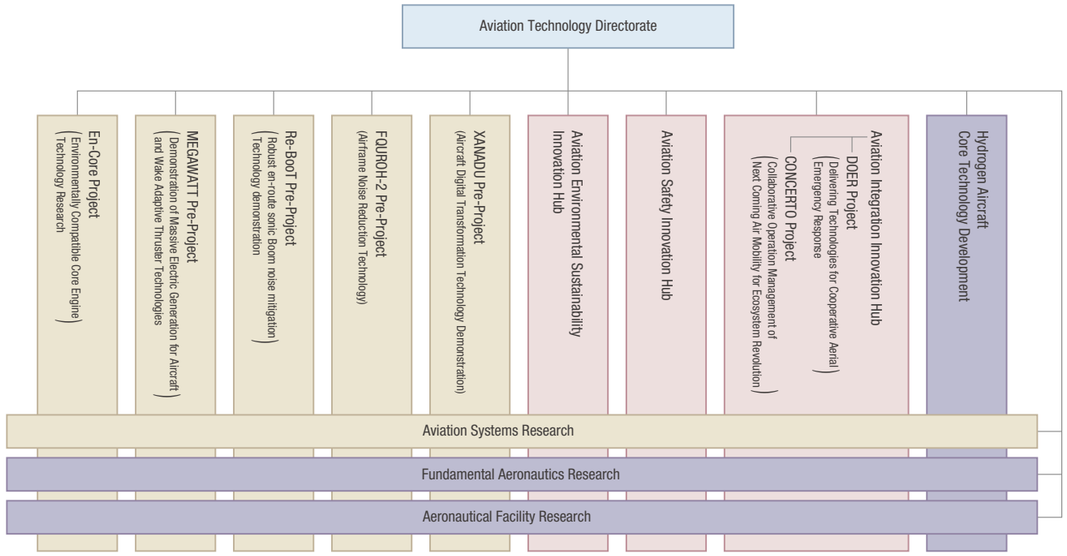
The Aviation Technology Directorate (“JAXA Aviation”) has set the goals of future vision in the field of air transport, aviation integration, and aviation industry respectively as follows. To achieve these goals, we promote three R&D programs, while also pursuing aviation systems research and fundamental aeronautics that cut across the full gamut of R&D to support activities in each program areas, thereby creating a framework that enables us to continually generate R&D projects that are based on government policies and meet societal needs.

- Connecting the world with high-speed air transport with minimal environmental impact
- Bringing the benefits of aviation to all in both daily life and disaster relief
- Leading the world with a digitalized, circular aviation industry



Creating ecosystem for open innovation

[Research and Development Structure]



As of September 2024

[Innovation and collaboration]

JAXA Aviation provides new value to society through open innovation by collaborating with diverse players across industries and sectors. At the heart of these efforts are our three innovation hubs: Aviation Safety Innovation Hub, Aviation Environmental Sustainability Innovation Hub, and Aviation Integration Innovation Hub. Each Innovation Hub promotes research activities that provide solutions to society with a major impact.

For smooth and practical implementation of R&D results for use in public, we also make our efforts to establish ecosystems for collaboration and innovation. These efforts include building collaborative frameworks, such as government-industry-academia consortia where diverse stakeholders work together with a shared vision and leveraging their strength in a multidisciplinary and cross-functional manner, as well as taking part in standardization activities to establish international rules that better help Japanese industry to enter the market. These efforts will focus particularly on the new R&D fields of electric hybrid propulsion technology, multi-type aircraft and operations integration technology, and aircraft life cycle digital transformation (DX) technology. Also, we will provide fundamental research facilities and testing and analysis technologies that will serve as the core of new R&D ecosystems, such as cyber platform that enable collaboration in cyberspace.

[International collaboration]

To enhance its technical capabilities and give them back to society through collaboration, JAXA Aviation works closely with overseas aviation research institutions, private sector companies, and universities, and engages in a wide variety of mutually beneficial joint research activities, ranging from fundamental research to flight demonstration of new technology.

Through international collaborations with global partners such as NASA, ONERA, DLR, and Boeing, for example, JAXA aims to create synergy in tackling global challenges facing aviation today and in the future. These activities provide unique opportunities for researchers to gain invaluable insights and knowledge. We also participate in the International Forum for Aviation Research (IFAR), an international network of aviation research institutions, currently consisting of 26 members from around the world. Our activities related to IFAR provide opportunities to engage in dialogue toward technical cooperation and develop human resources, in close relationships of trust with global aviation research institutions.

Boeing-JAXA high-level meeting (10 Dec 2021)

Sky Green+

Contributing to environment- and user-friendly sustainable air transport

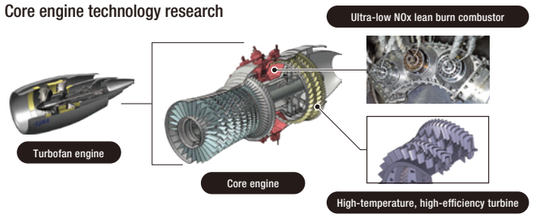
The COVID-19 pandemic resulted in a dramatic decline in the number of air travelers, and the impact was particularly acute in 2020 when the number fell by about 60% from the previous year.*1 In the long term, however, demand for air travel is expected to continue growing.*2 Industry players already have their sights set on post-pandemic growth in air transport, and are making active moves aimed at providing high added value. These include reduction of CO_2 emissions toward carbon neutrality, reduction of the environmental impact of aircraft such as noise around airports, and introduction of supersonic transport.

*1 International Civil Aviation Organization (ICAO), "Effects of Novel Coronavirus (COVID-19) on Civil Aviation: Economic Impact Analysis," ICAO Air Transport Bureau/January 2021
*2 Japan Aircraft Development Corporation (JADC), "Worldwide Market Forecast (2020–2040)"

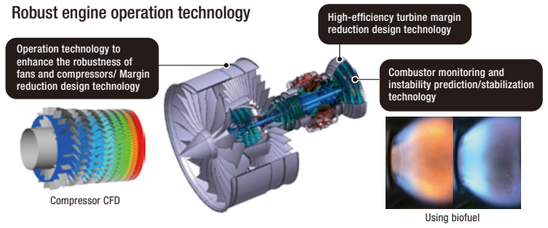
Through this program, JAXA Aviation is working closely with industry and other stakeholders to build on past R&D achievements and contribute to the advancement of sustainable air transport that is environment- and user-friendly.

- **Core engine technology** that enhances environmental performance (reduction of CO_2/NO_x emissions)
- **Robust engine operation technology** to expand operating range enabling reduced fuel consumption/weight and improve safety
- **Innovative low-drag and lightweight airframe technology** that realizes superior environmental performance
- **Electric hybrid propulsion technology/hydrogen electric engine technology** that radically reduce CO_2 emissions
- **Airframe noise reduction technology** that cuts noise coming from landing gears and high-lift devices
- **Silent supersonic aircraft technology** that reduces sonic booms over a wide area

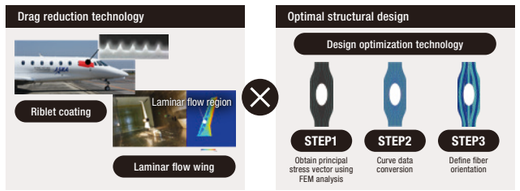
Core engine technology research



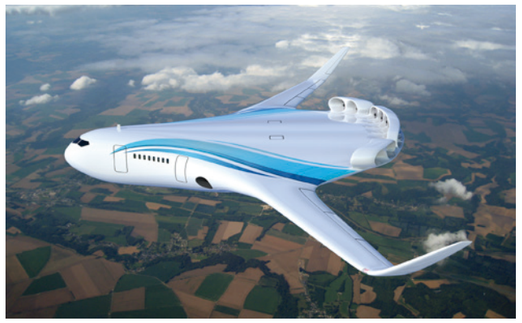
Robust engine operation technology



Innovative low-drag and lightweight airframe technology



Emission free aircraft (CG image)



Supersonic aircraft applied with low-boom design technology (CG image)

Sky4All

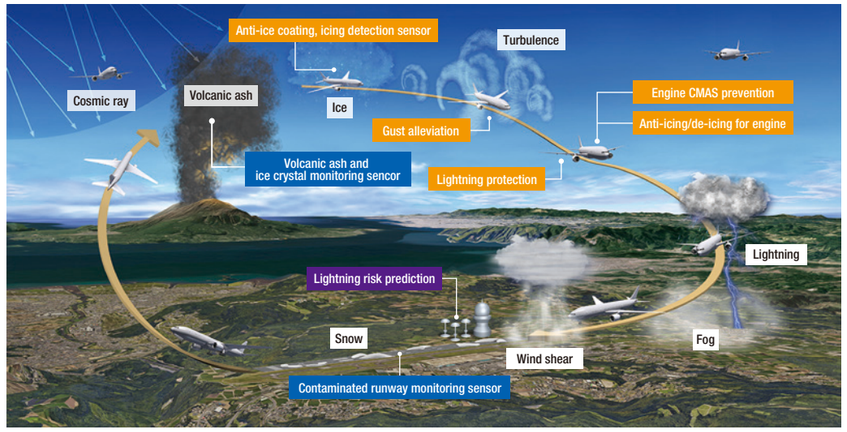
Bringing aviation closer to people in daily life and disaster relief

To prevent aircraft accidents and ensure air transport remains safe and reliable into the future, continuous effort to improve the safety of aircraft operation is essential. Moreover, there are growing expectations for wider use of aviation toward the realization of a sustainable and resilient society. These include logistics services using unmanned aerial vehicles (UAVs) and on-demand mobility for greater efficiency and convenience, as well as infrastructure for disaster relief, crisis management, and aerial platforms (for communication, observation, etc.).

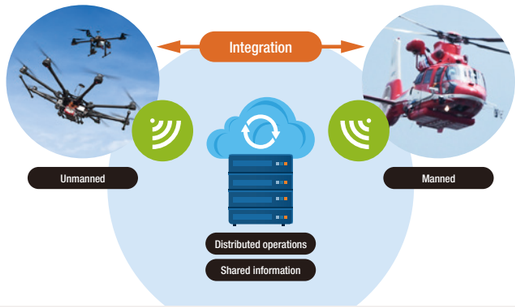
The Sky4All stands for sky for all-people, all-situations, all-vehicles, and all-weather. This program promotes R&D that helps improve safety and efficiency of aircraft operation and facilitate wider use of aviation.

- **WEATHER-Eye technology**, which consists of detection, prediction, and prevention technologies to protect aircraft operations from the threats of special weather conditions (snow and ice, lightning, turbulence, volcanic ash, etc.) that are the most common causes of aircraft accidents.
- **Operational constraints mitigation technology**, which assists decision-making based on sophisticated aviation weather information
- **Multi-type aircraft and operations integration technology** that realizes integrated manned/unmanned aircraft operation and eVTOL high-density operation in the low-altitude airspace, by further enhancing the **integrated operation system for disaster relief and crisis management (D-NET3)**

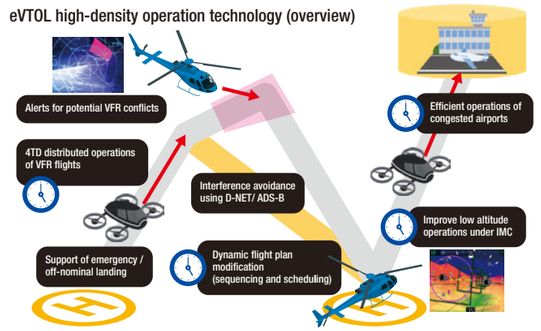
WEATHER-Eye technology (overview)



Integrated manned/unmanned aircraft operation technology



eVTOL high-density operation technology (overview)



Sky DX

Driving digital transformation of the entire life cycle of aircraft

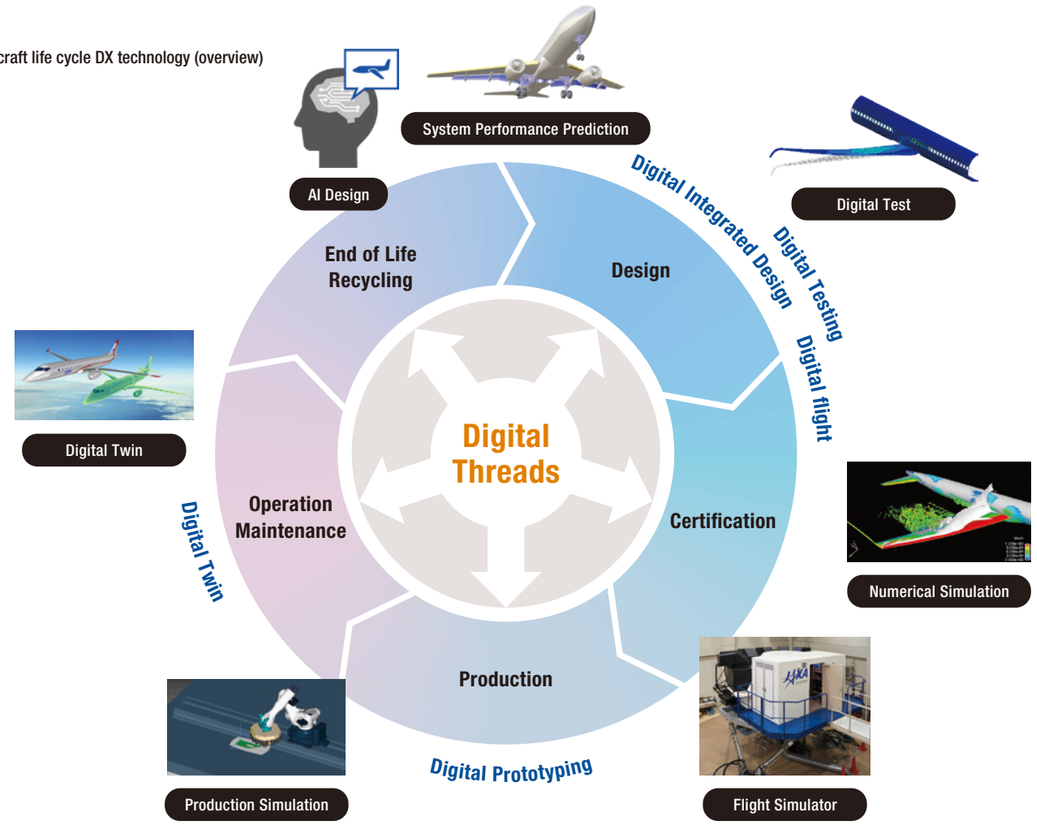
The whole life cycle of aircraft ranging from design to end of life must be streamlined and expedited through digital transformation (DX) in order to make Japan's aviation industry more competitive internationally and sustainable.

This program seeks to digitally transform the entire life cycle of aircraft, which consists of design, certification, production, operation, maintenance, end of life, and recycling. JAXA's strengths in numerical simulation and other analytical technology, as well as testing and measurement technologies are fully leveraged in this effort.

- Fast, efficient, multidisciplinary **digital integrated design technology**
- **Digital flight technology** that substitutes for flight tests necessary for design and certification tests
- **Digital testing technology** that substitutes for material and structural tests
- **Digital prototyping technology** for virtual manufacturing simulation

We are also addressing fundamental autonomous flight technology for new air mobility.

Aircraft life cycle DX technology (overview)



Strategically supporting R&D as aviation systems coordinator

[Aviation Systems Research]

The demands of the aviation industry are becoming increasingly diverse, including the goal of achieving carbon neutrality by 2050 and enhancing convenience in mobility and logistics. In light of these trends, JAXA is systematically working to promote research and development and improve efficacy by exploring future aircraft concepts and the technologies needed to realize them. This includes conducting system-level performance evaluation of elemental technologies, and facilitating the standardization and sharing of design tools. Additionally, we provide comprehensive support for R&D through project management and systems engineering.

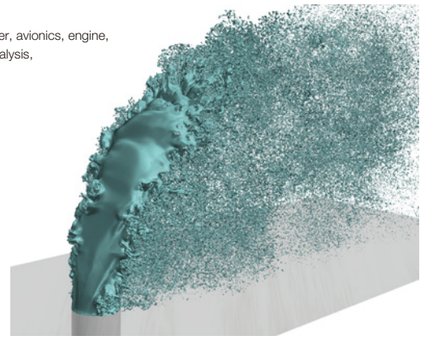
Hydrogen turbo fan and electric hybrid propulsion aircraft (rendering image)

Supporting R&D with advanced, pioneering expertise

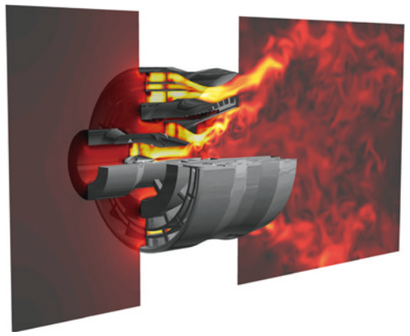
[Fundamental Research]

We strategically pursue fundamental research to create world leading technologies*, by taking into account the technological trends in Japan and overseas and along the line of JAXA Aviation's R&D area. An example is a study to dramatically improve the performance of jet engine combustors. The challenge in this research is modeling phenomena that significantly affect the performance of components whose mechanism remain unsolved. We try to understand these phenomena by conducting detailed physics-based analyses, based on which simulation models are created. In addition, we contribute to the development of an aviation-integrated society by introducing new methods that can significantly reduce computational load in massively parallel computing in the future and building JAXA's original spray combustion analysis software.

* Fluid, acoustics, flight, weather, avionics, engine, structure, material, numerical analysis, data science, etc.



Atomization process of liquid fuel jet



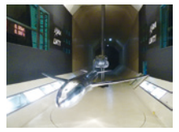
Mach number distribution of the aeroengine fuel nozzle analysis performed with engine combustion simulation software "HINOCA"

[Facility Technology]

We operate some of Japan's foremost test facilities and engage in research to develop new and innovative testing methods and analysis technologies. Our test facilities cover a wide range of technical fields vital to aerospace development, including wind tunnels, propulsion test facilities, flight test facilities, structure and materials test facilities, and some of them are among the largest in Japan. We also operate information infrastructure facilities to promote the provision and use of test data and analysis tools that are products of JAXA's research. These facilities are also widely used by researchers and engineers outside JAXA to help make Japan's industry more competitive.

Main test facilities

Wind Tunnels



6.5mx5.5m
Low-speed Wind Tunnel

Propulsion Test Facilities

Ground-level jet engine test facility

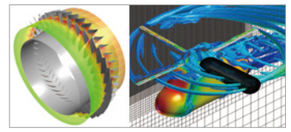
Flight Test Facilities

Jet flying test bed "Hisho"

Structures and Materials Test Facilities

CFRP panel compression test

Information Infrastructure Facilities



CFD analysis examples
(aeroengine compressor turbine blades/ interference between helicopter fuselage and rotors)