

Dilemmas on doors

Doors are obviously a vital part of the coach - but can be a troublesome component. Piers Connor explores the subject of doors

The devil, they say is in the detail and nowhere is this more true than in the issues surrounding train door systems. In almost every stage of the life of a railway passenger coach, doors give trouble, starting with design, continuing through fitting and setting up, day-to-day use, safety issues and ending with maintenance problems. One manufacturer suggests that although doors make up only 2-3% of the total car price, they provide up to 25% of the operational relevance.

Design

At the design stage, thinking starts with how many doors there should be, how big should they be, where should they go and who should control them. For the modern railway in Britain, we seem to be stuck with two designs, the long distance end door arrangement or the

commuter 1/3 + 2/3 doorway positions. Powered doors cost seats, so they are kept to an acceptable minimum. A Class 423 Trailer Second vehicle with 10 slam doors on each side had seats for 98 passengers. The equivalent vehicle of Class 450 that replaced it has 56 fixed and nine tip-up seats, a third less, and it has four doors per side, three fifths less. On the plus side, we have a safer car body structure.

Door opening width is crucial. A doorway may be wide enough to allow two persons to pass at the same time (1,400mm) but this will be prevented if anyone is standing against the draught screen - the proverbial 'door sentry'. To mitigate against this, a 200mm standback space or a wider doorway is essential. Since the early 1990s the London Underground has adopted a 1,600mm double doorway as

The last day of slam-door service at Waterloo on 25 May 2005. Note yellow door edges, permitting conductor to see if a door is not properly shut. The unit is Class 421/8 4-CIG 'Greyhound' No 1398. Brian Morrison



New Victoria Line stock, showing doors sliding on the outside of the body. Kim Rennie



Sliding plug doors on a refurbished Class 465/1 Networker. Brian Morrison

standard to combat the problem. A wide doorway provides a faster loading rate – one person/second/door is a typical rate but, of course, it comes at the price of seat loss.

Then there's the question of how to fit doors – in, on or outside the car body; should they slide, swing, fold or plug or a combination of some sort? What power system should they have and where should the 'door engine' go – on the floor or in the roof?

For almost 20 years, sliding plug doors have been the preferred option. They provide a weather proof, non-rattle, draught free seal but they need a complex drive system and careful maintenance. They are also very slow to open and close, taking up to triple the time for a simple sliding door. They do provide the smooth exterior body line beloved of train architects and they make exterior cleaning easier.

In London, the trains built for the Underground since the early 1990s have the doors mounted outside the bodysell. This was introduced following a trial on the experimental

1986 stock, where the all-aluminium structure required the use of outside hung doors in order to accommodate the door pillars. During the trials, a train discarded one of its doors in the tunnel but that's what trials are for and, after some years of bedding in the maintenance process, the production versions became very reliable.

Previous construction had doors sliding into pockets in the bodysell. This was adequate and mechanically simple and it served its purpose for almost 100 years but it did reduce the interior width of the vehicle and added weight, particularly to the small tube cars. In recent times, there has been a drift back to the pocket style door for some trains, as seen on the Bombardier Classes 376/378 and Hitachi Class 395 designs.

Air or electric?

Modern door operators are usually electrically powered and mounted at cant rail level over the door void. Floor mounted operators used to be the rule but difficulties with water and rubbish

entry and the desire to get an obstruction free guidance system led to the top mounted design. Indeed, so great were the benefits, that the refurbishment of the Class 303 stock for the Glasgow suburban area in 1984 saw the floor-mounted operators exchanged for top-mounted units at not inconsiderable expense.

Hitachi designers have stuck to air operation for the Class 395 and they have provided a system to clamp and pneumatically seal the doors to allow 225km/h running in comfort. They have stuck to what they know and retained the system used for many years on the Japanese Shinkansen high speed trains.

Regardless of what the Japanese do, the UK preference is for electric over compressed air power. Air is quick and was better than the available electric operators for many years but it can suffer from the effects of condensation, it needs extensive pipework and big compressors; the door operators need a reservoir on every car and, in my experience, some muck will get into the system despite the best efforts of driers, drainers and maintainers.

In 1994, the first UK fleet installation of electric operators on the Class 323 units proved that development had progressed sufficiently to allow air operators to be dropped. London Underground held onto them for many more years, largely because they have to have rotary, floor-mounted operators on tube cars since there is no room at cant rail level for them. For their new trains (2009 tube stock and 'S' stock), they got electric operators, despite an assertion to me at the time of the specification by a senior engineer that it would happen 'over my dead body'. Happily, he survived conversion to electricity.

Safety

One of the biggest issues for door systems is safety. This is not to say that doors are not safe. Train doors are safer than they have ever been. With the old 'slam' doors as originally designed, the problem was that people were assumed to know how to behave with them. Before locking was introduced, many passengers would open the doors before the train stopped with all its inherent risks and then jump off at what they thought was a suitable speed. At the major London termini, some seasoned commuters were able to reach the end of the platform before the driver. There were incidents of doors being opened maliciously on trains at speed, or doors being opened by late-arriving commuters as trains departed. There were also a surprising number of occasions where doors opened on moving trains due to defective catches or locks. We should not forget how dangerous this proved. A Health & Safety Executive report of 1993 recorded that almost 20 people were killed each year due to falls from moving trains. Eventually, it led to a call for all doors to be locked. Central door locking, as it became known, was mandatory from 1 January 2006.

With central locking on Mk 3 coaches and power doors on most other types, trains do not start until doors are shut and locked and passengers can't open them while the train is

moving. Even staff doors have to be locked. As always, better safety comes at a higher price. Now, the train starting process is, in some instances, longer than the time spent getting passengers on and off the train. A survey of one train operator showed that the time spent between the conductor getting 'Right Away' and the train starting to move could be as long as 23 seconds. This must be frustrating for the latecomer who stands on the platform for 20 seconds banging on the doors thinking they should be allowed to board a train that hasn't left yet.

DOO or 2PO?

The traditional method of train operation had a driver to do the driving and a guard to look after the passengers and do 'station duties' – check boarding and alighting was complete, check the starting signal was off, check train doors were closed and, finally, give the driver the bell signal. Nowadays there is a wide variety of train staffing options, ranging from DOO (driver-only operation) to various two-person (2PO) plus modes, using conductors, train managers, customer hosts and ticket inspectors (sorry, revenue control staff) in almost as many combinations as there are train operating companies (TOCs).

Train door control systems are now developed according to individual companies' requirements or the latest fashion, depending on how you look at it. DOO conversion is always designed in. Many modern fleets are equipped with driver-operated door release, even on trains with guards who are responsible for closing the doors and providing the starting signal, so DOO conversion is a simple switch, on the train at least. Another useful DOO aid is in-cab CCTV using on-train cameras. These first appeared on main line routes in 2005 but London Underground introduced a track to train CCTV system on the Central Line with the 1992 tube stock. The tight structure gauge doesn't have room to allow car-mounted cameras.

Of course, DOO might seem the obvious method of choice for a TOC. It keeps the staffing costs down, although perhaps not as much as we might think, and it reduces the cancellation risks if only one person has to sign on to work the train instead of two. However, DOO has proved unpopular with passengers who, rightly or wrongly, think they are less safe with only one member of staff on a train.

One consideration that may not be widely appreciated is that guards provides a useful training ground for future drivers. It's all very well dipping into a pool of on-board caterers, customer hosts or platform staff for driver training but, in my experience, few of them know anything about trains, nor how they operate. A guard, on the other hand, gets to be with the train for most of its work, gets to interact with the train equipment and the driver on a regular basis and could, given the right training and incentives, assist with problems. In the current economic climate, driver recruitment should not be a problem but a



Hitachi-built Class 395, featuring air-operated sliding pocket doors. Brian Morrison

TOC's succession plan should look forward to a time when more drivers need to be taken on.

Training a driver with no previous experience is a time-consuming business. It can take from 15 months to two years to get an off-the-street recruit on the front as a qualified and route-signed driver. This period could be cut significantly if the applicant has the sort of experience of real, on the road, operations that a guard gets with a few years on the trains. You could think of it like this: 'New driver training – expensive; three years' experience as a guard – priceless!'

Alarms

A controversial part of the power door operating process is the warning alarm system. This tries to be all things to all men (and women) but a report published by the DfT showed that the system is an excellent example of how to irritate the majority of passengers, disturb residents living close to stations, provide a system that is often misused, cause delays to trains and still fail adequately to help the less able.

It describes how the door close warning bleeps are usually interpreted by passengers on the platform as a 'time to get on the train' message rather than the intended 'stand clear' message.

The standard time for the bleep duration was set at three seconds before closure starts, but this has been the subject of a number of derogations due to the cumulative delays to frequently stopping services like the London Underground. And, the open warning doesn't help the visually impaired find the open button nor indicate which side the doors will open. In an attempt to get over this, on the Underground's new trains, a voice tells you which side the doors will open. I wonder how many passengers could tell you which side of a train is the left or right.

Recycling

Many modern train door systems incorporate some form of recycling (reopening and closing again on encountering an obstruction). Despite doomsayers forecasting train delays caused by passengers deliberately pushing on doors to prevent them closing, it doesn't seem to have become a serious problem.

London Underground has resisted recycling up to now – being that much more vulnerable to short delays of this type – but the company has accepted it on its new trains.

LU has also adopted dragging detection. This operates only after the doors are closed and locked and uses a sensitive door edge to detect a

deformation caused by a trapped strap or clothing pulling against it. Detection will apply train brakes.

Reliability

In failure terms, there are wide variations. Traditionally, power door system failures were reported to be around 50% of all train defects but this was in the days when systems on trains were simpler and door equipment was at the more complex end of the scale. For the older trains in service today, one senior engineer told me that the figure is now more like 25% and some modern types get as good as 5%. The biggest problem, from a maintenance point of view, is the time and accuracy required to set up powered doors to ensure trouble-free operation and closure detection within the specified limits.

A useful feature on trains is the external bodyside light which indicates an open door circuit or unlocked door. London Underground imported the idea from the US and adopted it in the late 1940s. It is now standard on all trains. Although it helps to locate a faulty door quickly, in recent builds it has been hijacked additionally to indicate such things as brake faults, circuit breakers opening or passenger

alarm operation. You really need to be an expert to see your way out of trouble if a brake supply circuit breaker trips open in a station platform just as the train is about to depart.

The TMS bites back

The risks invoked by the use of multiple fault warnings were dramatically highlighted on a new train on the Underground's Victoria Line a few weeks ago. Modern rolling stock is equipped with on-board, processor-based, train management systems (TMS). These offer the driver real-time information on the state of the train and provide downloadable maintenance data. They can also provide much needed assistance or guidance for the crew if something goes wrong with the train whilst it's in service.

In one, well publicised instance during a rush hour morning a few weeks ago, a new 2009 stock train on the Victoria Line came to an abrupt halt between stations. The TMS scrolled a list of faults triggered by the train. When the driver checked his screen, a 'door obstacle detected' message was top of the list and he informed the control centre that he had a door problem and that the train had stopped as a result. The emergency brakes were locked on. The control centre and driver started working



Open and closed doors on FGV HST at Paddington. The HSTs are fitted with central door locking operated by the guard, but there is no interlocking with the traction power - meaning it is theoretically possible for a train to set off without all doors properly shut. Brian Morrison

together to try to get the door problem sorted out. After an hour without success, it was arranged that passengers should be taken off and walked to the next station. The power to the current rails had to be switched off to do it. Another hour went by before everyone was safely off the train and current was switched back on to try again to get the train brakes released.

Now, one of the things you need to get train brakes released is a compressed air supply. With power restored, the driver, by now in the company of sundry big hats, suits and technicians, waited for the train's air supply to recharge. Repeated glances at the air gauge on his control desk showed it wasn't happening. A technician was dispatched down the train to investigate and he discovered that, on the sixth car, there was a big hole somewhere underneath through which air was noisily escaping. With a quick isolation of the offending bit of pipe, air was rapidly restored, the brakes released and the train driven back to the depot.

And the door fault? There wasn't one. At the previous station, a closing door had momentarily met an obstruction, probably someone jumping on at the last moment. The train started before the 'door obstacle detected' message had registered on the TMS which, being programmed to hold minor messages until the train reached the next station so as not to distract the driver whilst on the move, stored it. Unfortunately, the next stop was not the next station, it was the emergency brake application induced by the air loss. The TMS, displaying various faults triggered as a result of the loss, correctly showed the loss first but it was scrolled past by all the other faults so the door obstacle message came top of the list. Our poor driver, understandably forgetting the golden rule of always checking power supply and air pressure first when you have an unexpected stop was, together with a mélange of managers and technicians, led up a very long and tortuous garden path, by a very clever computer.



Experimental power-operated door on Mk 3 coach being tried out by Chiltern Railways (p90, last month). Door release on these doors would be by the driver (allowing release as soon as the train is at a stand), and there would be interlocking with the traction power. Richard Tuplin

Lessons to be learned? Most certainly. First, computers (especially those on trains it seems) are not as fast at picking up messages as you might think, as our door message must have taken a second or two to get to the TMS. Second, make sure your TMS displays to you what you need to know in the right order and third, don't forget that when you are up to your backside in the proverbial alligators, it's a good idea to check that you're trying to drain the right swamp.

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