IT'S ABOUT BUMS ON COMFY SEATS

What makes a seat comfortable? The often-derided "ironing board" on newer trains is better for your body than softer cushions. PAUL CLIFTON finds out how the next generation of train could transform our travel experience – at little extra cost

Remember those lovely, squishy, springy seats on a slam-door train? Do you ever find yourself sitting on the rock-hard seat of a Class 801 into Paddington, your backside aching from its paper-thin padding, and wonder where it all went wrong?

Take off those rose-tinted spectacles. Because you've probably forgotten how difficult it was to read a newspaper whilst bouncing around on those old cushions. And, back then, you didn't have to answer emails or compile reports on your laptop. In fact, you probably didn't do any work during the journey. And you certainly didn't catch up on your favourite TV series, scroll through your social media feeds or swipe right for the latest people on your dating app.

In short, what passengers need in order to consider their rail journey "comfortable" has changed enormously. And it is still changing, as leisure journeys become increasingly important on trains that were designed largely around commuting or business travel.

It's not just about the chair you sit on, or available legroom. It's about how tightly the seats are packed into the carriage. It's about background noise, lighting, visibility though the window, and whether the seat absorbs the overall movement of the train – or exacerbates it. It's also about the experience of getting from the platform to your seat, and even your impression of the seat cover colour. So your sensation of "comfort" starts well before you even sit down.

Comfort is psychological as well as physical.

Every element of this can be measured. The Institute of Sound and Vibration Research at the University of Southampton has been studying how people respond to it since the 1960s. The work has focused on comfort, fatigue, motion sickness and a passenger's ability to carry out tasks during the journey: writing, reading, working or relaxing.

"We understand the individual building blocks of the passenger experience reasonably well," says Dr Martin Toward, a senior engineer in the human factors research unit. "The challenge is that passengers experience these things together, as part of a whole journey, whereas the industry still tends to assess them separately.

"Dynamic comfort is not the same as static comfort. A seat that feels very comfy when you first sit down may not feel so comfy after a few hours of travel.

"Different people experience comfort differently. As we get older, we get stiffer. The resonance frequency goes up from around 4Hz to 5.5Hz, which is quite a big shift.

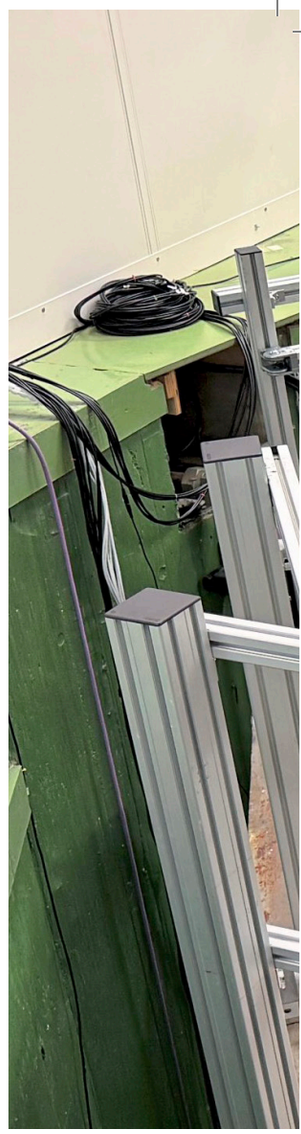
Because your dynamic resonance is higher as an older person, and because there's quite a bit of vibration on trains at low frequency, typically an older person will find a seat on a train more uncomfortable.

"An older person might also have different body composition, and might appreciate a softer seat. There are many other factors in play. But weight doesn't matter too much. As people get bigger, the contact area with the seat also increases. Bony people tend to feel the seat more.

"You need a seat that works for most passengers but is at least acceptable for the outliers."

Dr Toward uses an extraordinary simulator. The entire university building has been constructed around it. It's a platform mounted in a large hollow chamber. The platform can move across six axes: up and down, side to side, back and front, measuring roll, pitch and yaw as it rises and falls by half a metre in any direction. It can precisely replicate the movement of any specific type of train. During *RAIL*'s visit, researchers are assessing a new seat design for French operator SNCF. And for this demonstration, the movements of an old Pacer are dialled in.

"The only limitation is really what we can safely subject



They have been derided as "ironing board" seats – such as these on a Thameslink train, but they are actually better for the body, say experts at the University of Southampton.

Seats in Mark 1 carriages had plenty of padding but were they really more comfortable?

RAIL's Paul Clifton about to put a train seat to the test in a simulator at the University of Southampton.

people to," he explains, as I am strapped in to my seat for a bumpy ride, and handed an emergency distress button, similar to the one patients are given during an MRI scan. "We also do military work," Dr Toward adds, "where we have to limit people to quite short sessions.

"We are building an aircraft cabin for it. As well as reproducing the seating environment, we can do the thermal environment, humidity, lighting and a 360-degree sound field as well. We can explore any variable of the journey you want. We've had 300 people on it, six at a time for six hours, with a steward serving them food, as we change the levels of noise, temperature and vibration."

There is no single "comfortable" train seat. It involves a range of trade-offs between different passenger requirements, as well as the design restrictions required of the manufacturer. Seat backs are taller now, to comply with tougher crash safety rules. But that impedes the view. Durability, ease of cleaning and cost considerations mean compromises.

Increasing demand for travel has led train operators to insist on more seats in a carriage, leading to fewer tables and the seats not aligning with the windows – a criticism often aimed at Hitachi's IET fleet.

"Last weekend I travelled to Lancaster, using a newer Class 805 and an older Voyager," says Dr Toward. "On the Class 805 the tables are a little higher, which gives better legroom and a better height for working. They fold, so you can get in and out more easily. The air conditioning is more stable, and the carriages feel quieter.

"They got a lot right. But the seats are perceived as hard, and that can overrule all other considerations.

"The static comfort is something you feel immediately, and you make your decision about that comfort in a few seconds. That counts for a lot. A dynamic comfort decision takes time to assess during a journey.

"A soft seat can feel comfortable initially but, once the train is moving, it may behave worse. Railway seats do not simply absorb vibration; at the lower frequencies typical of railway motion, they often amplify it.

"In purely dynamic terms, all train seats make the ride worse. With pretty much all train seats, it is more comfortable to sit on the floor than sit on the seat. So the closer you can get to a rigid seat, the more comfortable it becomes. Firmer seating can improve stability for working on laptops or browsing mobile devices, but then introduce pressure discomfort over longer periods."

"Older trains tended to have lower passenger density, wider seats and more legroom. Passenger perceptions are, therefore, wrapped up in more than just cushion softness.

"Clearly, some trains have got the balance wrong between static comfort and dynamic comfort. On a Class 800, the balance is in favour of dynamic ride. Making the cushions thinner gives more legroom, or increases the carriage capacity based on the same legroom. It's a trade-off."

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BAKED-IN DESIGN SHORTCOMINGS

During the procurement process, train builders are required to submit their competing bids against specific measurements: number of seats, legroom, ease of access, fire and crash safety requirements and so on. Bids can be assessed against a range of fixed numbers which aid decision-making, but which do not necessarily reflect the overall passenger experience.

“Trains are largely designed for business,” Dr Toward says. “Increasingly now, leisure is more important. It is discretionary: people can choose to take the car instead, or simply not travel at all.

Dr Toward has conducted years of research into motion sickness, particularly on tilting trains. On Pendolinos, the carriage is rolled into curves to reduce the lateral force.

“For some people, the train is an extension of the office. For others it can be an extension of the living room. If the environment is right, then speed of the journey is less of a factor. So the passenger requirements have moved away from the simple metrics that were used to procure the train.

“My perception is that passenger comfort is not necessarily at the centre of the decision-making process.”

STANDING UP OR FALLING OVER

But it’s not just seating – the Southampton simulator is also used to measure the comfort of passengers who stand, or who walk along a moving train. An instrument-laden treadmill is fixed to the platform, and ability to balance against train vibration is assessed.

“We measure how likely people are to fall over,” says Dr Toward. “On mass transit this is increasingly important.

“We look at hand support. Just being able to touch something with the lightest finger pressure adds a huge amount of stability – having that fixed reference point, even without exerting any force.

“We look at how high those hand supports should be, which is important for people walking along the aisle. Typically, when people lose stability, their gait widens: they spread themselves out. This kind of metric is very important,

The Southampton simulator is also used to measure the comfort of passengers who stand, or who walk along a moving train.

both for safety and comfort. Now there is phone signal on the Underground, people are on their devices while standing, and that changes how you think about comfort."

Dr Toward has conducted years of research into motion sickness, particularly on tilting trains. On Pendolinos, the carriage is rolled into curves, to reduce the lateral force. At its most extreme, this prevents passengers being 'redistributed' across the carriage.

"Fully compensating for the cornering forces actually increases motion sickness," he says.

"If you have 100% compensation for the corner, so that going round a corner feels the same as being on the straight, a lot of the motion sickness comes from sensory conflict. People get pretty ill with it. The same with only 50% compensation. There's a happy medium at around 70-80% compensation, as it reduces the mismatch between what passengers see, what they expect to feel, and what their inner ear is actually sensing."

SAVING MONEY

"Field trials on the railway are really expensive," Dr Toward points out. "Doing it in our laboratory is a very efficient way to hone in on the critical elements of comfort. We can look at the variables in isolation: the thickness of the seat, the type of foam used. That's useful in itself. But we can go beyond that, to look at how each of the variables of comfort combine, and measure them very precisely.

"Passengers experience rail as a whole system. Factors such as ride quality, seating, sound, crowding, posture, temperature, lighting, stress and emotional context all interact. The wider emotional experience of travel is not universally uplifting, and influences our perception of comfort more than we acknowledge.

"In terms of improving the passenger experience, these costs are not large, compared with the cost of building a train. There are big wins to be had here, as the reasons for travelling by train change. It's a massive opportunity to move away from the simple metrics that have been used during rolling stock procurement in the past, where passenger comfort was largely forgotten about."

Our search for a comfy train seat continues overleaf – do take a seat and make yourself comfortable...

Dr Toward says that there is no single comfortable train seat. This one, on an EMR Class 170 train yet to be refurbished, has certainly seen better days.

THE BEST TRAIN SEAT…THE SEARCH CONTINUES

The seat is the core of rail's unique selling point: chair, table, window, says behavioural scientist Pete Dyson. Here, he responds to Martin Toward's research into rail comfort, talking to PAUL CLIFTON

"The railway doesn't really understand the unique selling point of its service," says Pete Dyson, co-author of the book *Transport for Humans*. "It is the seat, the table and the window.

"It can be the most comfortable and most pleasant way of travelling. First Class rail really ticks all those boxes. Standard class isn't there. It often falls short of sitting in your car, even if the car takes longer and is on congested roads. The seat is the crucial bit of a triumvirate of horizontal space for your drink, book or electronic device, and a window that is pleasant to look out of."

Dyson is completing a PhD at Bath University. In 2020 he joined the Department for Transport (DfT) as its first behavioural scientist. "People are not cargo," he points out. He says we choose how and when we travel, influenced by habit, status, comfort and many other factors that are not captured by engineering alone. Transport, he says, needs to be better adapted to human needs.

His perception of train travel ranges from the social purpose of moving between two places to the choice of fabric influencing how a passenger feels about the comfort of the foam padding beneath it.

"Comfort is a concept bundled up with other sensory experiences and expectations," he explains. "Whether we find the seat comfortable is also about perceptions about anxiety or relaxation, noise or disturbance in the carriage, and ease of getting to the seat in the first place.

"But how we design carriages has not kept up with expectations of what a comfortable seat should be. It has been too set on seating configurations, maximising capacity.

"The targets for what makes a good trip, or a good railway carriage, have been bound up by what can be quantified during procurement of the carriage. The metrics are chosen by measurable competitive tendering. They've been reduced to simple, and not very human, measures that leave comfort out of the equation.

"Behavioural science can adapt transport to a more balanced diet of options, breaking free of fast-food thinking. Travelling in healthier and more sustainable ways, overcoming the default to driving a car.

"I'll speculate that seats in the wider world – offices, homes, cars, restaurants – have moved on, raising customer expectations. In an age of ergonomics and posture being mainstream ideas, quite fairly passengers are more sensitive to the pain of uncomfortable seating.

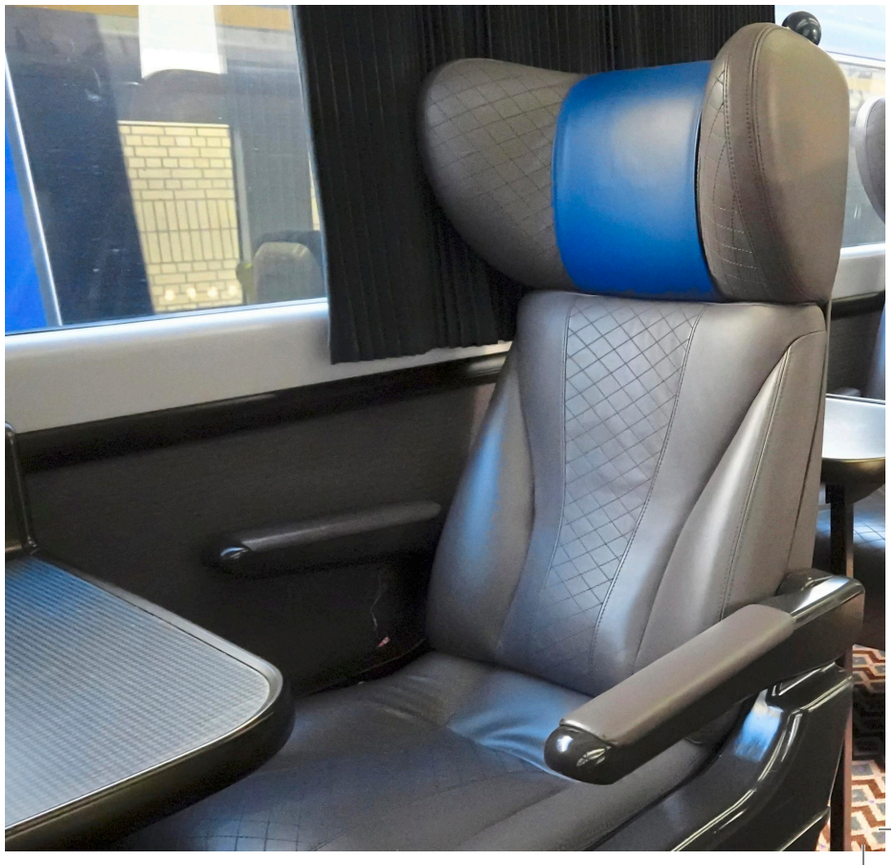
"Go upstream: what is the purpose of railways?" Dyson asks. "Why do we have them? Previously the objective was bums on seats: maximum people-carrying, largely for commuting and business travel. Demand is now more about leisure, and even more clearly about modal shift. It's about attracting people who have the choice to travel in other ways. The game is to be competitive against those other options. That moves comfort and the passenger experience much higher up the priority list.

"In this context, it makes sense to pay more attention to the seating, not forgetting about it, once the rolling stock contract has been signed. Complaints received after procurement are received but largely ignored, because engineering decisions have been taken and are seen as fixed."

Rail's strength is also its weakness, he argues. It can do many things: it is good at commuting, business travel, leisure journeys, socially important trips and bringing in international tourism. But that makes it hard to optimise for any one particular activity.

"What it has not been good at is looking beyond its immediate impact of moving people and objects, and measuring outcomes on a wider scale. Look at the recent decisions around HS2, where the benefits are measured in speed and capacity: things that are numerically easier to define. There is a convenience to immediate, quantifiable metrics. It should not stop there.

"When Canary Wharf was built, it was not apparent just how much the finance sector was going to grow, compared to other sectors. The Jubilee line was seen at the time as a quick way to get to somewhere nobody particularly wanted to be. It



Behavioural scientist Pete Dyson believes First Class railway carriages tick all the boxes when it comes to the seat, the table and the window. There is the option of individual seating with a table in this ScotRail HST First Class carriage.

far outstripped the benefits that had been imagined.

"Wind forwards a decade to the millennium. It led to the large infrastructure project of the Millennium Dome. It was derided, but it went on to become the world's largest music venue for many years in a row.

"Another decade later, the 2012 Olympics was a transport-enabled event that could not have been predicted when transport needs were appraised in the 1980s.

"People have to be stronger in their transport choices. With HS2's recent announcement, it was the cutting of the top speed that got a lot of commentary in the media. It was not translated into what that means for the passenger experience: a journey time increase of only three minutes. It was in the Department for Transport press release, but it was the engineering changes that got the headlines, not what it would mean for people on the train.

"By looking at what makes transport good for people, we unlock a whole set of ideas and policies that matter to travellers, often at relatively smaller cost, that can improve the experience and increase demand for travelling."

Dyson reckons the bus industry is well ahead of rail in this. The switch to battery power generates stories wherever the latest Chinese-built buses are introduced. But he sees more important gains at the roadside.

Pete Dyson, co-author of the book "Transport for Humans" picks out Merseyrail as an example of good practice of procuring new rolling stock, namely the new Class 777s.

What the interior of Standard Class in LNER's new Class 897 trains will look like. LNER says that the interior design has been developed with customer and stakeholder feedback in mind.

"By paying attention to what people care about on a bus trip, authorities are now investing a lot more in bus stops and bus shelters," he points out. "This would fall outside the normal engineering equation. The bus stop can't make the journey quicker, more punctual or cheaper. But people said they would not take the bus, because it meant standing at the side of the road in the rain, with no indication of when the bus would arrive. Now, by investing moderate sums in bus shelters and passenger information, and partly funded through advertising on the shelters, passenger satisfaction has improved and brought a much-needed upturn in otherwise declining ridership."

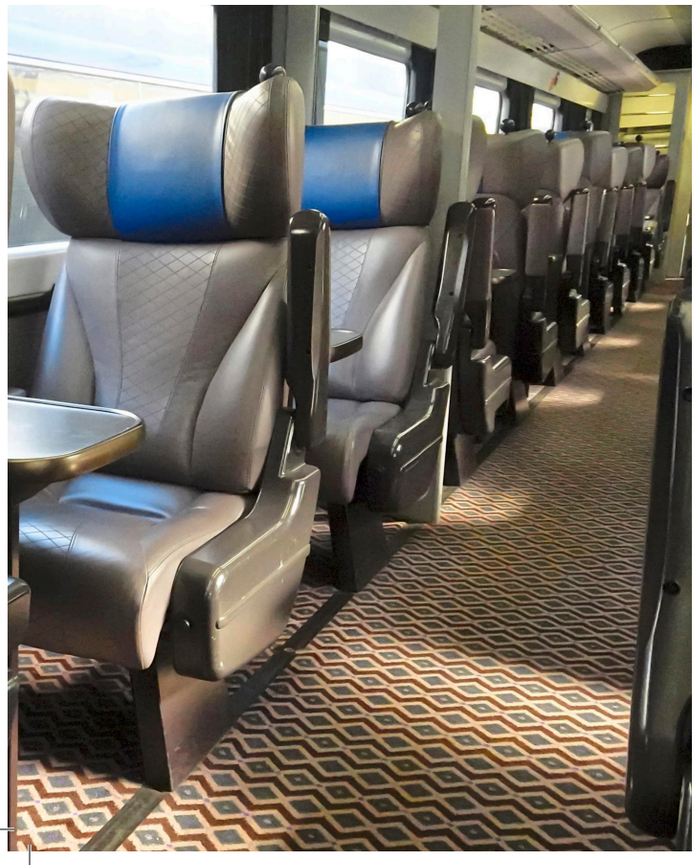
He picks out Merseyrail as an example of good practice: "I know the process it went through in five years of procuring the new rolling stock. It engaged what great engineers would acknowledge as great user design: a participatory approach.

"People described everything from the seating arrangement to the CCTV, to a livery that meant something locally and that they could feel proud of. The result is a train that people like, even before it comes alive."

Every point Dyson makes comes back to the fundamental point of who the railway is for: the human needs and choices, not the data and number-crunching that takes place before contracts are awarded.

Dyson adds: "For a long time, the railway has been sampling people who are using the service, asking what they want. But if you want to grow the number of passengers, it would be bizarre to ask only the people who are already using it. We're not speaking to the non-users, the non-travellers. They have different needs. Because, if their needs were being met, they would already be using the train.

"The research needs to pivot, to find out what the wider audience wants, if it is to give rail a go. It comes back to rail's unique selling point: the seat, the table and the window."



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