

X-76: A New High-Category Tiltrotor Stepping Into the Spotlight

Recently, I had the honor of receiving the latest issue of the Newsletter from BELLFLIGHT.COM. It reported good progress in developing the next-generation version of the famous tiltrotor family behind the V-22 Osprey and the V-280 Valor. The actual report is here:

<https://news.bellflight.com/en-US/263055-bell-completes-critical-design-review-on-darpa-sprint-x-plane-program-receives-official-x-plane-designation/>

A great artistic rendering of the aircraft concept is added to the story, which—most probably—will generate a mass of comments from readers. The presented new stop-fold rotor technology has made me too want to comment.

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The main concept behind the X-76 design seems uncomplicated. The small table included below with basic performance data for the future tiltrotor indicates that the aircraft remains subsonic. Additionally, the transport functionality that both the V-22 and the V-280 tiltrotors have remains the same. Therefore, the changes in the X-76 propulsion system serve some other purpose.

All modifications to the propulsion system seem aimed at addressing known proprotor issues of the V-22 and the V-280 tiltrotors. For example, blades are not only stop-and-fold, but most likely have a much lower blade twist than predecessors. This make low-speed flight (vertical takeoff and landing, and hover in particular) more stable and safer, particularly from vortex ring state (VRS). Such proprotors however cannot work well at high cruising speeds; therefore they stop first and then fold.

To maintain or slightly boost top cruising speed, the X-76 utilizes a separate turbofan (turbojet?) propulsion system, which becomes dominant as soon as the proprotor blades have folded.



The **Bell X-76** (part of DARPA's SPRINT program) is not a supersonic aircraft; its planned top speed is approximately **Mach 0.7 to Mach 0.8**.

The aircraft is designed to achieve cruise speeds between **400 and 450 knots** (roughly 460–518 mph or 740–833 km/h). At typical cruising altitudes, 450 knots equates to roughly Mach 0.75–0.80, which is near-jet speed but below the sound barrier (Mach 1.0).

Key Performance Specs

- **Cruise Speed:** Over 400 knots (460 mph).
- **Maximum Targeted Speed:** 450 knots (518 mph).
- **Mach Range:** High subsonic, typically around **Mach 0.7–0.8** depending on altitude.
- **Propulsion:** Hybrid system using "stop-fold" rotors for vertical takeoff and a jet engine for high-speed cruise.

Unlike historical Bell X-planes like the **Bell X-1** (the first to break Mach 1), the X-76 focuses on combining **vertical takeoff and landing (VTOL)** with the speed of a fixed-wing jet to support missions where runways are unavailable.

https://stallfreepropellers.com/wp-content/uploads/2026/03/The-Bell-X-76-part-of-DARPA-s-SPRINT-program-is-not-a-supersonic-aircraft_01.png

The good news? The "old" proprotor issues are fully eliminated by this new concept. However, this comes at a high cost. The prototype image does not reflect the horrible complexity that folding blades require both mechanically and in terms of controls. Also, the additional turbofan propulsion introduced for cruising flight is essentially duplicate that doesn't increase the level of useful redundancy in the aircraft. (A duplicate but no redundancy!)

The Fundamental Aerodynamic Compromise

It is important to understand that all hardships of the V-22 performance are rooted in one single problem — also called the aerodynamic compromise of the current V-22 proprotor blade design.

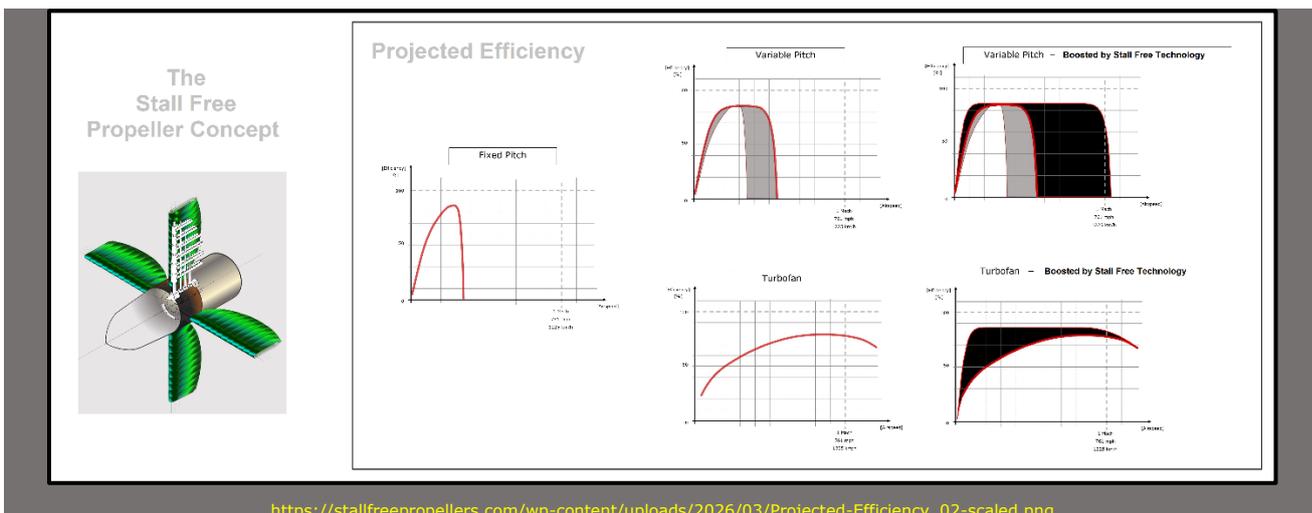
The current V-22 proprotor blade design represents a fundamental aerodynamic compromise—a high fixed twist (around 45–47.5°) optimized for high-speed cruise (as a propeller) but causing deep stall on the inboard sections during hover, low-speed maneuvers, and certain descent profiles. This contributes to lower hover efficiency, higher downwash/outwash, increased vibration/noise, and susceptibility to VRS precursors.

The X-76 concept avoids this by simply not using “universal” proprotors. To ensure good stability at low speeds, proprotors with low blade twist (checked visually on the rendering) are applied. These are in fact small-diameter helicopter rotors. At high-speed cruising flight these rotors simply get tucked away. For airplane flight mode a turbofan (turbojet?)—based cruising propulsion is activated. Turbofans are great engines with good efficiency figures also for high speeds.

We know companies like Bell, Boeing, and DARPA are sure capable enough to accomplish even such a complex task as building the X-76 according to this concept. Still, instead of embracing all this complexity, considering another engineering decision—based on a single blade-swap upgrade of the original V-22 system capably eliminating the aerodynamic compromise—may seem extremely attractive.

Note that for quite some time I have been advocating the adaptive rotor blade concept described in the US-11975816-B2 patent, which promises exactly this. See a full analysis at www.stallfreepropeller.com.

For a reminder about the effect the adaptive blades make on propeller characteristics, a theoretical chart is included below. (Turbofan diagrams within may also have a relevance to the present X-76 story.)



Competition

This should probably been my first argument. The new tiltrotor makes its entry in a highly competitive environment. Although the manufacturer is smart enough to effectively handle the complexity of its design, it may seem unwise to skip an obvious advantage that rivals would be happy to exploit.

We know the V-22 design has been around for several decades. Competitors can copy it anytime—some have already started doing so. If my statement about the aerodynamic compromise is accurate, then it would only require to perform that special “blade-swap upgrade” on the existing proprotors to completely ruin the superiority of the X-76!

Moreover, by removing the proprotor blade stall linked to the aerodynamic compromise, we don't just get better flight performance, but also eliminate all the sensors, actuators and control systems currently aimed at compensating, stabilizing and mitigating that unwanted blade stall. This means great reductions in system complexity. And in weight.

Chances are that competition, using an old but upgraded V-22, will beat the X-76! Of course, I could be wrong...

