The latest iteration of Honda Aircraft's innovative small jet sets new standards in range, fuel efficiency, performance and comfort – and is a pleasure to fly. We put it through its paces

A class apart

Michael Gerzanics San Jose

The lower end of the light jet market, once termed the entry jet segment, has three main contenders: Textron Aviation's Cessna Citation M2, Embraer's Phenom 100EV, and Honda Aircraft's HondaJet Elite.

A strong case can be made that Cessna popularised the small business jet field, with the prolific success of its Citation and Citation Jet models. Embraer, which has been manufacturing aircraft for more than 50 years, first delved into business jets in the late 1990s.

The Honda Motor Company, meanwhile, traces its roots to the period after the Second World War in Japan, where its founder, Soichiro Honda, built motorised bicycles. It advanced to produce motorcycles, and in 1964 became the world's largest manufacturer of them.

Next, Honda moved into the automotive market, where its precision and technical expertise allowed it to produce one of the world's most reliable automobile lines. For a number of years, the company honed its engineering talent by participating in Formula 1, first with its own car and engine but later solely as an engine manufacturer. Honda also is now one of two engine suppliers to the IndyCar racing series, and can be rightly proud of its recent victory in the 2020 Indianapolis 500.

Meanwhile, Honda Aircraft chief executive Michimasa Fujino developed the concept for what would be the company's first commercial offering, the HondaJet.

I have now been fortunate enough to fly all three of the highly capable but different leading aircraft in the light jet sector.

Each sports two medium-bypass turbofan engines and can carry four occupants in comfort to destinations at least 1,130nm (2,090km) away. All three have Garmin flightdecks and are certificated for single-pilot operations – an essential trait, as a good percentage of them are flown by owner operators. Yet once past these broad strokes there is one offering that is clearly different: the HondaJet Elite.

Under Fujino's guidance, Honda Aircraft has deployed notable innovations that by several

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Type is optimised for single-pilot operation, and has a maximum reach of 1,438nm

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Reduced take-off distance is one of several major improvements in updated model

measures elevate its design to the top of its class.

The most striking feature that differentiates the type from its classmates is its overall configuration. The HondaJet has its engines mounted like no other business jet. Termed over-the-wing engine mount (OTWEM), the company says the distinctive look brings measurable benefits.

Conventional wisdom holds that mounting anything above a wing carries a drag penalty compared with an underwing configuration. From an aerodynamic standpoint, however, the OTWEM configuration increases fuel efficiency by reducing wave drag, which is the result of shock waves generated at transonic speeds. By carefully evaluating wave patterns, Fujino's team determined the optimal location of engines and pylons to harness favourable interference patterns.

The location is defined by its chord-wise, height above, and span-wise location. The first two were determined primarily by aerodynamic factors, expressed as ratios of engine inlet size to chord length and vertical from wing upper surface, respectively. Span-wise location – distance outboard from the fuselage – was largely dictated by structural and aeroelastic considerations. Remarkably, at some points in the flight envelope the engine/wing combination has less drag than the bare wing itself would have.

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OTWEM also brings other benefits, especially with respect to passenger comfort. The engines do not encroach on the fuselage, allowing for a larger cabin and tail-cone baggage compartment. Additionally, engine vibrations are dissipated through the wing structure rather than a short fuselage-mounted pylon.

Innovative design

The wing itself also highlights the HondaJet's technological prowess. It has a natural laminar flow (NLF) aerofoil developed specifically by the company. Typical NLF wings allow laminar flow to about 25% of the chord, but Honda Aircraft says its wing maintains laminar flow to 44% on the upper surface and 60% on the lower surface. The aerofoil's cross section is also thicker than typical NLF designs, allowing for increased fuel tankage in the wings.

Another innovation employed on the HondaJet is an all-composite fuselage. Composites allow the fuselage's shape to be optimised for laminar flow and attendant drag reduction. Since composites are stronger and stiffer than metal construction, cabin interior volume can be maximised for a given exterior profile, while composite structures can also typically be lighter than ones constructed with aluminium.

A back-of-the-envelope calculation, however, shows that a typically equipped HondaJet has a structural weight fraction on a par with the Phenom 100EV and greater than the Citation M2. Finally, composite structures are less susceptible to corrosion, with lower scheduled maintenance costs.

The original HondaJet received US certification in 2015, with the improved Elite model following three years later. Major improvements added with the update include reduced take-off distances, along with increased range and payload capacity.

I accompanied Peter Kriegler, HondaJet's North America sales director, as he performed the pre-flight walkaround inspection of our preview flight aircraft – Elite model serial number 42000141, registered N256BB.

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Cockpit features a Garmin G3000-based avionics system and has an uncluttered feel

Visually, the OTWEM layout does take a moment or two to get used to. To my eye, the engines were mounted lower, more forward and more outboard than a conventional tail-mounting scheme would have dictated.

High quality

During the inspection, I marvelled at the superb fit and finish of the aircraft's exterior surfaces. The wing's polished heated leading edge glistened in the strong sunlight. Few if any fasteners protruded from the upper surface of the wing, having been milled from a single piece of aluminium. These two facets no doubt help to maximise laminar airflow.

As we neared the empennage, Kriegler highlighted the numerous holes drilled in the engine inlets, which reduce noise and vibration in the cabin. A single-point gravity fuelling port is mounted below the vertical stabiliser high on the tail cone. Part of the 213nm range advantage offered by the Elite over the prior model is gained by its tankage of an additional 61 litres (16USgal) of fuel. Rounding the tail, Kriegler pointed out the enlarged horizontal stabiliser and elevator, critical to the Elite's 135m (443ft) shorter take-off distance (sea level, standard day). While slightly lagging the competition at sea level, the HondaJet Elite turns the tables under hot and high operating conditions – 5,000ft and 25°C (57°F) – where it requires significantly less runway than its rivals.

Once on the left-hand side of the tail cone, Kriegler opened the external baggage compartment door. The opening was at a comfortable height, as there was no engine pylon to contend with.

With the walkaround complete, I entered the aircraft and surveyed the passenger cabin, which had a club four configuration and optional galley. As could be expected, the quality of the furnishings was very high. The HondaJet's cabin is longer than those of its rivals, with the length used to increase space between the facing seats. According to the manufacturer, they provide 200mm (8in) more leg room than the Phenom 100EV and 360mm more than the Citation M2. The enclosed lavatory was well appointed and featured skylights to provide an airy feeling. Uniquely for its class, it has a sink and is externally serviced.

Like the Phenom and M2, the HondaJet has a Garmin G3000-based avionics system. While all three types benefit from having three large 14in displays and two 6in touchscreen controllers, I found the HondaJet's flightdeck was a step above its rivals. Overall, it was clean and uncluttered.

Pre-start flows consisted primarily of ensuring all switches were in the NORM/ON position and rotary knobs placed at the 12 o'clock position. Kriegler guided me through the flight management system (FMS) initialisation process, as well as loading of weight and balance information. One nice feature was the take-off/landing distance management function, which combines FMS and XM weather information to compute and display performance data.

Ensuring all pre-flight steps were completed was facilitated by the electronic checklist and its yoke-mounted control, with a combined scroll wheel and select button.

As is typical for most FADEC-controlled engines, starting the two GE Honda Aero Engines HF120-H1As was a snap. During the taxi to San Jose International airport's runway 30L for departure, I found the steer-by-wire nose wheel steering (NWS) sensitive at slow

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Gerzanics, with the test example

Honda Aircraft HondaJet Elite specifications

Dimensions	
Length	12.1m
Height	4.5m
Wingspan	13.0m
Passenger cabin	
Length	3.69m
Width	1.52m
Height (flat floor)	1.47m
Baggage stowage (nose)	0.25cb m, 91kg
Baggage stowage (tail cone)	1.61cb m, 181kg
Weights	
Maximum take-off weight	4,853kg
Maximum landing weight	4,517kg
Useful load (excluding pilot)	1,645kg
Performance	
Take-off distance*	1,064m
Operating ceiling	43,000ft
Range**	1,438nm
Landing distance***	1,075m

Source: Honda Aircraft *MTOW, SL, ISA **4 occupants, MTOW, NBAA IFR ***MLW, SL, ISA

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Overwing engines increase fuel efficiency by reducing wave drag

speeds, but it did allow for tight turns on the ramp.

With the flaps set to take-off/approach (TO/APPR), take-off speeds for the 4,345kg (9,580lb) aircraft (including two occupants and 880kg of fuel) were: 104kt (192km/h), 109kt and 116kt. I was able to devote all my attention outside the aircraft when I taxied into take-off position, as the HondaJet has an automatic lighting system. This uses GPS information as well as aircraft speed, altitude and configuration to automatically manage the external lights.

Once cleared for take-off I advanced the thrust levers to the TO detent. Acceleration was predictably brisk as the HondaJet has the highest thrust-to-weight ratio of the aforementioned light jets. The speed-sensitive NWS made centreline tracking easy, with no tendency to over control.

At 109kt, light to moderate yoke forces were needed to establish a take-off attitude of approximately 15°. Once airborne I raised the gear and retracted the flaps passing 130kt. Past the departure end of the runway I turned the aircraft downwind for a visual circuit to what would be a full-stop landing. This short hop was flown for the benefit of our photographer on the ground, but would also allow me to gain a feel for how the HondaJet handled in the pattern.

On an extended downwind I lowered the gear and set the flaps to TO/APPR. Starting the turn to final I set the flaps to LDG, fully extended. I used FMS vertical path guidance to monitor my turning descent to final, allowing me to roll out on a 3° glide path for runway 30L. About 50% N1 on the engines held the fully configured HondaJet at the target speed of 109kt.

Situational awareness

Passing about 50ft radar altitude I retarded the thrust levers to IDLE. After initially over flaring, I lowered the nose and the aircraft settled nicely on to the runway. As I slowed the aircraft for runway turn off, the SurfaceWatch system announced “5,000ft remaining”. Even on a long runway in clear conditions, I found the callout helpful. For operations out of short/contaminated runways in adverse conditions, the SurfaceWatch system would no doubt greatly enhance situational awareness; a valuable commodity in a single pilot aircraft.

The second take-off was much like the first, but once airborne, I followed FMS guidance to track the TECKY 3 RNAV departure procedure. With the aircraft cleaned up, I set the thrust levers to the maximum continuous thrust (MCT) detent. I followed the default VNAV guidance, which held 210kt until transition to Mach 0.57.

For the latter part of the climb I engaged the autopilot and familiarised myself with the very capable G3000 system. One really impressive function was the display of active Temporary Flight Restriction areas. There were a good number of these along our route because of uncontrolled forest fires, and had we been lower they would have affected our flight.

On a standard day Honda Aircraft lists a time to 41,000ft at maximum take-off weight (MTOW) of 20min – faster than both the Phenom and M2. While we were about 450kg under MTOW, time from brake release to our levelling at 41,000ft was just over 21min. The longer time was the result of intermediate level offs and hotter than standard (ISA +15°C) conditions for the majority of the climb.

Level at 41,000ft I left the thrust levers in the MCT

Honda Aircraft HondaJet Elite versus competitors

	HondaJet Elite	Phenom 100EV	Citation M2
Cabin (L* x W x H)	3.69 x 1.52 x 1.47m	3.35 x 1.55 x 1.5m	3.4 x 1.47 x 1.4m
Cabin volume	6.29cb m	6.03cb m	5.61cb m
Accomodation	2 flightdeck + 5-6** (4 with optional galley)	2 flightdeck + 4-6**	2 flightdeck + 6 (belted lavatory standard)
Range***	1,438nm	1,178nm	1,302nm
Maximum cruise speed	422kt	406kt	404kt
Maximum operating Mach speed	0.72	0.7	0.71
Engines	2 x GE Honda Aero Engines HF120	2 x Pratt & Whitney Canada PW617F1-E	2 x Williams International FJ44-1AP-21,
Thrust	2,050lb	1,730lb	1,965lb
Take-off distance	1,064m	972m	978m
Landing distance	825m (5 occupants), 1,075m (MLW)	741m (4 occupants), 837m (MLW)	789m (MLW)
Thrust-to-weight ratio	38.3%	32.3%	36.7%
Wing loading, kg/sq m	295.9	259.8	217.8
Price	$5.3m	$4.25m	$5.31m

Source: Manufacturers MLW = maximum landing weight *Including lavatory **Belted lavatory optional ***NBAA IFR, 4 occupants

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Cabin (*top*) and tail-cone luggage compartment (*above*) can be larger without fuselage-mounted engines

detent, and allowed the jet to slowly accelerate. During the acceleration I took off my headset and was impressed by the sound of near silence. Kriegler and I were easily able to converse at normal voice levels. He remarked that the largest contributor to the ambient noise was the environmental control system fan, confirmed by the drop in sound when he turned it down to a slower speed.

Next, I noted the cabin altitude had levelled at 7,580ft. The airframer lists a cabin altitude of 8,000ft at 43,000ft for the 0.59bar (8.56psi) delta p system. After about 5min at (ISA+1°C) with an indicated airspeed of 208kt, total fuel flow was 680lb/h as the jet clipped along at a true airspeed of 405kt.

I then retarded the thrust levers to slow the HondaJet to long-range cruise speed. To ease pilot workload and increase efficiency in cruise conditions the aircraft has a cruise speed control (CSC) function. This uses the FADECs to modulate N1s (+/-5% from engagement condition) to maintain set speed. Once stable at M0.613 (177kt indicated airspeed – KIAS) I engaged the CSC. Total fuel flow of 480lb/h maintained a pace of 352kt true airspeed.

With four occupants, Honda Aircraft lists an NBAA range of 1,438nm, a capability borne out by my preview day observations.

Cruise points complete, we started a descent and allowed the HondaJet to accelerate to VMO; 270KIAS. I performed a series of sharp small control inputs in all three control axes, and the aircraft response was well damped.

The HondaJet's speed brakes are aft tail cone panels that open like clam shells, not the typical wing surface panels. To slow the aircraft below VMO I opened the speed brakes, which slowed us without the airframe buffet typically felt in other aircraft. One reason Honda Aircraft has placed the speed brakes on the fuselage may be to keep the wing's NLF aerofoil unmolested by moving panels and attendant surface gaps.

Next I engaged the autopilot to observe the G3000 system's overspeed protection scheme. In a slight descent I advanced the thrust levers to accelerate the aircraft past 270kt, into the barber pole of the primary flight display's (PFD's) airspeed tape. An audible ditter sounded with "MAXSPD" displayed on the PFD. At 275kt, the protection scheme activated, with the autopilot pulling the nose up to reduce speed below the redline.

Slow-speed safety

Satisfied with the HondaJet's high-altitude and high-speed characteristics, I continued the descent to see how it handled at lower altitudes and speeds. Our Elite was equipped with the optional Stability and Protection (S+P) system, with roll and angle-of-attack functions. This is mechanised through the AP servos and intended to help the pilot keep the aircraft in the optimal flight envelope.

The first function we looked at was designed to enhance roll stability. In level flight at 200kt I rolled the aircraft into a 45° angle-of-bank (AoB) turn. On the PFD, two "whiskers" were displayed on the roll arc, indicating when the roll protection would trigger. Rolling past 45° required increased yoke pressure. Releasing the roll pressure at an AoB greater than 45° caused the jet to roll towards wings level but stopping at 30° AoB. With the S+P turned off I was able to execute 60° AoB steep turns, with no additional roll pressure required.

To summarise, when engaged, the S+P system provides electronically enhanced positive spiral stability at bank angles greater than 45°.

The next mode we investigated was the underspeed protection scheme, active when the autopilot was engaged. In level flight I retarded the thrust levers to IDLE and observed the aircraft slowing. As the airspeed approached 98kt indicated "MINSPD" was displayed on the PFD, while "AIRSPEED" was annunciated. Pretending to be a distracted pilot, I just watched as the autopilot pitched the nose over to maintain a safe airspeed. It does this without regard to the engaged autopilot pitch mode – ALT HOLD in this instance.

These roll, high- and low-speed protection modes will stack the deck in favour of a safe outcome for a distracted pilot.

The final set of manoeuvres we accomplished were two approaches to stall. The first was in a clean configuration. Slowing in level flight at about 1kt/s the stick shaker activated at 106kt to signal an impending stall. In the shaker the wings were steady, with little if any airframe buffet. Smoothly relaxing yoke back pressure and advancing the thrust levers allowed the jet to recover to normal flight conditions.

The final approach to stall was in a landing configuration, gear down and flaps to LND. This time the shaker activated at 91kt, with the wings rock steady and no observed tendency to roll off. Recovery to normal flight conditions was again effected by lowering the nose and advancing the power.

Area manoeuvres complete, we turned towards San Jose for an autopilot-coupled instrument landing system approach to runway 30L. En route to the field I found the vertical profile display very helpful to comply with the altitude restrictions on the approach procedure. Outside HIVAK, the final approach fix, Kriegler simulated an engine failure by pulling the right thrust lever to IDLE. As we levelled at the glideslope intercept altitude I increased power on the left engine.

The HondaJet has a rudder bias system that uses the yaw damper servo to partially reduce pedal forces needed to compensate for asymmetric thrust conditions. The autopilot remained engaged and I used the PFD's slip/skid indicator to fine tune pedal displacement. Roughly 20kg of left pedal pressure was required to compensate for the asymmetric thrust condition.

The autopilot did a fine job of tracking the localiser and smoothly lowered the nose at glideslope intercept. With flaps set to TO/APPR approximately 50% N1 was needed on the right engine to maintain our target speed of 114kt. The rudder bias system was still active, but I did need some pedal to co-ordinate flight.

While Kriegler had briefed me that this approach would end in a missed approach, to demonstrate the HondaJet's coupled go-around capability, it was still a surprise when he called, "Go-Around" at decision height. I hit the thrust lever-mounted take-off/go-around switch and watched the autopilot smoothly pitch the aircraft to a 12° nose up attitude. As I advanced the thrust lever I fed in left rudder to maintain co-ordinated flight. At the TO detent (92% N1) approximately 35kg of rudder was needed to centre the slip/skid indicator.

The rudder bias system kept the needed force well below regulatory limits and would have mitigated the adverse effects had the pilot been slow in proper application of the rudder. With a positive rate of climb I raised the gear, retracting flaps as we accelerated through 130kt. Once the aircraft was cleaned up, we terminated the single-engined manoeuvres.

Go-arounds are a normal but infrequent manoeuvre. The HondaJet's coupled go-around capability is a definite safety enhancer, automating what can be a very demanding procedure.

Bigger, longer, faster

With a slight sigh of relief, having safely executed a single-engined approach and missed approach, I punched off the autopilot and used both engines to enter a visual downwind for runway 30L. The HondaJet's pleasing handling qualities made the visual circuit to a full-stop landing a joy to fly.

Once on the FBO ramp, shut-down procedures were minimal and rapidly accomplished. My 2h at the HondaJet Elite's controls had allowed me to see first-hand its strengths.

Honda Aircraft has set the standard for light jet cockpits. Optimised for single-pilot operations, the HondaJet Elite's G3000-based flightdeck offers a level of operational integration unmatched in its class, with pilot workload further reduced by the automation of routine tasks. The innovative OTWEM configuration reduces drag and increases range, while simultaneously allowing for the largest cabin in this class.

The NLF wing has a heavier loading than its rivals, helping it to cruise faster and offer a smoother ride in turbulent conditions. The HondaJet Elite's enlarged horizontal stabiliser and elevator have brought take-off distances more in line with those of its rivals, but a few may find landing field performance a concern.

Subjectively, I found the HondaJet Elite the most enjoyable light jet I have flown. Objectively, its large cabin, high cruise speed and long legs push it to the top of its class. For those driven by passion and performance the choice is clear: the HondaJet Elite.

Steer-by-wire nose wheel actuation allows for tight turns while taxiing