Boeing 737 Takeoffs: Not So Simple
By Stu Simpson

I was near Calgary's airport one recent evening and watched a Westjet Boeing 737 takeoff. Seeing the jet climb out southbound sparked memories of when I got to "fly" a full motion 737 simulator. Fellow club member Wade Miller, a senior Westjet captain, afforded me that rare and terrific opportunity. I recalled from our sim session that the 737's takeoff power settings are handled quite a bit differently than the way we handle takeoff settings in our planes.

I called Miller and asked him for some more details since my memory of them had faded. He provided those details which quickly underscored how the seemingly simple act of departure in a 737 isn't simple at all. Here's what Miller taught me.

The 737 doesn't have throttle levers, per se; it has thrust levers. Think of them the way you'd think of the throttles on piston-powered airplanes; they control the amount of thrust the engines produce and how fast the airplane travels. At takeoff on a typical piston-engined airplane the pilot advances the throttle steadily to its maximum travel and usually keeps it there through the entire takeoff and climb phases of flight, though there may be a reduction on climb out. It doesn't work that way on a Boeing.

737 pilots nearly always perform reduced thrust, or de-rated, takeoffs. The takeoff thrust is usually set to somewhere between 88 and 92 percent.

Here's what happens. Prior to launch, the flight crew enters numerous parameters into the jet's flight management computer, or FMC. This includes data on airport location and elevation, runway length and condition, takeoff weight, wind, temperature, and more. The FMC then decides the optimal power setting for takeoff.

When it comes time to roll, the pilot flying will spool the engines up to 40% thrust, let them stabilize and begin the takeoff roll. Keep in mind that a bunch of other things are also happening right then, but we're only focusing on the power aspect. At the appropriate time in the roll, the pilot selects the TOGA switch. TOGA stands for Takeoff & Go Around. This moves the

thrust levers to what the FMC determined as optimal for that takeoff, and before long the Boeing has once again created the magic of flight.

So why not use full power on each takeoff? Miller explained it to me.

Jet engines, as well as turboprops, have a lot of power; sometimes too much (if such a thing really exists). If the crew selects full thrust at takeoff, also known as 'max rated', the airplane's nose-up pitch angle would be far too excessive to maintain noise abatement criteria and vertical departure criteria. The engines simply make more noise when they make more power.

Though unlikely, using full power could in some situations endanger the airplane. If a crew uses max rated, and forgets to retract flaps and slats as the plane accelerates through those devices' limit speeds, they risk getting damaged. And don't forget about the 250 knot speed restriction below 10,000 feet.

But the biggest reason for de-rated takeoffs is to save on fuel and engine wear. Going with max rated thrust is hard on the engines and sucks lots of kerosene. The thinking is that if there are no challenges such as a short runway, or other climb requirements like surrounding terrain to clear, crews can reduce the thrust, and thus reduce costs and engine wear.

"Sometimes our hands are tied, though," Wade told me. "If we're heavy, have high temperatures and/or short runways," - conditions frequently found in places like Kona, Hawaii, or Kahului , Maui – "we'll use max rated." He said crews may also use max rated when the runway is contaminated with a lot of snow or slush, or when wind shear is present.

"I'll tell you," Miller added, "using max rated thrust is a handful. Don't get me wrong; it's also a lot of fun. But it's challenging to manage all that power."

It can scare the passengers, too, due to the increased deck angle and the higher noise level. It's not mandatory, but Miller said some crews make an announcement to the guests in the back before using max rated. It's that extreme. Pilots will reduce the power from max as soon as they can once airborne.

There’s another factor Wade mentioned that I hadn’t expected. “Sometimes when we’re about to roll on a good VFR day, tower will instruct us to maintain visual separation with the aircraft that just departed ahead of us. We can’t see that traffic over our nose if our climb angle is too high on a high power takeoff.”

The amount of thrust a Boeing crew uses can really vary. “The lowest I’ve ever used is 76%,” Miller said. “That was leaving Victoria with only 30 passengers on a cool, calm night on a short trip to Calgary.” The maximum allowed is 101.5%, but using that setting rarely happens.

Piston pilots typically takeoff with as much power as they can generate. Once established in the climb, a pilot might bring back the power to save a bit of gas and ease up on the engine. What may seem counter intuitive is that 737 pilots actually increase power as they climb. Once the jet is clear of the noise abatement altitude, usually 3000 feet AGL, crews can spool up to increase their climb and more quickly reach an efficient cruise altitude.

Power-to-weight ratios on piston singles occupy very little space on performance charts and offer relatively few options overall. On commercial jets the power-to-weight ratios and performance ranges are by design huge, and provide pilots and airlines with a lot more variables to maximize their efficiency.

Try this: Next time you have a long paved runway ahead of you, set your takeoff RPM to two or three hundred less than your typical full throttle setting. You’ll likely be surprised how little difference it makes on your takeoff roll. But, your fuel burn, noise level, and engine temperatures will be noticeably lower, especially for those with larger engines and higher power-to-weight ratios. Obviously, be careful with this practice and throttle up to full power immediately if you realize you need it.

This likely shouldn't be a common practice on recreational airplanes. There's not always an excess of power in recreational aircraft, and Calgary normally has higher density altitudes than most places in Canada. But in commercial aircraft like the big jets, it’s a very good thing to have all that excess power available. That just makes things safer, and more efficient, all round.