Turbofan engine makers active in business aviation—such as General Electric, Honeywell, Pratt & Whitney Canada, Rolls-Royce and Snecma—all have their hands full with research-and-development (R&D) programs, many of which are driven by aircraft programs. However, almost all of the engine companies also run demonstration programs that will not necessarily morph into full engine development. Instead, these demonstrators ensure technologies are ready when an aircraft maker issues a request for proposals. One startup company—Price Induction—seems to have attracted enough interest to plan for a full certification program without any application. Repeated inquiries to Williams International about product development remained unanswered.

General Electric (GE) is developing the HF120 jointly with Honda for the HondaJet and Spectrum S40 Freedom business jets. The engine maker is currently working on the first fully conforming HF120, and plans to begin testing it by mid-year. “The program is on track for certification late this year or early in 2010,” Shawn O’Day, GE’s marketing leader for business and general aviation, told AIN. Entry into service for the HF120—rated at 2,095 pounds of thrust—is expected in 2010. The two partner companies have so far run 10 core and 10 full engines. Testing, teardown and rebuilding of full turbofan engines have been under way at Honda’s Aircraft Engine R&D Center in Japan for more than 18 months. This year, the engine is slated to undergo tests on a flying testbed, as well as on the HondaJet. By service entry, the HF120 is expected to have accumulated some 15,000 hours of ground and flight testing. HF120 engine production is to begin this year at GE’s Lynn, Mass. facility. Production will then transition to Honda Aero’s new factory in Burlington, N.C., which is slated to open in 2010. The GE Honda Aero Engines joint venture was formed in 2004. The HF120’s fan is a bladed integrated disk (blisk) and has wide-chord, swept blades. The fan’s final design was the culmination of a competition between GE and Honda teams. The two proposed designs were eventually merged. A two-stage booster—a composed of blisks—is followed by a single-stage centrifugal compressor. The impeller builds on Honda’s experience in Indy Car turbochargers.

The reverse-flow combustor features advanced materials for its laser-drilled multi-hole cooling arrangement. The single-stage high-pressure turbine has single-crystal blades that will “help reach the 5,000-hour TBO target,” O’Day said. The low-pressure turbine has two stages with two counter-rotating spools. The noise target is “Stage 4 with margin,” according to the manufacturers. Although the engine’s thrust falls below CAEP 6 compliance limits, GE and Honda still want emissions to remain within extrapolated CAEP 6 numbers. As for fuel burn, O’Day said he wants “better than that of same-class engines.” The HF120 weighs less than 400 pounds and has a bypass ratio of 2.9.

With regard to maintainability, O’Day promises all components of the engine will be accessible, with one-deep line replaceable units (LRUs). GE also has a core engine demonstration program that could form the basis for a 10,000-pound-thrust engine development. Dubbed eCore, “it is a starting point for business, regional and [single-aisle] commercial jets” covering 10,000 to 20,000 pounds of thrust, O’Day said. GE’s CF34 replacement plan is codenamed NG34 and will use eCore technology.

The eCore builds “to a great degree” on the core design of the GE9X, which is to power the Boeing 787. Thanks to advanced materials (such as ceramic matrix composites) and three-dimensional aerodynamics, the goal is to raise the pressure ratio to 20:1 with a corresponding 16-percent increase in fuel efficiency over the best GE engines currently in operation. A time frame for certification depends on aircraft makers, but O’Day believes 2015 could be possible.

The eCore belongs to a wider company demonstration program called Tech X. “With Tech X, we offer better integration; we look at the aircraft in a more holistic way,” said O’Day, who alluded to improved aircraft-nacelle integration, electric power and a new generation of engine diagnostics and prognosis as hallmarks of the program. The first eCore is to run this year in Evendale, Ohio.

Price Induction—a French startup company with just 22 employees—is now claiming to have raised enough funds to complete the certification program of its 570-pound-thrust DGen 380 turbofan. The core engine is poised to start a second series of ground tests. “We want to understand the core’s performance better,” deputy manager Romain Cassan told AIN. The first engine test campaign ended in 2007 after accruing 50 hours and 1,200 starts. The company expects to achieve certification of the DGen 380 late next year, and according to Cassan there is also enough money to certify an upgraded version, the DGen 390, in 2011.

Price Induction completed a €10 million ($13 million) fund-raising round last summer, adding Financière de Brionne and Aerofund as new shareholders. Despite the lack of a firm application, the program is going forward regardless. However, Cassan said Price Induction is talking to several companies that are interested in building a demonstrator aircraft. With such meager thrust, the platform would likely be in the four- to six-seat category, aircraft that are smaller than in-service very light jets (VLJs).
Bizjets will have to wait for an engine revolution

It seems unlikely that new engine architectures such as the geared turbofan or the open rotor will make it to business aviation in the near or even mid-term. According to engine manufacturers, these concepts are not suited to the needs of business aircraft, which require a lot of thrust during almost the entire flight. In previous decades the direct-drive turbofan gained popularity over the geared turbofan and the open-rotor concepts, but the fuel burn advantage the latter offers has prompted renewed interest recently. Separately, biofuels will probably find their way on board business aircraft.

According to Andrew Tanner, v-p for business and regional aviation at Pratt & Whitney Canada (P&WC), a geared turbofan is good for takeoff thrust but not as strong for the high cruise speeds business jets must provide. The manufacturer is developing a geared turbofan for two regional jets—the Mitsubishi MRJ and the Bombardier C Series—and claims the engines will provide major improvements in noise and fuel burn.

Honeywell has long been producing both direct-drive and geared turbofans, as its HTF7000 and TFE731 series, respectively; Mike Bevans, manager for technical sales, sees both geometries as “viable going forward into the future.” In sales, he sees both geometries as “viable going forward into the future.”

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“Basically, we took the 300-hp RR300 and increased the airflow,” Ken Roberts, Rolls-Royce president for helicopters, told AIN. Design engineers enlarged the compressor and modified the turbine and other components. The purpose of increasing the airflow was to “keep the operating temperature relatively modest,” he explained. Designers could also have increased power by raising temperatures. Like the RR300, the RR500 will have an electronic engine monitor- ing system, and it retains hydropneumatic engine control and will benefit from extended maintenance intervals. While the older Rolls-Royce 250 has TBOs of 1,750 and 3,500 hours for minor and full shop visits, respectively, the RR500 will have 2,000-hour and 4,000-hour intervals.

The new engine is slightly more powerful than the 250 series 2 (which ranges from 420 to 475 shp). “It is targeted at new applications,” Roberts said, but he acknowledged that some existing Model 250 applications might move to the RR500.

Rolls-Royce announced the RR500 turboprop last summer at the EAA AirVenture airshow. The company said it is running the turboprop and turboshift programs “in a very integrated fashion.” The RR500 uses the same engine mounts as the Model 250, making it retrofittable to Model 250-powered helicopters. The RR300 is itself certified as derivative on the Model 250’s type certificate.

Rolls-Royce last month launched the RR500 turboshaft, a 475-shp derivative of the RR300 that powers the in-development Robinson R66. Certification is scheduled for late 2011, with deliveries pegged to begin in the first quarter of 2012.

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BIOFUELS FOR BUSINESS AVIATION

As concern for the environment gathers urgency, a number of manufacturers are studying the use of biofuels, which they consider a low-CO₂ alternative to petroleum-based fuels.

Will biofuels come to business aviation? Yes, according to Ron Rich, Honeywell’s director of advanced technology. In short, if they are suitable for aviation, they are suitable for business aviation. Honeywell subsidiary UOP, which specializes in refining, has developed technology to convert natural oils and greases into fuel for military jets. “There is more to come in the near future,” he predicted.

Mike Bevans, the company’s manager for technical sales, said Honeywell has yet to see requests for biofuel capability in the technical requirements it gets from business jet manufacturers. “Biofuels can be developed to work in business aviation engines, although business aviation will likely follow the airline industry in adopting them,” he predicted. Honeywell engineers expect to extrapolate current biofuel work on APU combustors to business jet engines.

Shawn O’Day, GE’s marketing leader for business and general aviation, agreed that the future is bright for the development of biofuels. GE has been involved in testing biofuels on CFM56 and CF6 engines. Virgin Atlantic flew one of its Boeing 747s on a short-haul flight with one CF6 engine fed by a biofuel made from babassu and coconut oil.

The current focus is on finding environmentally acceptable biofuels. Early ones, such as ethanol, still compete with food in agriculture. In January, Continental Airlines operated a Boeing 737-800 using a blend of 50 percent jet fuel and 50 percent biofuel. The latter was derived from algae (2.5 percent) and jatropha plant (47.5 percent) oils to power the number-two CFM56-7B engine. The left engine, fed only by jet fuel, burned 5 percent more fuel than the right one. Jatropha grows in arid areas and is thus said to be a viable source for biofuel.

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ROLLS LAUNCHES RR500 TURBOSHAFT

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that since the first core engine demonstrator program already results,” Cassan said.

The DGen has one fan, one stage of high-pressure compressor, one stage of high-pressure turbine and one stage of low-pressure turbine. This apparent simplicity disguises innovations such as a geared fan and a shaft-mounted electric generator. The bypass ratio, at 7.6, is high for this class of engine.

Pratt & Whitney Canada (P&WC) is investing C$1.5 billion (US$1.2 billion) in R&D between 2007 and 2011. Selected to power the Cessna Citation Columbus, the PW810 is on schedule to run this summer, Andrew Tanner, v-p for business and technical sales for propulsion engines. Certification of the 8,830-pound-thrust HTF7250G “in the middle of full-scale tests there. Crosswind tests have been performed at Rolls-Royce’s outdoor jet engine testing facility, located at NASA’s John C. Stennis Space Center in Mississippi.

Engine certification and clearance for the first G650 flight are planned for the second half of this year. "We are working closely with Dassault and progressively delivering on program technologies. We are not able to provide engine specification details or discuss our program at this time, as we remain in the joint feasibility phase,” a company spokesman told AIN.

Power requirements for a business jet encompass more than takeoff thrust. Climb thrust is also important, as is cruise thrust to maintain high speed at altitude. The Falcon SMS will replace the discontinued Falcon 50EX as an entry-level Falcon.

Snecma claims fuel burn to be 15 percent lower than that of current engines. Maintenance will be on condition—a giant leap, according to Finet. NOx emissions are expected to be 50 percent better than CAEP 6 standards, while noise is expected to be 20 dB better than Stage 4 limits.

Early last month it was reported that Dassault wants more thrust from the Rolls-Royce RB282 engine that will power the still-under-wraps Falcon SMS super-midsize business jet, suggesting a size or weight increase for the latest rendition of the twinjet. So far Rolls-Royce has discussed 10,000 pounds of thrust.

The British engine manufacturer told AIN in the middle of last month: “We are working closely with Dassault and progressively delivering on program technologies. We are not able to provide engine specification details or discuss our program at this time, as we remain in the joint feasibility phase,” a company spokesman told AIN.

Five development engines have undergone operability, performance and endurance testing at various locations, including the company’s Dahlewitz facility in Germany, which is also the headquarters of Rolls-Royce’s corporate and regional airliner engine business. The nacelles and thrust reversers have also been undergoing tests there. Crosswind tests have been performed at Rolls-Royce’s outdoor jet engine testing facility, located at NASA’s John C. Stennis Space Center in Mississippi.

Engine certification and clearance for the first G650 flight are planned for the second half of this year, while deliveries of the aircraft are scheduled to begin in 2012.

Above: Honeywell has tested its so-called “quiet high-speed fan” at the component, rig and full engine levels. Left: Rolls-Royce is developing the BR725 for the Gulfstream G650. Engine certification is pegged for the second half of this year.

Price Induction delivered one engine, in September, to the ISAE, a Toulouse-based aerospace engineering school that now uses a DGen 380 for educational purposes. “They keep us informed on their own test results,” Cassan said.

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The HP engine and APU that powers the Embraer Phenom 300, is “almost all done,” according to the engine manufacturer. Certification, however, has been postponed by a few months, to the middle of this year. The PW353E is “similar” to other PW353s, such as the PW353D that powers the Hawker Beechcraft 450XP and the PW353B on the Cessna Citation Encore.

In terms of V1L powerplants, P&WC’s PW600 series is now in service, including the PW610F for the Eclipse 500, the PW615F for the Cessna Citation Mustang and the PW617F for the Embraer Phenom 100. Pressed about the overly optimistic targets include halving NOx emissions, along with a “sizeable cut” in hydrocarbons, carbon monoxide and particulates, Richard said. Noise is expected to be 20 dB within the current Stage 4 standards.

France-based Snecma continues development of the Silvercrest, although it has so far failed to find an application for its first business jet engine. The Silvercrest’s thrust is in the 9,500- to 12,000-pound range. Program director Laurence Finet told AIN that since the first core engine test campaign concluded early last year, engine parts have been thoroughly examined. “The results confirmed we met our objectives for robustness and dynamic behavior,” she said. Snecma engineers found that the compressor’s surge margin was better than expected.

The core engine ran 80 hours, including 60 hours with combustion on. Takeoff setting was tried, at more than 20,000 rpm. From the time the program receives full engine launch—the green light that follows an aircraft maker’s selecting the engine—Snecma anticipates it will need three years to get the powerplant certified.

Snecma expects to appoint partners in the full program, since the $100 million core engine demonstrator program already involved two such collaborators. Turbomeca (like Snecma, a Safran company) helped design the centrifugal compressor, and Avio helped with the combustor.

Finet emphasized reducing the number of engine stages has been a major goal. Having a centrifugal compressor helps, since it is equivalent to three axial stages, she said. The compressor has one centrifugal and four axial stages.

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