Landing the Q400
Update
Version 7

Written by a Q400 Captain with 5 YRS Q400 experience
Name withheld to avoid complications

BACKGROUND TO THIS UPDATE

I wrote the original, unofficial discussion / opinion paper, attached below, about 1 year ago.
Since then, I have sought to improve and learn from other pilots and refine the lessons and ideas that I put into that paper. This update includes some new ideas as well as some refinement of those ideas already documented. These notes are a collection of my latest thoughts. I do not claim they are the best ideas around, just that they work and are the best ideas I know of.

The original is too wordy, lacks diagrams and needs a rewrite. But I could not be bothered, so I have just added this six page update to the start of it.

The first six pages update the original notes. The update covers:

1. Approach path management flap 15 and 35
2. Flare technique Flap 15
    - I find the new Flap 15 approach technique both simpler and more effective than the previous technique.
3. It does not update the Flap 35 flare technique.
    - I still use the '15 foot eyeballs' technique to land Flap 35, as discussed. I have found that it is a robust, by the numbers technique that I have not needed to modify.

Q400 APPROACH TECHNIQUE – ALL FLAP SETTINGS
POWER AND ATTITUDE = PERFORMANCE

The aim of the approach is to fly a stable approach (glideslope and airspeed) to a smooth, accurate landing.

I have watched many people chasing airspeed and glideslope down finals, to satisfy this requirement. They constantly change the pitch and power in a diligent effort to achieve and maintain airspeed or glideslope. By the time they touch down, they are unhappy and exhausted.

<u>Confession / Sacrilege #1</u> – I do not fly airspeed or glideslope down finals (but don't tell anyone). In fact, on final approach, the airspeed indicator is only a secondary part of my scan. Now, before you have me arrested for my crimes against aviation, allow me to explain myself.

The fact is, <u>***no one has ever flown airspeed down finals***</u>, they just think they have. When on finals, the pilot holds the pitch lever (pitch attitude) in one hand and the power levers in the other. Therefore, all pilots fly power and attitude, whether they realise it or not. Flying airspeed down finals is a myth. Those who say they do are actually just chasing performance and making life hard for themselves.

We were all taught that <u>chasing performance is a bad idea</u>, and not the right way to fly. This, in my humble opinion, is half the reason that some pilots find the Q400 hard to land. It is absolutely unforgiving of poor technique. The other half of the reason people find the Q400 hard to land is that they <u>try to correct excessive sink rate with pitch</u>. They end up slow, low on energy, with a high pitch attitude and a high sink rate into the flare, resulting in a heavy landing or tail strike. This condition is obvious beforehand. The solution is to apply power and go around.

On finals, we should consciously set and hold a pitch on the AH/Sight Picture and torque (the only two things we directly control), assess their effect on performance (secondary scan – airspeed, aim point and PAPI), and make deliberate, accurate and timely corrections as required.

In fact, pitch should remain relatively fixed, with only power changing (quite a bit at times). The airspeed will vary about a mean but that is OK. Chasing it will destabilise the approach. The approach technique is thus reduced to just one moving part. Realising that this is actually how to fly the Q400 down finals will make the whole experience much more satisfying, as you will finally feel in control of what is happening. It works.

CONTROLLING AIRSPEED AND GLIDESLOPE

Primary Effects on Final

Pitch (reference the AH or sight picture) controls airspeed

Gust factors aside, if airspeed is unstable on final, it is (paradoxically) because you are looking at the airspeed indicator, rather than setting and holding the correct pitch on the AH, and crosschecking the airspeed indicator

Power controls glideslope / aim point / sink rate / PAPI.

The PAPI is a very obvious and good indicator of how your power setting is working.

It is quite easy to feel the sink before you see it, using this method, and correct it early, with a trickle of power

Secondary Effects on Final

The secondary effect of pitch is glideslope and the secondary effect of power is airspeed. This may not be as obvious in other aircraft, but in the Q400 the primary effects are strong and the secondary effects are weak.

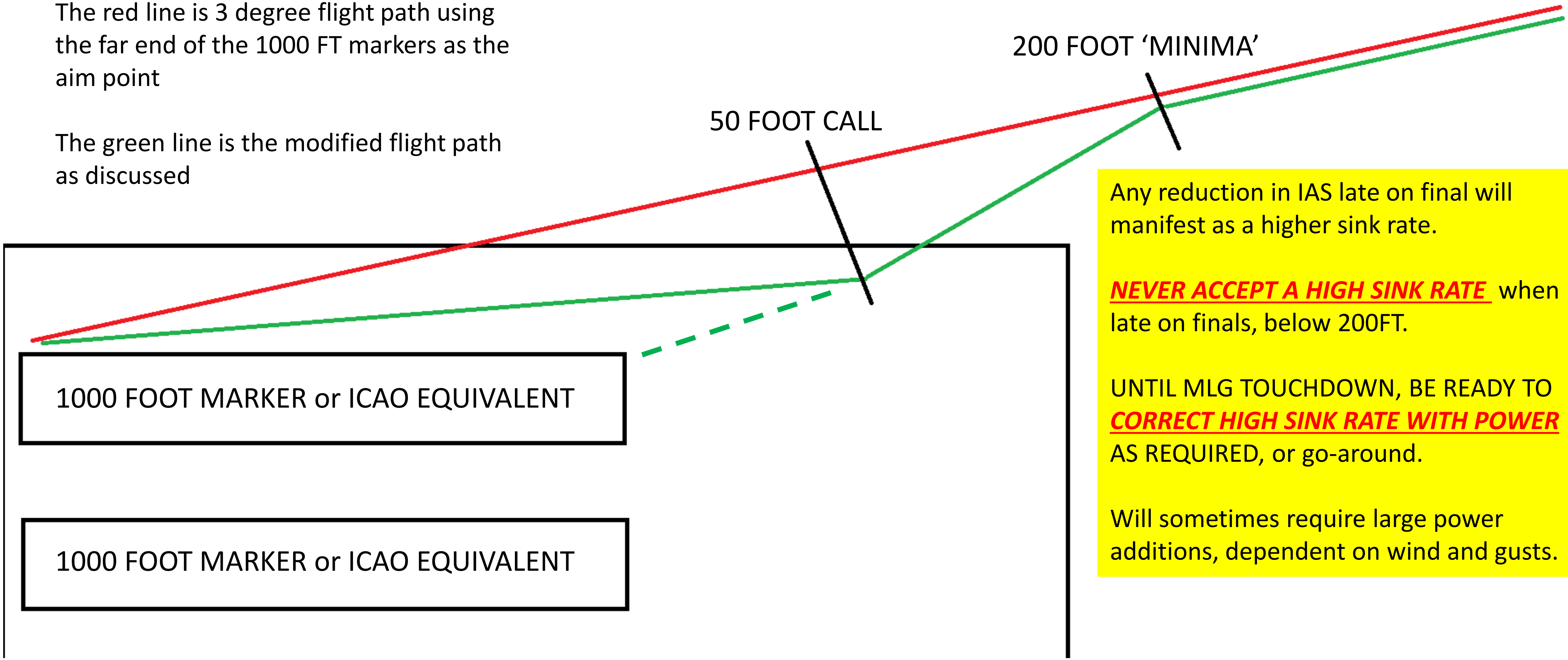
I do use pitch to fix glideslope and power to control airspeed, but only to fix gross errors and only to complement the primary inputs I have already made. Once I am in the groove, I don’t need to do it.

Once I have stabilised my approach path, my primary scan down finals is pitch and power. My secondary scan is airspeed and PAPI/aim point. I find this a simple and effective technique that works day or night and in any weather conditions. Power, attitude and environmental factors control the three major forces that effect the flight path on finals. We control two of these forces and must remain responsive to changes caused by the third.

FLAP 15 APPROACH AND LANDING

The red line is 3 degree flight path using the far end of the 1000 FT markers as the aim point

The green line is the modified flight path as discussed



Any reduction in IAS late on final will manifest as a higher sink rate.

NEVER ACCEPT A HIGH SINK RATE when late on finals, below 200FT.

UNTIL MLG TOUCHDOWN, BE READY TO ***CORRECT HIGH SINK RATE WITH POWER*** AS REQUIRED, or go-around.

Will sometimes require large power additions, dependent on wind and gusts.

- Fly straight down the 3 degree flight path to 200 FT using the far end of the 1000 FT markers as the aim point.
- At 200 FT, move the aim point to the near end of the 1000 FT markers. Leave power set (but power as required for sink rate).
- At the 50 FT callout, move the aim point back to the far end of the 1000 FT markers.
- This modification to the flight path slows down the last 50 FT of descent, into the flare, without compromising the original aim point or energy state. Very subtle and simple but remarkably effective. Power as required to maintain flight path.

‘15 FT EYEBALLS’
MY FLAP 35 LANDING TECHNIQUE

- I take Flap 35 at 1500ft AGL, as it gives me extra time to set up and stabilise the landing. I only tend to do flap 35’s when practicing for, or executing a challenging landing to a short runway.
- My favourite Flap 35 landing technique is to hold my aim point at the start of the 1000 FT markers down finals and listen to the callouts. Note – this is different to the Flap 15 aim point.
- (P.S. power off 3-4% Tq, Flap 35, through 100FT or your aim point will move up the runway. I presume that this is due to ground effect)
- By listening to the timing of the 50, 40, 30, 20 callouts, I judge when the 15FT call would be made.
- At this point, using peripheral vision, I note my eyeball height above the ground.
- I then ease back on the control column to hold my eyeballs at that same height and, once I am holding my ‘eyeball sink rate’ at zero, I reduce the power (amount dependent on energy state) and allow the MLG to sink down onto the runway. PITCH FIRST, POWER SECOND.
- I have found this technique to be the basis for good, consistent, smooth STOL landings.
- The one ‘danger’ of this technique is that, if you do it too high (20 FT) you can exceed 5 degrees pitch prior to main gear touchdown. For this reason, you need a good idea of what 5 degrees looks and feels like so that you don’t exceed it (the 5 degree call from the PM is a last resort). In this case, allow the aircraft to ‘fall’ the last few feet (control the ‘fall’ with power), while holding 5 degrees.

LANDING THE Q400

The Original Notes

- These are general and unofficial notes on Q400 landing techniques and ideas.
- They contain my opinions and are intended as discussion points only.
- They are intended to assist in answering the question – What techniques should I use so to consistently land the Q400 within the stable approach parameters, and why?
- They are based on many years of practical experience and discussions with many pilots, flying and landing the real aircraft in real situations.
- Flaring and Landing the Q400 is an inexact science and, unless otherwise stated, these techniques are guaranteed to probably work most of the time. No one I've seen gets it right all the time.
- These notes are a guide only. Do whatever works to achieve a stable approach and comfortable touchdown.
- The US Navy approach technique is to hold an absolutely fixed angle of attack all the way down finals and use small power changes to maintain glideslope and aim-point. Therefore, once established on finals, their (ideal) stable approach technique has only 1 moving part. i.e., Hold a fixed angle of attack (pitch) and use minor power changes. I have found this technique to be the basis for consistent stable approaches in the Q400.
- A stable approach maximises the chance of a smooth and accurate landing.

Q400 BASIC DESIGN FEATURES AND LIMITS

- General
  - The correct landing techniques need to account for the features of the Q400, as well as local environmental factors.
  - They should prevent any chance of a heavy landing.
  - They should be simple, repeatable and involve a minimum of moving parts.
- Big Engines
  - The Q400 has powerful and responsive engines
  - Small (1-2%) torque changes have a large effect and
  - large changes (5%+), if left uncorrected, can tend to destabilise an approach very rapidly.
- A long fuselage.
  - The long fuselage limits the maximum pitch that can be used in the flare and landing.
  - The total pitch change during approach and flare is no greater than 4 degrees if Flap 15.
- A relatively small and highly loaded, ‘dagger-like’ wing
  - The combination of low speed on approach, small wing and restricted pitch range means that pitching, late on finals, can only have a limited and sluggish effect on the approach path.

Q400 BASIC DESIGN FEATURES AND LIMITS

- Landing Gear
  - The main gear is not trailing-link and is quite unforgiving.
  - It feeds all the landing impact shocks directly into the wing structure and fuselage (and passengers).
  - The only way to consistently have smooth-ish landings is to fly the aircraft onto the runway rather than flaring it onto the runway.
- Momentum
  - The airframe has considerable momentum and adjusting the flight path, especially at low speed, takes time and height.
- Fly By Wire
  - The Q400 pitch feel, power and rudder feel are fly by wire and this limits and distorts the feel of the aeroplane. When flying the 200/300 you feel real control forces in real time. In the Q400, the control forces are artificial and delayed, and this takes time to get used to.
  - Unlike the Q200 or 300, you cannot fly this aircraft using the seat of your pants. You fly it primarily with your eyes and a disciplined scan.
  - This limited, delayed and artificial feel is a good reason to strive for a simple approach and landing technique with as few moving parts as possible.

Q400 BASIC DESIGN FEATURES AND LIMITS

- Q400 / Bugsmasher Differences and Flare Techniques
  - Bugsmashers tend to have big fat wings, tiny little engines, low momentum and a large pitch range in the flare.
    - So you can pull the power off at the start of the flare, initiate a large pitch change, and use the wing to arrest the sink rate.
    - Bugsmasher approach path control and flare techniques tend to be 70% wing and 30% engine.
  - The Q400 has a small, thin and highly loaded wing, big effective engines, high momentum and very limited pitch range in the flare.
    - The Q400 approach path management and flare technique is 70% engine and 30% wing.
    - Q400 pilots must un-learn Bugsmasher techniques for flaring and correcting excessive sink rates, as they are opposite in the Q400.

HEAVY LANDINGS IN THE Q400

- An excessively high sink rate is the last thing that happens prior to a heavy landing.
- Preventing or correcting an excessively high sink rate it is the key to preventing a heavy landing.
- An excessively high sink rate is very obvious to anyone who is looking out the front window.
- Trying to correct a high sink rate, late on finals and at low speed, by ‘pitching up’ by just a few degrees is almost useless. The sight picture changes but the approach path doesn’t, and the aircraft will tend to keep descending at a high sink rate onto the runway.
- Power + Attitude = Performance. If very little Attitude change is available on approach in the Q400, then Power must become the primary method for controlling the approach path (Performance).
- The only way to correct a high sink rate late on finals, in the real aeroplane, is by immediately applying power as required (it may require a very large power change, very late) to achieve the desired effect (look out the window and see the sink rate reduce).
- The first effect of this power change is to immediately reduce the sink rate. It will not result in a significant airspeed increase unless the power is left on after the sink rate has reduced. A small increase in pitch can be initiated after this power application and subsequent correction. This technique is immediate and effective and guaranteed to prevent a heavy landing.
- Pitch has some limited and delayed effect on sink rate but power has a large and immediate effect on sink rate.

- In my opinion, Q400 pilots must look out the window, hold the sight picture and shape of the approach constant, and not allow an excessively high sink rate to develop, especially below 200 FT on finals and into the flare, without immediately correcting it by applying power as required.
- Until they have conditioned themselves to do this, they are susceptible to heavy landings.
- Pitch is somewhat important but has limited effect. Powering out of excessive sink rates late on finals, or in the flare, is <u>guaranteed</u> to prevent heavy landings. It can lead to a go-around (rare), but it will have prevented damage to the aircraft.

‘Q400 HEAVY LANDING - GET OUT OF JAIL FREE CARD’

<u>POWER-OUT OF EXCESSIVE SINK RATES,</u>
<u>ESPECIALLY LATE ON FINALS OR INTO THE FLARE.</u>

You can get everything else totally wrong and out of shape (i.e. pitch, airspeed, aim point, torque), but then save yourself from a heavy landing / tail strike on landing with this one action.

(If in doubt, add power. If necessary, go around. Could it be any simpler or clearer?)

- Why don’t I aggressively chase the IAS and why do I stress approach shape in the last 200 FT, power and pitch?
    - It is because, if the approach has been stable and it holds its shape through the last 200 FT, and your pitch and power stay relatively constant, then IAS can not vary by that much.
    - If external factors do effect the approach path, the sink rate and aim point will change, and these changes will be obvious to anyone concentrating on maintaining a constant sight picture.
    - Also, you can have everything correct and yet the environmental factors can cause an increase in sink rate that must be corrected. This is done by holding everything else constant and just adding power as required.

ENVIRONMENTAL EFFECTS

- The Boundary Layer Effect.
  - If you are at 500 FT on finals into an airfield surrounded by flat terrain, then the wind speed you are experiencing is likely to be relatively laminar flow and unaffected by ground features.
  - The same is true landing in Horn Island RW 08, where the prevailing South Easterly wind has spent the last 3000KM over the Pacific Ocean and is laminar flow right down to the sea surface.
  - Once you get to 50 FT or less, you enter the boundary layer where the trees etc. surrounding the runway effect the wind and slow it down. So, it is normal to have about a 5 KT reduction in airspeed, sometimes significantly more, when descending through about 50 FT in light to moderate winds. This occurs very late and results in a sudden loss of IAS and can cause a sudden and dramatic increase in sink rate, just as you are commencing the flare. The only way to fix this is to add power as required to hold the shape of the approach (sound familiar).
- The Temperature Effect.
  - In remote areas, on hot and clear days, the (black) runway can generate significant thermal activity. The air is sucked in from around the runway and gets lifted once it is over the runway surface.
  - This is most noticeable in light headwinds.
  - This effect causes the wind (and therefore stable IAS) at 500 FT to be about 5 KTS more than it is close to the ground. The air gets drawn in and down, from behind the aircraft, late on finals.
  - This effect seems to increase sink late on finals and reduce the headwind (and therefore IAS) by up to 5 KTS.
  - This effect has been noticed from 400 FT on finals and is easier to see late on finals.
  - Wait for it and add power as required to hold the shape of the approach.
- Ref+10 on Approach.
  - Due to the above environmental effects, when flying into these types of airfields, you can expect an increase in sink and a reduction in IAS of about 5KTS at or about the flare.
  - So, flying Ref+10 down finals, in the relatively stable and unaffected layer of air, and holding everything steady and constant into the flare, will normally result in touching down at Ref+5 or thereabouts.
  - If these effects cause an increase in the sink rate late on finals, then look out the front and add power as required to hold the shape of the approach.

1000 - 700 FT AGL (SETUP)

- Get configured with checks done and a stable speed (Vref+10), power setting and pitch by 1000 FT (700 FT at the very lowest), on PAPI, with a fixed aim point (the start of the 1000 FT markers). From this point it is a matter of keeping the approach 'on the rails' and absolutely constant, with as few 'moving parts' as possible.
  1. Glideslope – The first constant (establishing these constants early and keeping them fixed, reduces the moving parts and workload in the approach)
     - Firstly, get onto a 3 degree glideslope and then stay on it.
     - Use pitch, power or whatever to achieve this quickly. This far out, you can make big aggressive changes.
  2. Aim Point – The second constant
     - Fix the aim point at the start of the 1000 FT markers and then don't let it move an inch, until the flare.
     - It defeats the purpose of flying Ref+5 all the way down finals if you allow the aim point to wander down the runway.
  3. Speed – Achieve Vref+10, +/-5
     - Ref+10 is a good start point, in the middle of the speed range, and allows you to get a feel for the approach without working too hard.
     - Once established, a 5 knot reduction will normally happen by itself late on finals due to boundary layer environmental factors., discussed previously.
  4. Pitch – The third constant. Collectively, these 3 constants (Glideslope, Aim Point and Pitch) are the sight picture, which itself should remain constant.
     - While at Vref+10, note the deck angle, view and pitch (approx. 1 degree nose up, F15 and 4 degrees nose down F35).
     - Hold this pitch constant, all the way down final. This will help keep the speed at approx. Ref+10.
     - The speed will vary, but so long as it fluctuates around Vref+10, +/-5, don't chase it.
     - Chasing the speed aggressively with power or pitch will destabilise the approach. The aim for the entire approach phase is to hold a constant shape (airframe deck angle, glide path and aim point) and allow the speed to hunt around an average Ref+10.
     - If the IAS is consistently high or low, adjust pitch.
  5. Power – Approx 15% Flap 15, 25% Flap 35, + 2% if props are 1020.
     - For each landing situation, there will be one specific torque setting that will hold the approach stable in ideal conditions. Use trial and error each time to determine this exact power setting. For flap 15 landings, I have seen it as low as 11% and as high as 20% depending on weight, wind and prop RPM. Getting this setting right, making small changes and returning to it every time the approach is back in shape, is the biggest key to a stable approach.
     - Use small power changes to hold the aim point constant
     - Try to feel and correct flight path changes before you see them, and aim to use small power changes and scan the torque gauges.
     - Power should be stable in smooth conditions. Power should not need to vary by more than 1-2% except to correct changes in wind or sink.
     - Scan the torque gauges to return to this exact power setting each time the approach is 'back on the rails'.
  6. Stable – From here on in, keep the sight picture constant and stable and use small power changes to make small glide path corrections.
     - In making large glideslope high/low corrections, I tend to find that I lead with power and use it to make most (70%) of the correction, and then follow up with small pitch changes to make the last, small (30%) of the correction. I tend to use both power and pitch to make large flightpath corrections.
     - My scan tends to be sight picture (glideslope, aim point, pitch), torque, sight picture, IAS/Pitch, sight picture, torque, etc.

500 FT AGL (PUF CHECKS)

- I do the following at about 600 FT so I am just ahead of it
  - PUF Check
    - Props, Undercarriage, Flaps
    - In my case I check
      - Props (condition lever position)
      - Props (RPM)
      - Bleeds (ED BLEEDS annunciation is white, not yellow, meaning the Bleed Selector is at Min, not Norm)
      - Undercarriage (3 greens)
      - Flaps (set correctly)
      - Clearance (Taxi Lt On)
    - Now you see why I start it at 600 FT
    - I don’t do it all at once but look out the front and glace in momentarily at one thing at a time.
- Continue flying the stable approach to the fixed aim point, using only small changes in Torque and keeping the sight picture and everything else fixed.
- Once through 500 FT, the aim is to arrive at 200 FT at or slightly below Ref+10 and not above glideslope.

200 FT AGL

- This is the end of the approach segment for me. There is no further chance of bringing the aim point closer to you and it is time to begin shaping the approach path, energy state and pitch for the flare and landing.
- Up until this point I may have made large changes to torque to hold my aim point, correct airspeed or adjust sink rate. At 200 FT, unless those things are under control, its time to think about going around.
- At this point I tend to accept wherever my aim point is, if it has moved up the runway, and then shape the arrival to that point as best as possible. I cease to chase the ideal aim point (with power) and just accept the actual aim point. If this aim point is outside the acceptable criteria for that landing, its time to think about going around.
- At 200FT I look at the torque gauges and reset my torque to the 'fixed' approach setting I determined at the start of the approach. This setting should keep me in the ballpark for the last part of the approach and, if its not quite right, it will not have time to significantly effect the shape of the landing. The only reason I would change this torque setting significantly is to increase it to prevent or correct an excessive sink rate, and then reduce it again. Of course, if my speed is tending low or high I would adjust the torque for that as well.
- Most of the runways we land on are not marginal in length and so the consequences of carrying a little too much speed (5-10 KTS) are small, and may lead to a go around after touchdown at worst. However, the consequences of arriving too slow are much more significant, as you may end up with a high sink rate into the flare, potentially leading to a heavy landing (corrected by adding sufficient power as discussed).

50 -10 FT AGL

- Hold the aim point and shape of the approach down to 10 FT or whatever your landing technique requires.
- If you are on a 3 degree glide path at 120 KTS you are descending at about 10 FT per second.
- Therefore, the callouts 50, 40, 30, 20, 10 should occur steadily and about 1 second apart.
- If they do, then you have done a good job and should have a reasonable landing.
- If they come faster than that, you are descending too fast, (add power).
- Somewhere in this segment, the boundary layer effect normally happens and you can expect to lose about 5 KTS airspeed.
- Watch the sink rate and don’t allow it to increase (add power).

10 -0 FT AGL
‘FLARE’ and TOUCHDOWN

- I initiate the flare at or just before the 10 FT call, with a small pitch change, increasing to 5 DEG nose up, and use power (i.e. leave the power set, or even add power) to arrest the sink rate.
- In a crosswind landing, I remove the crab at about 30 FT and never take the power off.
- Once the sink rate is approaching zero, trickle the power off into the touchdown with 5 DEG pitch. 5 degrees is the ideal pitch for a smooth touchdown. This is the only technique that I know of that will consistently set up a relatively smooth touchdown, more often than not, in most environmental conditions. I effectively fly the aircraft onto the runway, in a low and stable energy state.
- Low energy, low power setting and excessive sink rate at the start of the flare in the Q400 is a recipe for a heavy landing. In this case, add power as required.
- Once the MLG is down, select DISC and lower the nose.
- Having the power levers at Flight Idle just before touchdown is not always possible but it does have a significant effect on the landing roll if it is achievable, especially if the props are at 1020. This is because, upon selection of Disc, it takes less time (a few seconds less) for the props to get to Disc if they start at the low pitch stop (i.e. Flight Idle) and these few seconds, at a high groundspeed, make a noticeable difference to the overall landing roll.

ROLLOUT

- I tend to get on the brakes to warm them up and reduce speed to 50 KTS.
- I do this to prevent overruns and start the next phase of the roll.

TIPS ON SHAPING THE APPROACH PATH BELOW 500 FT

- At 200 FT, being high, fast (greater than Ref+10) or both, is a setup for a heavy landing and almost always leads to a firm landing.
  - This is because, instead of leaving the power set and accepting a longer landing to an adjusted aim point (if still within acceptable criteria), everyone tends to drop the nose and reduce power. This leads to an increase in descent rate and a steadily reducing airspeed. If you do this, and don’t positively correct it through 100 FT or so, you will approach the flare with a higher than normal rate of descent, a low power setting and a reducing airspeed (i.e. a perfect recipe for a heavy landing). This low speed, low power and high sink rate arrival is often then combined with the environmental effects that can further increase the sink rate and reduce IAS, very late on finals (if so, add power as required).
  - I therefore prefer to be at or below Ref+10 and not above glideslope at 200 FT.
- How to achieve this (At or below Ref+10 and not above 3 degree glide path through 200 FT)
  - To achieve this, it is easiest to take advantage of the natural ‘harmonic’, related to corrections in the approach path.
  - The momentum of the aircraft means that it takes about 200 FT for *small* changes in power or pitch to be fully reflected in the approach path.
  - This means that, if you want to be *very* slightly low and stable at 200 FT, you set the power slightly low through, or just before 400 FT (Stable Power -1 or -2%), let the approach path drift slowly down to ½ a dot low, and then correct this (Stable power +2 to +4%) through, or just before, 200 FT.
  - The slightly additional power, from here on in, should not increase the IAS, because of the additional drag at the lower speed/higher pitch and the slightly shallower approach angle.
  - You should then approach the flare (a further 200 FT below), from either 3 degrees or a *slightly* shallower angle, with a stable (non-reducing) airspeed, with power on, to an aim point *slightly* high in the sight picture. This setup is ideal for an easy, controlled touchdown. But, don’t overdo it, by allowing a high sink rate to build below 400 FT or by allowing a low airspeed to destabilise the approach. Further power additions may also be needed in the last 200 FT to counter the additional sink related to environmental factors. As discussed previously, this additional power will not increase IAS so long as it is returned to the stable setting once the sink rate reduces to normal.
  - This technique pre-supposes that you are stable, on speed and on slope (to maybe ½ a dot high) through 500 FT.

Q400 HEAVY LANDING - OTHER THOUGHTS

- COUPLED ILS APPROACHES
  - I doubt that there has ever been a heavy landing off a coupled ILS approach in the Q400, in spite of the often challenging weather conditions.
  - If correct, this would be for two reasons.
    1. The aircraft is configured and stable early, and
    2. The aircraft is ‘locked onto’ a very accurate 3 degree glide path for an extended period of time, prior to touchdown.
  - These factors maximise the chances of being set up with a stable glideslope, aim point, airspeed, pitch, power and rate of descent by 200 FT, when the typical CAT 1 approach normally terminates.
  - Once the automation is disconnected, all the pilot needs to do is to manually follow the flight director, look out the window and maintain these stable and proven settings for the last 200 FT and into the flare.
  - The pilot must therefore work very hard to ‘not’ be stable at 200 FT, and is then given a very limited opportunity to destabilise the approach in the last few seconds.
  - To me, the ILS coupled approach is the ‘gold standard’ of Q400 approaches. The further the actual approach being flown diverges from this ideal, the more likely a heavy landing becomes.
- NON ILS APPROACHES
  - Therefore, pilots flying any approach in the Q400 that is not a coupled ILS, would do well to imitate as many of their characteristics as possible, for as long as possible.
  - That is, if the approach is being flown into a difficult runway, or in difficult environmental conditions, the pilot may choose to raise the altitude at which they establish the stable approach, and then concentrate on holding the glideslope and the other factors, as precisely as possible.

Q400 LANDING – MOST CHALLENGING DILEMMA

- WIND GUSTS OF 5-10 KNOTS (or more) LATE ON FINALS, BELOW 500FT
    - The dilemma is that, you may have conducted a good, stable approach until late on finals, with all settings stable. At some point below 500FT, you encounter a wind gust, often associated with a small downburst when entering a rain shower on finals, that increases the airspeed to a value that exceeds the stable approach criteria. What do you do?
- CONSIDERATIONS
    - Before answering this question, I want to consider why this is a particular dilemma in the Q400.
    - The Q400 can accelerate very rapidly due to the large, powerful and responsive engines. This means that, if you are looking at a high sink rate or a heavy landing, the solution is immediate and effective (add power). So, this scenario is not much of a dilemma.
    - But, the Q400 does not decelerate rapidly, especially on a 3 degree approach path. The only way of decelerating significantly, while maintaining a 3 degree glidepath, is to pull the power to idle and then sit back and hope it slows down. The problem with this technique below 500FT is fourfold
        1. It takes a lot of time to work, time you do not have if you are late on finals.
        2. You have just destabilised the approach (stable approach criteria allows small torque changes only, below 500FT AGL) and triggered a mandatory go around based on company stable approach criteria. PS, mandatory is mandatory. Better to go around.
        3. You just know that being on final approach, below 500FT and flight idle in a Q400 will not end well. It will result in a high sink rate, a speed below Vref or a destabilised and wildly varying torque setting (0% to 30%) as your start 'chasing-after-the-plane' at low altitude.
        4. Gusts end. So when you come out the other side of the gust, you will lose 5-10 knots, the last thing you want when entering the flare.
- THE ANSWER – Do Nothing, or Go Around
    - **Do nothing.** This is based on the fact that, according to the stable approach criteria, the airspeed must be sustained above stable approach criteria to destabilise the approach. If the rest of the approach has been stable, the sudden increase can only be caused by a gust. If you assess that the gust will not be sustained, do nothing, leave everything stable and set, and continue for a landing.
    - You may chose to reduce power by up to 5% (but no more) knowing that you will have to reintroduce it before the flare.
    - The other factor here is that a slightly higher speed into the flare is not a problem, as your groundspeed will not have increased. Also, as previously mentioned, carrying a bit of extra speed can do minimal harm if the runway is long, which is the case for most of our landings.
    - **Go Around**. This is a perfectly justifiable response. If you judge that the IAS increase has destabilised your approach, go around.
    - The one thing **NOT TO DO** is to pull the power to flight idle. It is ineffective, hazardous at low level and triggers a mandatory go around below 500FT AGL. PS, If it has got that bad, what makes you think it won't get worse?

Q400 FLARE TECHNIQUES – COMMON GROUND

- In previous versions of this opinion piece, I had deliberately steered away from recommending any specific flare techniques as I have seen various techniques used, depending on the situation. I use at least four that I can think of, depending on flap, crosswind, etc. I do not imagine that mine are any better or worse than anyone else's, so I didn’t include them.
- A discussion of flare techniques will definitely lead to many strong opinions from everyone, and little in the way of common ground. This discussion seeks to identify the common ground that all pilots must be aware of when landing the Q400.
- What flare technique should I use? The short answer is, do whatever works and don’t be afraid to add power when it gets all-out-of-shape. But, whatever the technique used, be aware of the similarities and limitations that are common to all techniques.
- I have included my current thoughts on flap 15 and 35 flare techniques and, no doubt, these will be widely criticised/ridiculed/rejected. I do not claim they are the best, just that they are the best techniques I know of. I am sure that there are other valid techniques that I do not know of. I strongly suggest that you develop your own techniques, but do not ignore the common ground.

PITCH AWARENESS IS VITAL
<u>FIXED PITCH</u> – VARIABLE POWER

- In essence, the Q400 has very little pitch change capability and, at some point (5 degrees), you reach the limit.
- So at some point in every Q400 flare, there comes a time where you can no longer pitch-up, irrespective of the technique used. (The closer to Vref the approach is flown, the less pitch-up is available in the flare, before 5 degrees is reached).
- At this point, any further pitch up will ONLY damage the aircraft and, at the low speeds involved, will have no effect whatsoever on the flight path.
- *The first and most important thing that every Q400 pilot must be aware of is that, in the flare, there very quickly comes a point (5 degrees) when you should no longer pull back on the control column,* ***<u>NO MATTER WHAT THE SITUATION, AND NO MATTER WHAT ELSE IS HAPPENING</u>****. At this point, power becomes your ONLY variable option (<u>add power</u>).*
- For this reason, all Q400 landings, at some point in the flare (5 degrees), become a fixed pitch, variable power manoeuvre.
- From then on, no more pitch-up is permissible, under any circumstances, and the landing becomes an exercise in <u>looking out the window</u>, **<u>holding a constant pitch</u>** and moving the power levers to schedule a sink rate, while **<u>NOT</u>** pulling back **<u>UNDER ANY CIRCUMSTANCES WHATSOEVER</u>** until after the nose gear is on the ground.
- It is a new landing concept that must become second nature. Pitch is limited, power is not.

FIXED PITCH, VARIABLE POWER

- Power plus Attitude = Performance (smooth, safe touchdown)
- At the risk of stating the blindingly obvious, if pitch is relatively fixed (very limited at best) then power must be variable, otherwise, by definition, you are not controlling the flight path and have become just another passenger on the aircraft, hoping for a good landing.
- All Q400 pilots must be aware that ALL landings are a POWER AS REQUIRED manoeuvre.
- Any thought of ‘religiously’ fixing a power setting that it will always work is false logic. This concept is guaranteed to lead to inconsistent landings. There is no magic fixed power setting that will work at all times. Power MUST be understood to be an available and unlimited variable that the pilots can and must apply as required (0% to 100%, or even 125%) to accomplish the landing, terrain avoidance, windshear correction or go-around.
- The ideal is to pitch up slightly at the start of the flare to reduce the sink rate, and then hold that pitch attitude and touch down smoothly with power reducing to Flight Idle.
- However, land with as much, or as little, power as required, to control the sink rate.

FIXED PITCH, VARIABLE POWER LANDING

- The ultimate proof of this statement is that the pilot can set a pitch attitude at anything from approximately 1 degree (Flap 15, Vref + 10) to 4 degrees (Vref) whilst coming down finals. Then, at the flare point (10ft), hold the pitch constant and add power to arrest the sink rate (i.e. flare) and then reduce power to roll the aircraft onto the runway.
- I do not think this is a good landing technique, and I do not use it often (only during Vref approaches, where the attitude tends to be close to 5 degrees), but it is proof that landing the Q400 is all about power management, whilst consciously holding pitch to within very strict and tight tolerances.
- In my view, this technique is not ideal, as it can land the aircraft smoothly but with very significant excess energy that the brakes and 'disc' must then dissipate.
- The best technique is to hold the sight picture (pitch, aimpoint, glideslope) constant, using (hopefully small) power changes, into the start of the flare (approx. 10 foot call, flap 15) and then pitch up a few degrees, observe the sink rate reduce, and then draw off the power to touchdown.
- The easiest way to judge this (Flap 15) is to move your aim point/sight picture from the start of the 1000ft markers to approx 2/3 down the remaining observed runway (ie, effectively a few degrees of deliberate and controlled pitch change while looking out the window), at or just before the 10 FT call, and then, with a low sink rate, draw off the power to touchdown.

CROSSWIND LANDINGS – MY OPINION ONLY

- As stated, I tend to eliminate the crab at about 30FT and, as a rule, tend not to reduce power for a crosswind landing.
- For a moderate to strong crosswind (10-15KTS+). If you select DISC, with the nosewheel still off the ground, the aircraft will yaw into wind quite strongly, especially during a 1020 RPM landing, just as the props reach the DISC angle. The following notes are my current working theory to explain this phenomena.
- My theory is that this is due, in part, to the rudder becoming less effective due to 3 factors - IAS reducing, fuselage shielding and disturbing the airflow over the rudder and the natural weathercocking effect.
- But I believe the major reason is that the upwind prop is facing undisturbed air, whereas the airflow over the downwind prop is disturbed and shielded by the fuselage. This enables the upwind prop to generate significantly more deceleration force than the downwind prop, when they are both at the DISC angle. This results in a strong yawing force into wind, just as the propellers arrive at the DISC angle. The effect is more pronounced for a 1020 RPM landing.
- For this reason, in crosswinds >8-12KTS, I tend to lower the nosewheel onto the runway prior to selecting power levers below flight idle, especially if I am doing a 1020RPM landing.