THE LONGREACH *flyer*

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Newsletter No. 3

EDITORIAL

This issue marks the first significant contribution from one of our members. Many of you will have heard of or, indeed, even used the ***Jacobson Flare***. For those who haven't David Jacobson has submitted his paper on the subject for publication in this issue. You will find it an interesting concept which may cause you to think about your own flare technique. Naturally, being a fair minded publication, we sought to have someone publish an official response to David's proposal but no one was forthcoming enough to put finger to word processor so it was left to me again! My brief ***Analysis of the Jacobson Flare*** immediately follows his paper. If someone feels that David's paper warrants further comment or analysis please don't hesitate to write to me.

The article on ground effect in the last issue has caused some pleasing feedback; particularly concerning the function and design of the horizontal stabiliser. This may be in part due to one of our Senior Check Captains asking people why the tailplane has dihedral. Once again I have enlisted Dan Newman's help in outlining a few brief reasons for the variability of tailplane design and in particular ***Tailplane Dihedral***.

The Australian correspondent for Flight International, Paul Phelan, has submitted an article to Seagoon's Column on ***Acoustic Lift Technology*** which you may find interesting or noisy depending on your viewpoint!

The section entitled ***AIPA Technical Topics*** contains our viewpoint/concerns on Minimum Equipment List (MEL) items and Authority to Proceed (ATP) dispensations. The previous Quarterly Question also had some people proffering answers (usually correct) up the track. ***The Quarterly Answer*** briefly outlines why the amount of thrust available is significantly reduced with increasing altitude. There is also a related ***Quarterly Question*** which will, when the answer is given next edition, hopefully clarify the thrust/drag relationship at high altitude.

You will notice a significant increase in the advertising this issue - it is coming up to taxation season. Remember AIPA does not necessarily endorse a particular product or service. The amount of advertising is controlled and revenue from it is used to partially offset the production cost of the magazine.

One final note. The Bureau of Air Safety is about to issue its survey on advanced technology aircraft. Some of you will have participated in the setting up of the survey and had BASI sitting in your cockpits. It will now be issued Asia wide and AIPA wholeheartedly endorses participation. Who knows they may actually be able to come to a conclusion as to whether advanced technology cockpits increase or decrease pilot workload or, for that matter whether the man/machine interface is optimised or is in fact conducive to gross pilot error!

Richard Woodward

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Subject matter should be of an aviation technical nature. The Editor reserves the right whether to edit and publish any contribution, either in part or in whole. Where requested contributions will not be attributed. All contributions, other than Letters to the Editor, should be accompanied by a supporting Bibliography so that the veracity of the contents may be checked.

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ANALYSIS OF JACOBSON FLARE PROPOSAL

F/O Richard Woodward

In publishing David Jacobson's paper I am firstly acknowledging that David has put an awful lot of work into his proposed flare technique. Secondly I believe that aviation is a constant learning process and that David's paper contributes to that learning process. David has presented his paper to company training people with a view to having it adopted as a standard training practice. It was rejected for various reasons; not the least of which was that it didn't conform with Boeing recommended training procedures. Nevertheless several training schools around Australia are using the Jacobson flare as a training tool when teaching ab initio students.

When discussing the publication of David's paper with him I pointed out that I felt it only fair that a counter viewpoint or at least an unbiased analysis of its main thrust should be published as well. He was very happy for that to occur so in the absence of an official response I have had to tackle that task. In preparing this short dissertation I have sought the opinions of a few experts in the fields of instruction and flight dynamics but the comments are generally mine. In being presumptuous enough to critique his paper I am relying on my past experience as a military flying instructor and as a test pilot; I certainly can't claim to have training experience on, or a superior knowledge of, wide bodied jet operations.

MATHEMATICAL ANALYSIS

The mathematics of the Jacobson flare technique have been checked by a Boeing engineer as well as several other flight test and flight dynamics qualified people. Suffice to say that it is mathematically correct. A brief search of your own aircraft Flight Crew Training Manual for the appropriate information and a few minutes with your calculator should convince that the correct flare height for your aircraft can be determined by a fixed point on the ground. This is because of the fixed relationship between the sides of a 3 degree right triangle as David quite clearly explains in his paper. The main questions that would seem to arise from this are what happens if you are:

1. **High/low on glideslope?**
2. **Fast/slow on approach speed?**
3. **Landing at very heavy/light weights?**
4. **Landing at high density altitudes or in strong head/tailwinds?**
5. **Misjudge the ground based flare point?**

GLIDESLOPE TOLERANCE

One of the earliest and most consistent problems exhibited by students in the approach and landing phase of flight is maintenance of a fixed aiming point. The Jacobson flare technique is predicated on the maintenance of a fixed aim point/glideslope combination, so those people who can't do this need read no further. Actually this small attempt at a witticism has some relevance in that even an accurately flown T-VASIS can have a slight (approximately 15 feet) variation on the correct glidepath due to physical tolerances of the VASIS system. So what happens if you are, say, 10 feet high on glidepath at threshold cutoff? If the normal aim point has been maintained it should be reasonably obvious that if you ignore other visual and physical cues and commence the flare at the pre-determined flare point then you will be flaring fractionally too high. Conversely, if the approach is slightly on the low side the fixed flare point would result in too low a flare which hopefully would be even more obvious to the pilot than the high case. These slight deviations from the optimum glidepath are not as drastic as they sound because with aircraft approach speeds in the order of 120-150Kts IAS (60-75 metres/second) the difference in time between flaring 10 feet too high or too low when compared to the optimum point is less than a second, which is within acceptable tolerances when the dynamic and variable nature of the flare manoeuvre is taken into account.

FAST/SLOW ON APPROACH

If you are 5 Kts IAS fast and stable on approach the aircraft attitude will be about one degree lower than normal. This in turn lowers the coaming cutoff angle the same amount and has the effect of delaying the disappearance of the fixed flare point slightly; about 20 feet horizontally. Conversely, a 5 Kts IAS slow error will result in the flare point disappearing 20 feet earlier which only amounts to one foot error in the vertical plane. As the aircraft is moving at more than 200 feet per second errors of this magnitude must be considered insignificant. In fact the fixed flare point is reasonably attitude and speed tolerant providing that the aircraft is on a stable glidepath and flown within normal parameters.

HEAVY/LIGHT WEIGHTS

Obviously there is a significant difference in rate of descent between landing at maximum landing weight and at the minimum possible weight. For a big jet this can be as much as 120 feet/min, or a 15% increase over a light weight landing. Interestingly though the vast landing weight range of jet transport aircraft tends to have little effect on the approach attitude, with the maximum deviation for a typical Boeing product being about half to one degree. Thus the flare cut-off point would disappear at the same time, irrespective of weight, providing that the aircraft is on the three degree glidepath. Some number crunching has convinced me that in order to achieve touchdown at the same point on the runway the difference in flare times between the two extremes would be a second or so with an average weight flare taking approximately six seconds. Once again it would appear that we are talking about errors in timing of only a half to one second or 200 feet horizontally. However, the difference in this situation is that the heavier and faster aircraft, be it B747 or B767, has at least 50% more inertia than the same aircraft at a minimum fuel landing weight. Thus a significant amount more work has to be done to arrest the rate of descent (same Force for a longer time or a greater Force for a shorter time - Newton's second law). In this case the arresting Force is provided by the increase in Lift due to the flare. Without getting too theoretical here and ignoring power contribution effects it would seem advisable to apply about the same force over a longer time; ie flare earlier!

Flaring at the same fixed point each time is possible but the consequences of not getting the rate of flare correct vary from an embarrassing thump to a heavy landing. Funnily enough, in his paper David mentioned his preferred options on heavy and light weight flares; flare earlier heavy weight and flare at the same point but at a slower rate in the light weight case. Depending on aircraft type a typical heavy weight flare point would be about 150-200 feet horizontally before the normal flare cut-off point. Having said that, it would seem to me that other physical and sensory cues such as ground rush might become the dominant triggers in this situation. It has been my experience that when tankering fuel and landing at maximum landing weight, the closure rate and apparent ground rush certainly provide a strong cue to flare earlier than normal. Conversely, when landing a lightweight B767 into a 45 knot headwind at Wellington there has been little apparent ground rush. The flare point in that situation has usually been triggered by either the very late closure rate cues or the sinking feeling generated by the inevitable windshear associated with the end of the runway, the seawall and the rocks in the harbour!

ATMOSPHERIC EFFECTS

Since we land at places like Harare with density altitudes in the order of 7000 feet it is worth mentioning the effect that density altitude has on the fixed flare point. For the same landing weight a high density altitude landing will occur at a higher TAS than a sea level landing. This results in an increase in aircraft momentum over the sea level case as well as slightly reduced aerodynamic damping. Therefore, whilst the aircraft may feel fractionally more responsive, it will effectively be landing as if at a heavier weight than it actually is. Similarly, as David mentioned, strong head/tail winds change the ground speed and thus the rate of descent for a three degree glidepath, which in turn can be treated as a light weight landing in headwinds and a heavy weight landing in tailwinds. No mention is made of windshear because at that stage in the landing process it is every man/woman for themselves!

MISJUDGEMENT OF FLARE POINT

As David points out in his paper misjudgement of the flare point does not significantly affect the flare height. Once again this is because of the fixed relationship between the sides of the 3 degree triangle; for every 20 feet or so change in horizontal distance there is only a one foot change in vertical distance. Consequently it would take a 200 foot/one second misjudgement to result in a 10 foot change in flare height. It is unlikely that errors of this magnitude would occur when all the available cues associated with ground closure are taken into account.

One other cause of flare point misjudgement worth considering is the variation in runway markings and PAPI/VASI and light locations at the various airfields we operate to around the world. Some of our more notable destinations do not have standard runway markings, or they are partially obscured by rubber deposits. Also they most certainly don't have T-VASIS and in some cases don't have a VASI/PAPI at all. Thus, whilst the calculation of flare point will remain the same for the various destinations, actually fixing that point on the ground may take some interpretation. Unfortunately it is the nature of long haul flying that the pilot may be landing at that particular airfield only once in many months or even years. This something to do with the average passenger sector length being 1700 nautical miles and only getting four landings a month or so. In other words using the Jacobson technique for these airfields may require some prior homework. Remember though that whilst this sounds like a significant point, longitudinal errors of judgement are within reason absorbed by the fixed 20:1 horizontal to vertical relationship.

FLARE TECHNIQUE

The Jacobson flare attempts to define a consistent flare point rather than an actual flare technique. David does go on to elaborate on the "Gentle Touch" flare technique as developed/described by David Robson. I think we were all told during our early training, or at least should have been told, to look towards the far end of the runway in order to properly assess ground closure cues (flattening of the peripheral horizon) so that thrust reduction and attitude change could be properly coordinated. I suspect that if you asked ten pilots how they actually flared the aircraft for landing you would get eleven answers, so in that context the technique described is a very good attempt to make this a consistent process with an identifiable aim. The flare and landing is a highly dynamic manoeuvre with as many variables as you basically care to name so I am not about to criticize any attempt at helping the pilot. My only comment would be that often a visual landing can be quite legally made where the pilot can't see a well defined horizon let alone the end of the landing surface. A smoggy and overcast early morning or late evening arrival in any number of European or Asian ports for example. It then becomes a bit of a conundrum where you look to land the aircraft. I believe this varies from pilot to pilot, and once again you would have difficulty getting a defined answer from a sample group. Having closely read David's paper and crunched the numbers I have of course attempted to cross check the veracity of his proposed technique with my own observations on the line. In my case I don't seem to look very far down the runway at all to land the aircraft - perhaps between 3000 and 5000 feet. I suspect that might be a product of my background as a helicopter pilot; in the hover it was much harder to pick up relative movement cues the further away you looked. Mind you, if you look in too close when landing an aircraft, particularly at night, there is a danger of target fixation and flying into that point without flaring at all!

TO JACOBSON FLARE OR NOT TO JACOBSON FLARE

I don't believe I should draw a conclusion on whether the Jacobson flare should be used or not. In truth some of us probably already use the disappearance of some feature as part of the trigger mechanism for the flare. The flare cutoff point is already in the lower part of your peripheral vision, and thus part of your normal scan, so there is no reason why it couldn't be used as part of the flare and landing process. However, I believe that the vast landing weight range of wide bodied jet aircraft and the dynamic nature of the flare and landing must be taken into account when deciding to actually commence the flare. The human brain is a very efficient digital computer which can readily resolve the vast quantity of information being used to land an aircraft. However, it is a known fact that an experienced pilot's pulse rate peaks at between 110 and 120 beats per minute during the flare, and it has been my experience that student pilots in the early stages of jet flying unconsciously stop breathing from the commencement of the flare till after the wheels touch down. Obviously it must be a stressful and demanding experience, otherwise anyone could do it and we would all be out of a job. David's paper has attempted to quantify and provide some consistency to what is a highly dynamic process, and for that he must be commended.

F/O Woodward is a graduate test pilot and fixed and rotary wing flying instructor.