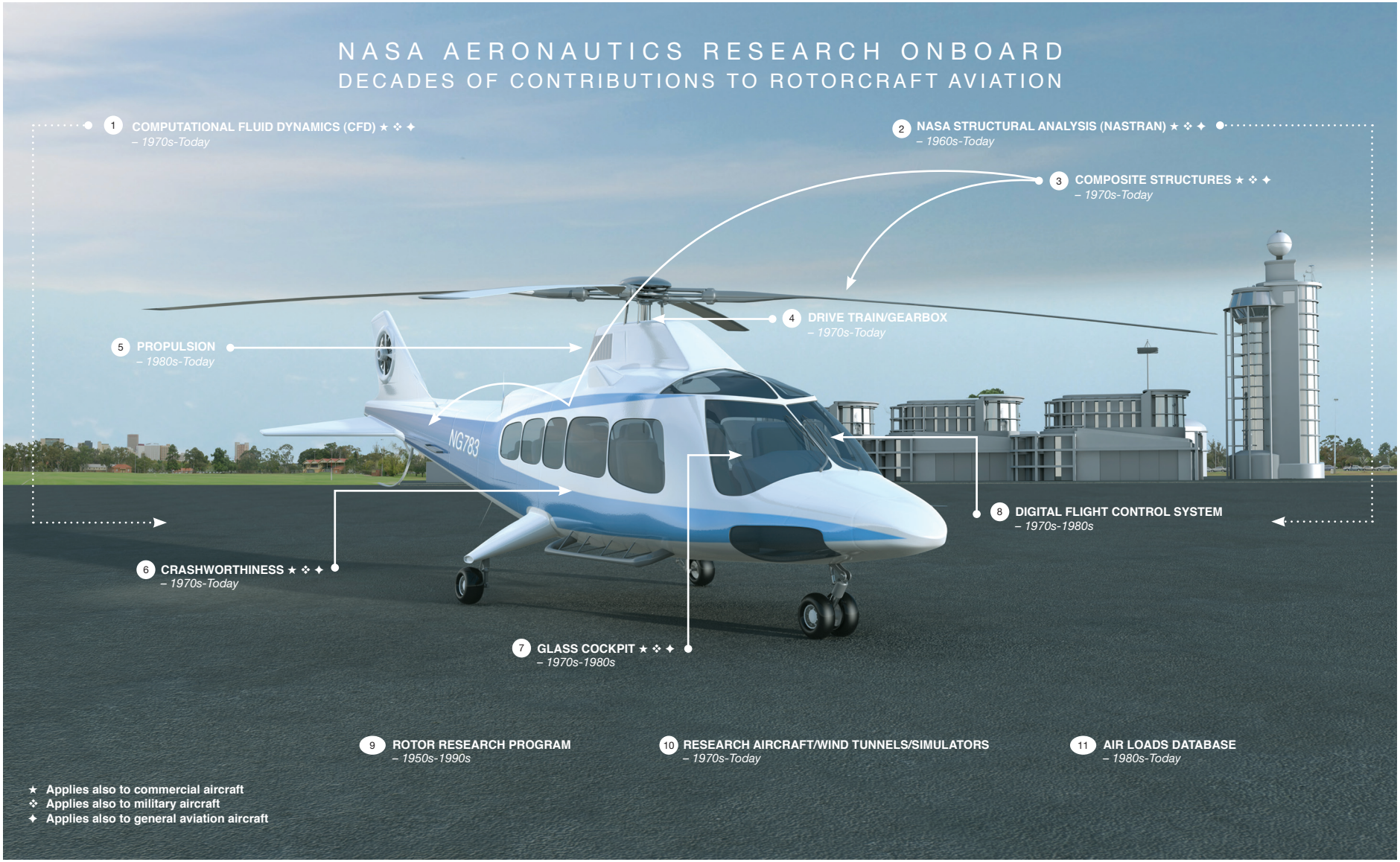
NASA AERONAUTICS RESEARCH ONBOARD
DECADES OF CONTRIBUTIONS TO ROTORCRAFT AVIATION
1 COMPUTATIONAL FLUID DYNAMICS (CFD) ★ ❖ ✦
– 1970s-Today
2 NASA STRUCTURAL ANALYSIS (NASTRAN) ★ ❖ ✦
– 1960s-Today
3 COMPOSITE STRUCTURES ★ ❖ ✦
– 1970s-Today
4 DRIVE TRAIN/GEARBOX
– 1970s-Today
5 PROPULSION
– 1980s-Today
6 CRASHWORTHINESS ★ ❖ ✦
– 1970s-Today
7 GLASS COCKPIT ★ ❖ ✦
– 1970s-1980s
8 DIGITAL FLIGHT CONTROL SYSTEM
– 1970s-1980s
9 ROTOR RESEARCH PROGRAM
– 1950s-1990s
10 RESEARCH AIRCRAFT/WIND TUNNELS/SIMULATORS
– 1970s-Today
11 AIR LOADS DATABASE
– 1980s-Today
★ Applies also to commercial aircraft
❖ Applies also to military aircraft
✦ Applies also to general aviation aircraft

1. Computational Fluid Dynamics (CFD)
Starting in the 1970s, NASA began developing sophisticated computer codes that could accurately predict the flow of fluids, such as the flow of air over an aircraft's wing, fuel through a space shuttle's main engine, or the complex interactions between a rotorcraft's main rotor blades, fuselage and its tail rotor.

Those ideas and codes became CFD, which today is considered a vital tool for the study of fluid dynamics and the development of new aircraft. CFD greatly reduces the time and cost required for designing and testing nearly any type of aircraft.

2. NASA Structural Analysis (NASTRAN)
In the 1960s, NASA partnered with industry to develop a common generic software program that engineers could use to model and analyze different aerospace structures, including any kind of spacecraft or aircraft. Today, NASTRAN is an "industry-standard" tool for computer-aided engineering of all types of structures.

3. Composite Structures
NASA first partnered with industry during the 1970s to conduct research on how to develop high-strength, nonmetallic materials that could replace heavier metals on aircraft. Gradually, composite materials have replaced metals in helicopter fuselages and rotor blades, and have become critical for reducing the weight of vertical-flight vehicles. NASA research also identified new ways to detect fuselage damage.

4. Drive Train/Gearbox
During the 1970s, NASA and the U.S. Army discovered the benefits of new transmission designs, and developed new advanced transmission gears and cooling methods. Today, the research partnership is working to develop new gears with higher strength and longer life, and new methods to monitor transmission health.

5. Propulsion
During the 1980s, the NASA/U.S. Army partnership conducted research to increase understanding of high-altitude and high-load engine operations. Today, researchers use new helicopter engine computer simulations and new materials to help improve engine fuel efficiency.

6. Crashworthiness
From the 1970s through today, NASA has used its special gantry/swing cable facility adapted from the Apollo program to test the performance and durability of rotorcraft fuselage and components. The vertical drop tests or horizontal swing tests measure the survivability potential for occupants, structures and new composite materials.

7. Glass Cockpit
During the 1970s and 1980s, NASA created and tested the concept of an advanced cockpit configuration that replaced dial and gauge instruments with flat panel digital displays. The digital displays presented information more efficiently and provided the flight crew with a more integrated, easily understood picture of the vehicle situation.

Glass cockpits are particularly valuable in rotorcraft for low-altitude, NAP-of-the-Earth ("near as possible") flight in bad weather.

8. Digital Flight Control System
During the 1970s and 1980s, NASA designed and flew the world's first automatic digital flight guidance system for rotorcraft called "V/STOLAND" (Vertical/Short Takeoff and Landing). The unique autopilot system permitted rotorcraft to follow a complex, helical flight profile in the airport terminal area to an automatic landing.

9. Rotor Research Program
Starting in the 1950s, NASA and the U.S. Army tested multiple modern rotors in flight and in NASA wind tunnels to evaluate performance. The tests generated data on rotor blade motion, loads, maneuvers and ground acoustics that was used to improve rotorcraft design.

Today, NASA researchers are exploring active control rotors that can improve safety and efficiency.

10. Research Aircraft/Wind Tunnels/Simulators
During the 1970s as NASA's research relationship with the U.S. Army intensified, NASA used a small fleet of helicopters including a UH-60 Black Hawk and a Bell AH-1G White Cobra to conduct rotor experiments and operational studies. Today, NASA wind tunnels are used to test rotorcraft aerodynamics and to validate new solutions for noise and vibration reduction. NASA simulators are also used to evaluate new vehicles and flight operations.

11. Air Loads Database
During the 1980s, NASA devised a unique method to capture data from a highly-instrumented rotor system during flight tests. The resulting database was used to refine rotorcraft designs—mainly the UH-60 Black Hawk helicopter—and is still used today to better predict structural responses in performance, efficiency, airflows, vibration and noise.

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