User or Designer; Who is in Control?

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I am writing this editorial on my return from a summer break in New England – a really delightful part of the world. I hired a shiny, brand new, car from Boston airport and in a couple of weeks managed to put nearly 2000 miles on the clock. And it nearly drove me mad. The car I mean. It may be that the problem lay in the contrast with my car back home, which is somewhat elderly, but the problem presented itself to me as a battle for control. Who is driving this damn car, me or the control systems under the bonnet (I mean the hood)?

I am familiar with flashing seatbelt signs if I try to drive away in my car without putting on my seatbelt. My wife's car has a persistent (and deliberately irritating) clicking noise to achieve the same end of forcing you to put on the belt. This has frequently caused me to reflect on the extent to which it is proper for the designer to seek deliberately to manipulate user behaviour – rather than merely facilitate it. But nothing I have driven in the UK prepared me for the degree of manipulation that this new car sought to achieve.

As I was driving out of the airport – with only 5 minutes experience of the car – I entered a tunnel. As the light level dropped, 'alert' bleepers sounded and the whole dashboard leapt to life in a quite alarming manner. Lights came on automatically, and in the second or so that it took me to work out what was going on, I was lucky to avoid running into the car in front. The following day (by now I was up in Maine) it started bleeping again, and since it was broad daylight I assumed that something else must be amiss. I finally tracked it down to low water level in the windscreen washer bottle. It would not stop bleeping – so I dutifully obeyed its command and stopped at a garage to fill it up; not because I particularly needed the windscreen washer, but because I had an urgent need to silence it! When, on the third day, it started bleeping again, there was a chorus from the back seat ... 'what does it want NOW?'

I could go on for some time listing all the obsessive quirks of the control systems that someone had decided I should be subjected to. You can't drive over 5 mph without all the doors locking ...you can't lock the car and walk away leaving a window open, etc., etc., etc. I imagine that many of these functions derive from the lunatic litigation culture in the US that has probably resulted in car manufacturers being sued for designing a car that it is possible to fall out of – or one that might get stolen because a window was left open. But the result for me was that I was constantly having to question 'what's it doing now?' For it seemed to have a life of its own – not to mention a deviant, obsessive personality.

And in the cool light of day, wearing my academic hat, I realise that my experience with this car provides a frightening echo of the everyday reality in civil aviation. In a recent study of global fatal accidents (Civil Aviation Authority, 1998) it emerges that 67% of all fatal accidents in the period 1980-96 arose through crew error, or what might be termed 'human factors'. Aircraft structures, and the reliability of airframes and engines has (according to the statistics) gone from strength to strength, but the number of accidents per passenger mile remains stubbornly constant. The cause now is (most likely) not engine failure or metal fatigue, but pilot failure or crew error.

The reason that I was reminded (by my irritating car) of this horrible statistic is that it has been well established in the literature of aircraft 'human factors', that the three most common questions asked on the flight deck between pilot and co-pilot are:

1. What's it doing now?
2. Why did it do that?
3. What will it do next?

To a mere passenger, who assumes that pilots know exactly what is going on, this is seriously worrying. For the reality of the modern passenger aircraft is that flying is (for the most part) done by the Flight Management System (FMS). It automatically engages procedures – and disengages them, with the pilot acting as the (largely) passive observer of this computer managed procedure. It automatically raises and lowers flaps; automatically pumps fuel from one tank to another; automatically seeks out and responds to radio beacons; automatically stabilises the trim in turbulence; automatically maintains cabin pressure and temperature; automatically adjusts the rudder; automatically lowers the undercarriage and automatically aligns the aircraft on a glide path into its port of arrival. In fact there is not much that it doesn't do.

So in normal flight (as pilots observe all this automatic activity) the inevitable question for cautious professional pilots will be 'why is it doing that?', and we should hope that they will not be too surprised by the answer to 'what will it do next?' In a more extreme situation however, when the aircraft starts doing something that the pilot thinks is peculiar, the urgent challenge is to work out what the FMS system is making it do. The

pilot might then be in a position to decide whether this is a good thing or not.

The questions I am forced to reflect on (by my experience in the car) centre on who *designs* FMS systems? And are they designed to make flying easier for the pilot, or are they designed to be a complete alternative pilot? In fact, of course FMS system are not *designed* at all (in the sense that they are not developed by designers). Rather, they are *programmed* by software engineers. And I suspect that the same applies to the vehicle control systems in the car. My experience of the resulting product was that it appeared to be constructed – like the very worst software – around what the system was capable of doing, rather than around what I wanted it to do.

Designers know that successful product development starts with the user. This is so central, that as early as Key Stage 2 the design and technology curriculum requires that pupils 'think about what products are used for, and the needs of the people who use them...' And the reality of users is that they are variable, adaptable, creative, and learn from experience. In fact they represent the very antithesis of system logic. Whilst it might be tempting to believe that our in-flight safety is assured by more and more high-tech, (software driven) flight decks, the reality is that the creative human pilot emerges as the one who has to pick up, and deal with, all the hassle that the systems create. In a recent study across eight airline fleets, by far the most common 'intervention events' by pilots were classed as 'work-arounds' in which they had to find ways to make the FMS system do something that it didn't want to do. An example of this is when the aircraft FMS system is incompatible with the air traffic control (ATC) system.

> 'If a height restriction is programmed in for a descent and the aircraft is subsequently cleared to a more distant waypoint, the height restriction falls out. This is incredibly irritating and very time consuming. It destroys the navigation profile and a whole load of power comes on because the aircraft thinks it is now too low, and by the time the restriction is reprogrammed, the profile is irrecoverable....'

> 'Switching from one runway to a parallel partner very close in. Once it has locked on, this switching can only be achieved at the expense of disengaging the autopilot and switching off the flight directors. This is a real design fault, especially at somewhere like Los Angeles (four parallel runways) ...'

Studies of this kind are forcing the CAA (and its European and American equivalents) to devise procedures for training and certification that consider the system as a whole – *including* the human operator. And about time too you might think. It is exactly what a *designer* would expect to do – not to mention 7-year-olds doing design and technology. And, given the general law that what happens in the US today will happen in the UK in 10 years time, I sincerely hope that car manufacturers do the same.