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FIREDRONES

Unmanned craft could be the edge against wildfires, FAA permitting

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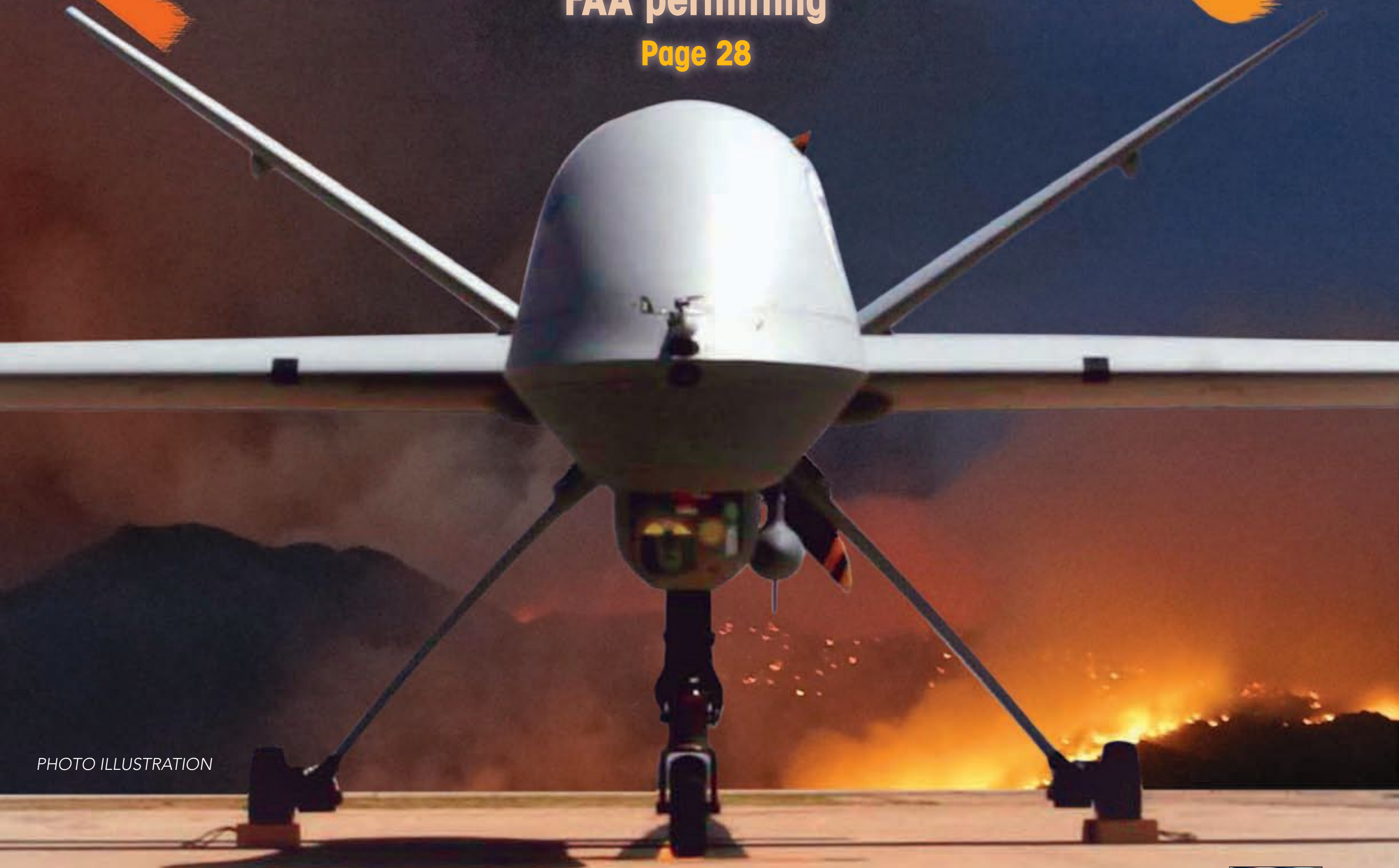

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Why astronauts train in planes

Veteran astronaut and pilot Tom Jones explains how a fleet of decades old jets continues to prepare astronauts for that moment when a spaceflight suddenly goes from smoothly on plan to a life-and-death test of teamwork.

I was a member of a National Research Council panel that in 2011 examined NASA's post-shuttle astronaut training needs. One day, Peggy Whitson, who was then NASA's chief astronaut, came to speak to us. She told us about her hair-raising, 2008 reentry after commanding Expedition 16 crew on the International Space Station. An explosive bolt failure caused her crew's Soyuz TMA-11 service module to separate late from the descent module. The flight computer, unable to fly the planned lifting reentry through the upper atmosphere, "down-moded" to a steeper and hotter ballistic reentry that subjected the crew to more than 8 Gs. Smoke entered the cabin and the crew executed the electrical fire checklist to power down most of their flight instruments. High winds in Kazakhstan then rewarded the crew with a hard landing. Whitson, a Ph.D. biochemist before she came to NASA, told us flatly that without her flight experience in NASA's T-38 jet trainers, the rapid-fire chain of emergencies might well have overwhelmed her. Instead, she stayed in the game as flight engineer and helped the Soyuz commander get the crew down safely.

Fortunately for Whitson and her astronaut colleagues, the T-38s today are still serving as the principal tools for Spaceflight Readiness Training (SFRT), despite the end of the shuttle era and constant pressure on NASA's budget. Astronauts routinely take the T-38 to altitudes above 40,000 feet and cruise close to the speed of sound to conduct aerobatic training or complete the SFRT syllabus. Such training

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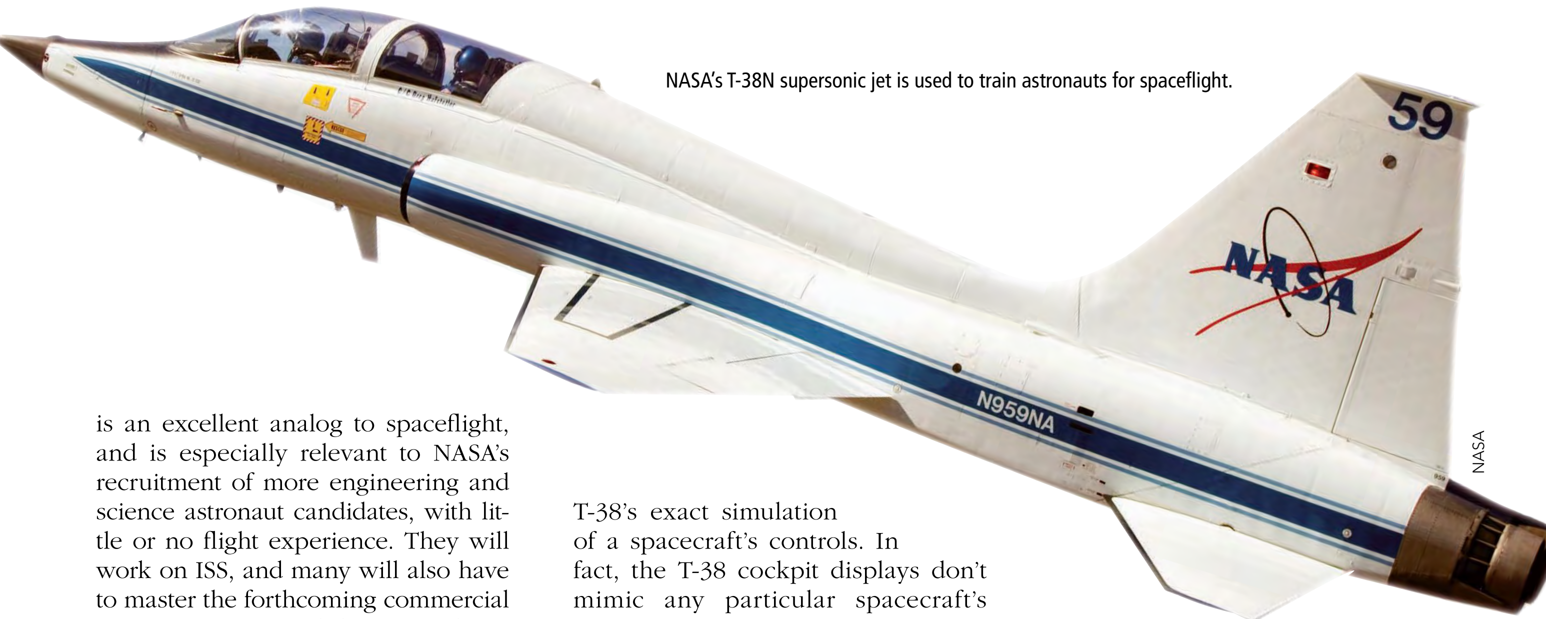
NASA's T-38N trainer jet cockpit displays don't look like that of any particular spacecraft. But its modern display technology is similar to those on the upgraded Soyuz capsules and new commercial space transports.



NASA's T-38N supersonic jet is used to train astronauts for spaceflight.

NASA

is an excellent analog to spaceflight, and is especially relevant to NASA's recruitment of more engineering and science astronaut candidates, with little or no flight experience. They will work on ISS, and many will also have to master the forthcoming commercial space transports and the Orion deep-space multipurpose crew module.

High-altitude classroom

Designed for training new Air Force pilots, the T-38s have front and rear cockpits with duplicate controls. NASA instructors or test-pilot-qualified astronauts fly the plane from the front cockpit, but non-test-pilot astronauts must ride in the rear, sharing duties with the front-seater. For example, I was an ex-Air Force pilot, once qualified in T38s and B-52s, when I became a shuttle astronaut. But as a mission specialist astronaut without test flying credentials, at NASA I flew in the rear cockpit, splitting hands-on flying time, navigation, and radio work with my front-seat colleague.

During the shuttle era, T-38 training honed the critical skills pilots needed to bring an orbiter to a safe landing in Florida (or California) after two or more weeks in space. There is less piloting to do in the wingless Soyuz and commercial crew transports when things go normally. But as Whitson's story shows, in spaceflight the situation can change quickly. NASA doesn't want to put its astronauts in those vehicles without having them first gain experience in dynamic flight using its fleet of T-38N Talons.

The value of Spaceflight Readiness Training does not stem from the T-38's exact simulation of a spacecraft's controls. In fact, the T-38 cockpit displays don't mimic any particular spacecraft's panel, although they use modern technology similar to those of the new commercial space transports and the upgraded Soyuz capsules.

What T-38 training does deliver is a dynamic environment that teaches astronauts to make good decisions, to coolly respond to deteriorating situations, and to operate as a team even under stress. A 2008 study by the Aircraft Operations Division and the Astronaut Office at Johnson Space Center concluded that the T-38s effectively instill discipline, prioritization, crew coordination, communication, decision-making, and space flight environment adaptation.

Prioritization and discipline, in particular, are keys to flight safety. Astronauts must identify the most critical tasks in flight and stay focused on solving them despite competing stresses and sensory distractions. Story Musgrave, my crew mate on Columbia's STS-80 mission in 1996, told a NASA interviewer that when you soar aloft in a T-38, "you're in a different world, a dynamic world — it doesn't matter whether it's a spacecraft or a T-38. It's understanding the rules, how to live within the rules."

Communication and crew coordination go hand-in-hand, as crewmembers share information and failure assessments and then work smoothly together to handle in-flight emergencies.

Decision-making in space closely mimics the fast-paced thinking needed in aviation, where multiple factors like weather, fuel state, systems malfunctions and converging traffic must be weighed quickly to accomplish the mission. While flying, there's no turning back from the consequences of your decision: Unlike in a simulator, what you decide can have a real impact on your safety or survival.

The physical sensations experienced in a T-38 — vibrations, G-forces, lowered cabin pressure and even the weight and smell of a parachute and oxygen mask — help prepare an astronaut for the unfamiliar sensory environment of spaceflight.

NASA's White Rocket

The Northrop T-38 Talon first flew in April 1959. The world's first supersonic trainer, it could reach speeds of Mach 1.3, and in 1962, a T-38A set world time-to-climb records to 3,000, 6,000, 9,000 and 12,000 meters. Pilots called it "the white rocket."

In the late 1980s, NASA began upgrading its T-38s to better meet specific astronaut training needs. The Aircraft Operations Division at NASA Johnson executed a phased aircraft

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avionics upgrade program, giving this improved T-38N a weather radar, flight management computer, and primary flight instruments displayed on "glass" cathode ray tubes. To improve crew safety, NASA in 2001 began installing new Martin Baker US16LA ejection seats. These zero-zero seats [capable of a safe ejection even at zero speed and zero altitude] broadened the escape envelope and eased the dangers the old seat posed for the shortest and lightest members of the astronaut corps.

Externally, the Talon received modified engine inlets and ejector nozzles to improve high-density-altitude takeoff and cruise performance. Those modifications have reduced the T-38's supersonic capability, but that speed regime is incidental to astronaut training.

NASA began a second cockpit upgrade program in 2006. "The way we went with our upgrade was more an advanced biz-jet mentality, suited to our flying cross-country missions and dealing with bad weather," recalls Richard N. "Dick" Clark, who until last November was chief of the Aircraft Operations Division in Houston. NASA added a weather data link to complement the existing weather radar; a GPS-based flight management system; and switched to large, flat-panel displays. "It's a much more capable and effective airplane today," Clark says.

NASA has reduced the size of the T-38 fleet to match the reduction in the astronaut corps from 150 fliers 10 years ago to 50 or 55 today. NASA now maintains 18 operational jets and two spares. In the last decade, the budget for the Aircraft Operations Division has declined by half.

NASA and its aviation maintenance contractor, DynCorp International, prepare seven aircraft and two spares for daily operations. Twelve to 15 sorties launch from Ellington Field in Houston each weekday, totaling about 4,000 flight hours per year.

From Wings to Rockets

The T-38 exposes trainees who are new to aviation to spaceflight-related activities such as preflight briefings, equipment inspections, checklists, radio discipline and handling emergencies. To get its new, non-aviator astronauts up the learning curve even more quickly, NASA sends them to the Navy's flight school at Naval Air Station Pensacola in Florida for a six-week, back-seat introductory course in basic flying.

Astronaut pilots fly 12-15 hours a month to maintain front-seat proficiency, while back-seat crewmembers aim for 6 hours per month. Astronauts not assigned to a mission spend about 10 percent of their training time in the T-38, while assigned crewmembers, with many competing training demands, log just 5 percent cockpit time. The goal is to get experienced military pilots and astronaut candidates fresh to aviation to perform as a capable, qualified T-38 crew, accumulating "classroom" time aloft.

NASA

NASA has upgraded its T-38N jets with Martin Baker US16LN ejection seats to lessen danger to astronaut trainees. The seats can safely eject occupants even at zero altitude and zero airspeed.

The National Research Council panel confirmed the need for continuing Spaceflight Readiness Training. Our 2011 report, "Preparing for the High Frontier," found that SFRT provided astronauts with training "that cannot be duplicated by current…or projected alternative techniques or technologies." The NRC recommended that "to ensure continued safety and mission success, NASA should maintain a spaceflight readiness training program that includes high performance aircraft."

Retired chief astronaut Ken Cockrell, my commander on two shuttle missions, says "aviation is certainly the closest analog to the operational environment of spaceflight. There are others that we have used or evaluated: the National Outdoor Leadership School, the underwater habitat, and submarine damage control training, to name three. But exposing future spacecraft crewmembers to the aviation environment, where things happen fast, where the crew needs to think and react quickly, and where the decisions they make can mean the difference between success and failure in a personally mortal sense, is the best way to help them be successful in space."

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