COCKPIT MUDDLE

BGA safety team highlights danger of control confusion

A 1947 paper by P M Fitts and R E Jones [1] is regarded as seminal in the field of human factors or ergonomics [2]. It established 'pilot-error' as a natural consequence of stress and workload and, by analysing 460 cases from WW2, found categories of errors that could largely be eliminated through cockpit design and standardisation. Half were *substitution errors*, in which the wrong control was operated; a further six per cent were *reversal errors*, moving a control in the wrong direction.

Seven decades later, our accident reports continue to describe the same errors. Since 1974, more than 70 gliders have been damaged, including six destroyed. Ten pilots have been injured: one fatally and one seriously. Despite a decline in gliding over this period, the accident rate from control confusion has not fallen significantly. Sadly, we still don't have a proper solution.

Left internal side wall of an ASW 20

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Reaching for the wrong lever

Skilled activities, Fitts and Jones explained, involve actions that are coordinated and automatic: a motorist need not look when moving his or her foot from accelerator to brake. Yet the authors found that even hugely experienced pilots were seldom sufficiently familiar with the controls of a particular cockpit to avoid occasionally operating the wrong control. The arrangement of throttle, mixture and propeller levers was a particular problem, and the adoption of distinct shapes in a standard layout was the suggested solution.

The most common substitution error amongst glider accidents is to use the undercarriage lever instead of the airbrake. Since the wheel has little effect upon a glider's approach path, the pilot is unable to steepen the descent, and the glider typically flies the length of the landing field, crossing the far boundary with significant height and often subconsciously increased airspeed. It is not unknown for a pilot to attempt two or three landings on the chosen field before coming to a halt. This nearly annual occurrence almost always damages the glider – usually seriously – and, while most pilots have survived unscathed, it must be utterly terrifying when the aircraft fails to respond to the control so near to the ground.

The problem is almost entirely limited to a single fuselage design, with the ASW 19/20 and Pegase accounting for 30 of the 35 events (and the only accident from using the undercarriage for flap), and the ASW 15 for three of the remaining five. Sadly, we cannot change the design of such lovely aircraft [3].

There have been 17 cases of using the flap instead of the airbrake. This can steepen the glideslope, but rarely enough to avoid the same result. A nasty consequence is that, if the pilot decides to put the 'airbrakes' away to turn at the far end of the field, the negative flap causes a sudden loss of lift that in some cases can stall the glider.

Fitts and Jones suggested that substitution errors might be reduced by ensuring adequate separation between controls, but, although positioning controls to avoid confusion is now a design requirement [4], glider designers have few options when cockpits are tight and control-run options limited. The authors also suggested that controls should have different shapes and modes of operation (eg turning rather than sliding), and aeroplane design codes now specify particular shapes for undercarriage, flaps and engine controls [5]. Many gliders do not distinguish, although some pilots have found their own solutions [3].

Confusion is not limited to similarly shaped controls, though. Pilots have used trim levers and release knobs instead of airbrakes; flaps, undercarriage and trim instead of the wheelbrake; flap instead of trim; trim instead of release; and the canopy jettison instead of the ventilator.

Moving the right lever the wrong way

A further principle of cockpit design is that controls should act in an intuitive sense. Pushing the stick, trim, airbrake or flap lever, throttle, carburettor heat or mixture control will generally help a post-war glider or aircraft speed up. To arrest our descent in the round-out, however, we can move the stick backwards or the airbrake lever forwards. Whether for this reason we do not know, but six pilots have opened airbrakes when they intended to close them. Poor currency and inexperience may have contributed.

A more direct problem occurs when the stick and airbrake or spoiler layout is

reversed, as in one or other seat of many side-by-side aircraft such as the T-21 and Grob 109. Nine aircraft have been damaged from the resulting confusion.

Uncertainty about the sense of a control has also caused many wheels-up landings.

Warning devices

Short of buying a different glider, there's little you can do to change the arrangement and action of different controls. Even changing the shape and feel of the handle would require airworthiness approval to ensure security and check for possible interference.

If mis-operation cannot be engineered out of an aircraft, the next recourse is to interlocks, sensors and alarms [6]. A warning might sound, for example, if an aeroplane's landing flap is extended before the landing gear has been lowered; or weight on the undercarriage might prevent its retraction.

Unfortunately, alarms can have unintended consequences, and previous accidents prompted the BGA to advise against fitting undercarriage warnings to gliders [7]: it is safer to land wheels-up than try to lower the wheel on approach. Few other control combinations would provide useful alerts, though a warning that the undercarriage is unlocked might have value.

Confirmation bias

The pilot is likely to realise immediately that the control is not having the intended effect, and in many cases will quickly correct the mistake. The trouble occurs when the pilot assumes that the problem lies elsewhere: strong lift or sink, or control failure. If the circumstances can be made to fit the erroneous assumption (*confirmation bias*) the pilot does not address the true problem, which persists, worsening the situation and increasing stress, urgency and panic. These in turn are known to reduce one's analytical ability and prompt a reversion to reflex responses and rehearsed actions.

The holes in the 'Swiss cheese' [8] are starting to line up. After standardisation, design and warning devices, the remaining barriers against an accident are down to the pilot. If we are not to rely upon the presence of mind of a flustered pilot with an incorrect diagnosis, that leaves only procedures, training and preparation.

Procedures and training

Procedures can help avoid grasping the wrong control. Airworthiness inspections ensure that the control handles are differently coloured, and the BGA trains to 'Identify and take hold of the airbrake lever' on the diagonal leg [9], well before it's needed for the final approach. If we look at the lever and check its colour (a good idea with any control), we should be well set up. Some countries include a downwind test of the airbrakes: it's mainly a check for icing after high altitude flight, but will also reveal if you've used the wrong control.

Procedural checks can fail: a straight-in approach has no diagonal leg, and the pilot might adjust another control after correctly selecting the airbrake.

Preparation

We're trained to consider *eventualities* before we launch, to prepare ourselves mentally for possible scenarios like a wingdrop or launch failure, and to decide in advance what our actions will be – release the cable or lower the nose, ensure airspeed and, if necessary, turn in a given direction. If stress affects our ability to analyse, we might at least be able to carry out a prior plan.

Pre-flight Threat and Error Management (TEM) might prepare us for some control confusion situations. This is particularly important on conversion flights: nearly one in 10 of these accidents were amongst the first six on type. Pilots of susceptible aircraft in particular might decide that:

- if the undercarriage isn't down on approach, I'll land wheels-up
- if the airbrakes don't steepen the descent, I'll look to see whether they're deployed/check I'm holding the right lever
- if there's strong sink, or a long ground roll on take-off, I'll check the airbrakes
- in a side-by-side aircraft, I'll fly from the seat with conventionally-handed controls; or
- the other pilot will fly the approach.

The last is an example of Crew Resource Management – the extra layer of defence against errors that's available in multi-pilot operations.

We can't measure the effectiveness of TEM at preventing or mitigating accidents, but it's considered a valuable approach. If all this fails, though, our accident records suggest one final pre-flight decision:

- if I can't control where I land, I'll at least keep flying the aircraft to the ground.

Controlled flight into a forgiving object is usually survived by the pilot, if not the glider.

Tim Freegarde and the BGA safety team

■ Clubs can obtain printed copies of Safety Briefings from the BGA Office.

SEVEN DECADES LATER, OUR ACCIDENT REPORTS CONTINUE TO DESCRIBE THE SAME ERRORS

■ The video Of Men and Machines [2] is a fascinating account of the pioneering days of human factors or ergonomics. For more specific information, see the BGA's Managing Flying Risk [7] and Instructor Manual [9].

[1] P M Fitts and R E Jones, Aero Medical Lab Report TSEAA-694-12 (1947) *https://tinyurl.com/flyright2019*
[2] Of Men and Machines, Nat. Educ. Television & Am. Psych. Assoc. (1962) *https://tinyurl.com/flyright2020*
[3] BGA Safety Alert (2010) *https://tinyurl.com/flyright2021*
[4] EASA CS-22.777 *https://tinyurl.com/flyright2022*
[5] EASA CS-23.781 *https://tinyurl.com/flyright2023*
[6] E L Wiener, NASA Report 4547 (1993) *https://tinyurl.com/flyright2024*
[7] BGA Managing Flying Risk *https://tinyurl.com/flyright2025*
[8] J Reason, BMJ 320, 768 (2000) *https://tinyurl.com/flyright2026*
[9] BGA Instructor Manual section 14-7 *https://tinyurl.com/flyright2027*

PREVIOUS 'FLY RIGHT' ARTICLES

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Keeping Safe in Thermals (June/July 19)
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