ENABLING INNOVATION IN DELIVERING HIGH CAPACITY RAIL

CATAPULT
Transport Systems

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FOREWORD

Rail travel has long been a backbone of travel in the UK. Being the oldest system in the world, it has had to evolve with the ever growing demands of our population. With rail travel and rail freight more than doubling in the last decade, there has been a significant need to address the problem of how rail will cope with increasing demand.

The new era of 'Intelligent Mobility', smarter, greener and more energy efficient movement of people and goods, has called for the transport industry to consider innovative ways to address the ever growing capacity issue right across our transport system.

The new era will need to adopt a more Human Factors led approach to design within rail, which is a shift from a more traditional technology or engineering focussed view. Understanding the needs and requirements of people that use the rail system will be key to efficiently optimising the railway's capacity. By enabling Government and the rail industry to better understand the rail user's future needs and embedding these needs within the industry's policy framework, within contracts, and then measuring delivery through Key Performance Indicators, will ensure the industry delivers a rail system compatible with emerging demand and the needs of tomorrow's rail users.

Considering the railway as a 'whole system' is imperative to understanding how to address the supply and demand of transport for users. It is key for any solution that attempts to address the problems within our transport network need to think of the holistic system in which we travel. Faster trains, with more carriages of greater length will only be effective if the infrastructure can support them and the platforms and stations, able to cope with the volumes of people that will enter and exit.

The UK is a world leader in utilising existing infrastructure and improving it with growing demand. As such, the UK has thus far maintained an incredible service whilst continually and incrementally upgrading elements of the system and improving capability. With the imminent construction of HS2, it is now the right time to examine how the UK might achieve a step change in whole railway system capability. The Rail industry is one where experimental innovation, can and increasingly must, be tried with a view to the wealth of valuable information for future decision makers that such experimentation can yield on a high density railway like our own.

Innovation is inherently risk-prone, but accepting this as part of the process of

learning from novel approaches and properly capturing and using the information that comes from trialling new approaches, will help us in building the confidence of taking calculated risks in executing innovative solutions.

Current trends in terms of rail user priorities are heading towards the need for more realistic levels of system capacity, real-time information to aid travel choices, greater retail and product flexibility, immediate system feedback and compensation when service levels drop below acceptable levels. It is impossible to think that the industry would be able to satisfy "all things for all people", but by understanding the user needs and ranking these in order of priority, it will be possible to improve the use of the railway capacity.

We hope that you enjoy the report and find it a thought-provoking and stimulating read.

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EXECUTIVE SUMMARY

The increasing demand for rail travel is placing a significant stress on the system which has limited capacity. The resulting impact on the level of crowding on many services into our cities is not delivering the experience that passengers are increasingly expecting in return for the level of fares they are paying.

There is a need for action. In the long term, the industry can't assume that passenger demand will continue to rise as new transport alternatives come to market which offer a better experience. Our infrastructure and operation is large, complex and, in many areas, ageing. Improvements in capacity and passenger experience will require innovation; it will require some of the assumptions and current thinking to be challenged and reimagined. This report is a call to action and identifies some of the main areas where new thinking can have an impact.

Improving capacity requires leadership and vision within the industry. There must be a focusing of attention on the resources and capabilities. This requires new, forward-thinking policy making which must deliver policy where the passenger is at the forefront.

There are a number of structural and organisational challenges to delivering more capacity. None more complex than the commercial and contractual framework that runs between the DfT and the train operators. Operators need new incentives and rewards for improving capacity. Better metrics should be established for capacity and levels of crowding that are built-in to the contracts. These must then be monitored and enforced. These frameworks need to reflect that innovative thinking and planning is meaningless unless it is delivered: train operators need the right structures to ensure they are pushed towards greater innovation, they deliver on their promises and they suffer no commercial penalty from their investment.

At the heart of the capacity issue is the question of the kind of experiences passengers want and that the industry is able to provide. Currently, industry policy reinforces the passenger expectation to be able to sit in reasonable comfort. This expectation is also strongly driven by the cost and pricing of rail tickets. Part of the shorter term solution could include how to make standing more attractive for passengers through more dynamic pricing models, through designing trains for more comfortable standing and through other levers which might influence passenger behaviour. A strategic description of the passenger experience should be better defined and set-out across the industry and by operators. This should be more than just saying "it will be better".

Progress in addressing capacity and experience requires a system-level approach. This is necessary to see the interconnections between parts of the transport system and how decisions made in one area can impact on others. Part of the issue is how to manage and spread demand. But there can be indirect influences on this, for example, limits in available car parking can result in more passengers having to use peak time services than is necessary as they struggle to get a space for their car when travelling later

There are, of course, wider social issues around the industry being able to manage demand and spread passenger travel across a wide time frame. The increasing move of businesses into cities and people living outside is one of the drivers of demand. So managing this needs businesses to be more flexible about the hours of working for example, and to find other ways to reduce the rush-hour demands on the rail system.

There is an important theme across the industry which is around getting the most out of the theoretical capacity that exists. A key aspect is improving reliability as train delays, both major and the sub-threshold ones, are a major drain on efficiency. There are many programmes underway to take a more proactive asset management approach to infrastructure maintenance which will improve this – the challenge is to ensure we get the benefits through more joined-up, integrated approaches.

Passengers have a part of play in the efficiency of the system. Passengers need to be helped to use the system quickly and effectively. We can look at new ways to manage people flow through our stations. There are emerging technologies that can help passengers make better decisions about which carriage to board thereby using all the capacity on the train. We can rethink the role of staff in the station and on-board the train and how they can help passengers. The challenge is to use behavioural techniques to create high performing passengers.

To meet the future demand, new capacity will have to be created in the system. Programmes such as the Digital Railway are key in enabling us to run more trains but there are also other areas to be explored that can deliver more short-term impact. The challenge of getting more passengers on the trains is complex: more adaptable and re-configurable interiors might be key to designing trains that can meet the needs of peak services as well as those times when the network is less busy. Engineering solutions like open carriages can also enable more flexible use by passengers, creating more space and allowing people to move more easily through a train.

For the success of UK rail to continue, we need to rise to meet the challenge of delivering more capacity whilst improving the passenger experience. We have to find new ways to unlock innovation, to make the space for developing and trying new ideas and to remove some of the organisational and commercial barriers. To work, system thinking and a user-centered approach have to be at the heart of policy making, engineering & design and operations.

PREFACE

This report was written by CCD Design & Ergonomics and produced with the support of the Transport Systems Catapult team.

The research was conducted with the significant support of industry experts. A full list of those individuals who participated in interviews and workshops is provided in the appendix.

We would especially like to thank, for their support and input, the Department for Transport and the Rail Executive.

INTRODUCTION

The demand for rail travel has increased enormously over the past decade. Around 1.7 billion journeys were completed in 2014 which is more than double the number in 2004. As a consequence, the demands on the system for more capacity are also rapidly increasing.

The ability of the rail network to keep pace with this demand is impacting on the quality of the travel experience for passengers. A lack of space to sit or stand is the third biggest driver of passenger dissatisfaction according to Transport Focus and the no.1 desired need according to the Transport Catapult Traveller Needs study[xxv]. Department for Transport figures showed that more than one in five passengers into London are forced to stand during the morning peak and there is a similar picture in other major cities around the country.

There is a clear need for action to increase capacity to deal with current and future demand. However, changes to infrastructure and train services are not easy to achieve within the constraints of our Victorian rail system. There are technical, engineering as well as commercial limitations which need to be overcome.

The Transport Systems Catapult is a technology and innovation centre for intelligent mobility. Its role is to drive and promote innovation and the use of intelligent technology to improve transport in the UK. The Catapult works in collaboration with industry, government, professional organisations and research bodies to look in new ways at big problems in transport.

The Department for Transport has sponsored this project with the Transport Systems Catapult to look at the problem of capacity on the railways and how innovation might break through some of the constraints to bring short and long term improvements. The Transport Systems Catapult has collaborated with CCD Design & Ergonomics who have provided the background research and facilitated engagement with industry expertise.

CONTEXT

Rail passenger demand has reached the highest level since the 1920s. The number of passenger journeys in 2014-15 reached 1.65 billion. Current forecasts anticipate continued growth with a further doubling in demand over the next 30 years[i].

This is a problem as we are running out of capacity in parts of the network at particular times of day. The latest statistics from the Department for Transport[ii] show that the overcrowding on services is worsening and that this demand is on services that were already very busy.

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The morning peak in London sees around 140,000 passengers standing as they arrive into the city which represents roughly 1 in 5 passengers.

The busiest route was that into Paddington Station which was running at 10% over its capacity. This picture is replicated in other major cities around the country: for example, Manchester was 3.3% over capacity (compared to London at 4.1%) and the most overcrowded train in 2014 was the 04.22 from Glasgow to Manchester.

It is perhaps worth noting that the level of crowding in the UK is significantly lower than some cities around the world. However, the cost of rail travel is higher here so looking at value, UK passengers are unlikely to accept higher levels of crowding.

The trend seems likely to continue. Property prices are increasingly driving people to live out of cities - Savills forecast that central London prices will rise 25.5 per cent over the next five years. The price gap is pushing more people to longer commutes in south east. However, it should be noted that in some other cities the opposite is true where 'out of city' living is more attractive and therefore more expensive.

At the same time, companies are increasingly moving into cities with an interestingly faster trend in cities other than London[iii]. This is shown in data published by the Office of National Statistics (ONS) in August 2015 showing that commuting distances are expanding and journeys to work are clustering around a smaller number of urban centres. It is echoed in the shift in average commuting times which have risen by 9% since 2005[iv] and in the fact that 48% of rail journeys are commutes to work.

One factor explaining the overall shift towards fewer and larger Travel to Work Areas (TTWAs) is the trend towards the clustering of jobs in

the city centres of the strongest cities, says Paul Swinney, senior economist at think-tank the Centre for Cities in an interview for Planning Resource[v]. These centres are the "engine rooms" that drive forward growth, he says, and as a consequence, certain businesses increasingly prefer to be based in such areas.

That's why skyscrapers are being built in London despite the cost of being there

Paul Swinney, Centre for Cities

The jobs that cluster in city centres tend to be highly skilled and well paid, so it seems likely that this trend will continue. Businesses base themselves where they can get the skilled staff they need, Swinney adds. Improving transport creates a bigger pool from which skilled workers can be drawn, he says. This trend is being seen in other counties as well, especially as a way to attract new staff amongst 'millenials'[vi].

For a variety of social reasons, it is desirable that people make these journeys on trains and public transport.Transport for London are forecasting a 60% increase in traffic congestion by 2031[vii]. As was beautifully demonstrated by the much copied poster for the City of Münster[viii],

public transport is a much more efficient way to get people in and out and around our cities. Whilst we have to recognise that for many the commute into a major city can currently only be made by rail, the future is not so clear. As an industry, it would be easy for the railways to be complacent that demand will just continue. But in the long term new alternatives will come to the market, for example, following the global investment currently being seen in autonomous vehicles[ix]. There is no room for assuming that passengers of tomorrow will continue to have no choice and so the service quality offered can be ignored.

Therefore, an important question is how can capacity be increased at the same time as providing a better level of service and experience to passengers? Passenger expectations are changing rapidly. Our views around the kind of travel we want are being shaped by our experience of other transport modes. Businesses from across all sectors are recognising the increasing value in focusing on service and experience to attract and retain customers. Technology such as social media is changing the way in which passengers engage with operators and this is also influencing expectations around experience.

In delivering higher capacity and better service, the solutions we develop also need to be considerate of those less able to use the railways. With an aging population, the concepts of inclusive design and accessibility are going to become increasingly relevant. Without focusing on them the theoretical capacity of our system will never be realised.

The equation in one sense is simple – the number of people on each train by the number of trains running – but in reality it is complex. The railway is a complex system and therefore our approach to the issue has to reflect system-thinking. There are three main elements to it:

1. There are a number of macro-components that sit around the whole issue: these might include DfT policy, regulations and standards.
2. Underneath that, the passenger journey metaphor can be used to identify the touchpoints that are influenced by passenger behaviour and sit at this junction between people and engineering. This would include elements like pre-travel information, travel to the station (e.g. bus schedules, car parking facilities, etc.), information at the station, circulation space and people movement within the station, the platform, the platform-train interface, and the train interior.

3. Finally, there are the parts which could be termed the foundations. For instance, the track, the signalling infrastructure, the timetable and maintenance regimes.

The challenge to the rail industry is how to address the scale and reach of the problem, how to look at solutions that deliver incremental change as well as bigger, probably longer term solutions that produce a step-change. Doing this will require more in the way of innovation and challenging some of the existing thinking around the problem. The role of this project has been to try to map out the problem, see what is being done in different parts of the world and other sectors and to prompt thinking differently about capacity.

LEADERSHIP AND VISION

To deliver real change around capacity will require a range of measures. Some will be local and detailed; these are likely to produce relatively small, incremental change which can be summed to supply a bigger impact. However, there are more macro, industry-wide issues that have to be tackled in order to give any step-change around capacity.

The Structure of the Railway Industry

The organisation of the railway industry in the UK does not make addressing capacity easy. In simple terms, in the context of capacity, there is policy making from the DfT, regulatory activity within the Office of Road and Rail (ORR) and delivery of improvements and operations by Network Rail and the Train Operating Companies (TOCs) with the involvement of their supply chains. There are groups such as the Railway Delivery Group who bring together the main railway organisations running events and campaigns. Finally, RSSB plays a role in driving research that can be utilised as well as driving programmes such as Future Railway.

All parts of the railway industry structure have a significant role to play in improving capacity. The likely measures required will be numerous and will be widespread. But to work effectively they will need to be joined up as they are connected within the railway ecosystem.

Whilst there are a number of policy papers published by different organisations that relate to capacity there is no single, industry vision of outcomes that are desired. There is no single, common plan of action. Arguably, the DfT should have the lead role to facilitate in the development of new policy and vision for capacity improvements.

If the capacity problem is going to be tackled then it needs a consistent and coordinated vision and modern, joined-up policy making.

CHALLENGE #1

Who will provide the single vision and leadership that all of the industry can fall in behind?

FUNDERS
DfT

PARLIAMENT

ORR

NETWORK RAIL / TFL / HS1

SAFETY BODIES
HSE / RAIB / RSSB

TRAIN OPERATORS

PASSENGERS
PASSENGER BODIES

INDUSTRY ORGANISATIONS
ATOC / RDG / ROSCO

an overview of the rail industry

A National Vision

Thinking around policy is often London-centric. Many of the capacity problems do lie in London but there are similar and different challenges in other parts of the country that have to be addressed.

Capacity in London is largely a feature of trains coming into the city in the morning gradually filling until capacity and then emptying at the terminus; the evening is a reverse of this starting at or near capacity and gradually emptying over the route. However, outside of London the picture is frequently different with a train often filling and emptying as it comes towards and passes the cities. The solutions that policy drives may be very different in each situation.

To provide policy that is united and consistent means that it has to be applicable, useful and relevant to all parts of the country facing capacity issues now and in the future.

CHALLENGE #2

How can we capture and coordinate a better understanding of the regional variations in how capacity works?

Making Policy for the Future

Policy can be a cumbersome tool that is slow to respond to change. In an inherently conservative and risk averse industry like rail, this can result in policy that is backwards looking by the time it is implemented. **To drive change in capacity, policy and vision has to be driven by social and technological trends like urbanisation, the influence of technology on working patterns and the aging population.**

Passenger Power

For many years the railway industry has often been accused of focusing on running a train set that just happens to have passengers

riding on it. Whilst not entirely fair, it does reflect the industry's heritage that is more vested in engineering and operations to deliver a commercial service.

Transport for London

TfL offers an interesting model in two respects. As an integrated, multi-modal operator it is able to present a more unified transport system to passengers. This is perhaps best represented by the Oyster ticketing system but extends to the visual branding. For example, with London Buses, a number of private operators run the routes but to the passenger this is almost invisible. The second aspect is the funding arrangement which means that, as a non-profit making organisation, TfL can invest its profits back into improving services. As such it is set up to keep passengers at the top of its priority list.

To address capacity requires the development of policy and frameworks that support train operators in being more passenger-orientated in their thinking and in investment decision making. In the current railway industry, organisations like Transport Focus and the Campaign for Better Transport offer the voice of the passenger. Whilst they are influential, they act as a research and a lobby group and have no direct power. In other organisations there is recognition of the passenger, for example, the Railway Delivery Group has working groups looking at customer experience. However the real tools and levers of action, such as the franchise agreements, have significantly less to say about passengers.

CHALLENGE #3

How do we get passenger needs sitting higher (or at the top) of priorities in policy making?

The Commercial Imperative

Innovation can be difficult to take on in a commercial environment when the outcomes are uncertain and the incentives for achievement are not clear. The current nature of rail franchising makes it difficult for train operating companies to invest in improving capacity when the link to any return on the investment is not obvious. Often the problem is that the investment cost falls to one party when a different organisation reaps the benefits. So in order to provide significant changes to capacity, there needs to be some challenges made to the commercial models operated by organisations in the industry, most notably with train operators. There are some significant opportunities for changing thinking: research from TSC & the Temple Group suggests that the "customer experience" market is going to grow from £0.3bn in 2014 to £91bn by 2025.

Innovation in this area has to be something that is delivered by the operators rather than just being an attractive offer in their bid. For example, it would be a positive step if more train operators had a Head of Innovation role in the business.

An important factor is to ensure that the commercial considerations and incentives don't produce the wrong result for passengers. For example, in Seoul a number of reforms were made in 2004 to its bus and metro services to remove commercial issues that were resulting in poor outcomes – previously operators sought maximum profit at the expense of passenger safety or comfort; bus drivers would race each other to try and get to the stop first to get the passengers as the operators were paid per passenger carried; drivers would even fail to stop for elderly or disabled passengers to avoid wasting time. Following the reforms, passenger satisfaction and ridership have risen significantly.

More capacity has to be built without affecting the ability of operators to make a profit; but it also has to be seen that the increase in capacity is not something that should be subsidised by the passenger. Their viewpoint is that a seat is a basic level of service which is what they have paid for. The challenge is paying for these improvements just to get the service up to a level of meeting a basic need.

In the future, especially for capacity and improving passenger experience, the franchise agreements have to give a much clearer direction on the balance between service quality and commercial decisions.

Residual Value Mechanisms

The DfT is now making greater use of Residual Value Mechanisms in train operator franchise agreements. These are intended to overcome the commercial resistance to investing during the lifespan of a franchise most notably when the payback period is likely to extend beyond the end of the franchise. In this case the Train Operator would receive an agreed payment from the DfT at the end of that period. Various options around how these are agreed are now being implemented. Unfortunately, it is one of those actions where is it not possible to quickly see if the desired outcome of increased investment are happening.

CHALLENGE #4

How can we create the environment whereby train operators prioritise passengers, which means providing capacity such that journeys are not a poor experience, whilst still making a profit?

[1] There are some variances to this, for example, South West Trains commuter services use 0.25m2 per passenger. Additionally, some train operators have no standing space allowance.

Making it Real

The DfT sets targets and publishes data on overcrowding based on the calculation of 'passengers in excess of capacity' (PiXC). Currently, the broad target for operators is that passengers should not have to stand for more than 20 minutes.

The capacity measure considers a space allowance per passenger of 0.45m^2 of floor space[1]. However, it is recognised that PiXC is a model and, importantly, it represents a statistical average so is not likely to be representative of the daily experience of many passengers.

These targets and standards are well meaning but the train operating companies have no mandatory targets in relation to PiXC or any other measure of crowding. So there is no incentive to meet them, and perhaps more crucially, there is no enforcement or penalties when they are currently regularly not met.

For the DfT to show leadership around capacity, the targets it sets have to be mandated to train operating companies as part of their service agreement. They also need to enforce compliance with significant penalties to operators who breech the agreements.

Influencing Expectations

These targets are important as part of delivering the service quality but they also set expectations amongst passengers. The target that a passenger should be able to sit on a journey of more than 20 minutes in the peak sets an expectation that a seat is a basic provision. The current policy reinforces the public perception that they have paid for a seat – which they have not, they have actually only purchased a right to travel.

The more complex question for the industry is whether or not this is the right expectation to be setting? Given the level of demand on the service and the constraints of the infrastructure, should policy be more that standing is an acceptable part of many rail journeys?

Is standing for a maximum of 20 minutes right or should we be focusing on longer but more comfortable standing on some services? Should we focus on how to make standing more acceptable to passengers?

Power of Big Data

Good decision making around policy has to be driven by good information. Historically the availability of good data on the railways has been problematic with a significant time delay between collection and use.

For data to become a stronger enabler to forming better policy, there will be increasing use of technological solutions that can generate data for use almost in real-time to inform decision making.

This might include new channels for understanding, capturing and analysing what passengers are experiencing on services such as social media. Perhaps of equal or more power is the increasing availability and affordableness of sensor technology under the Internet of Things banner. Getting useful data on where passengers are, where they are moving, how many are in a space, etc has always been a problem for the railways. Being able to get it now and combine historic data with other information such as weather is going to be increasingly valuable in making detailed predictions about future demand.

Policy Outputs

To help to unlock future capacity is policy capturing the right kinds of outputs? Are these the kind of outputs that are useful and helpful to train operators and their passengers? Are these being built-in to the funding and franchise agreements in the right way to have the necessary impact? Are the policy measures relevant to the real world?

It is critical that policy is defined in terms that are relevant to the real-world experience of passengers. Policy has to require train operators to meet levels of capacity through appropriate incentives or penalties.

But first it seems necessary to define the travel experience that the railway wants to deliver. There is a lack of definition around the kind of passenger experience that the capacity agenda should address. All of the passenger experience position papers and statements across the industry make very valid statements about seamless travel, better information, transparent ticketing structures etc. But none define the kind of experience that peak-time travel should be and should realistically be in the short to medium term.

CHALLENGE #5

Maybe we need to find a different experience that still has value to passengers?

Getting the right outcomes is the major challenge of policy. The policy output might be a drive towards provision of seating for all passengers. But, in the short term until significantly more capacity is introduced, this would logically lead to things like all seat reservations on all trains which would result in a lot more people having to wait for another train.

Getting the right outcomes might need different research into passenger needs that could use alternative design research methods in combination with market research techniques which capture passenger wants. **At the moment the industry seems stuck in trying to meet the expressed passenger 'want' to have a spacious and comfortable seat for every journey and being unable to meet this for many peak journeys into our cities.**

CASE STUDY

OPENCAPACITY AND C2C
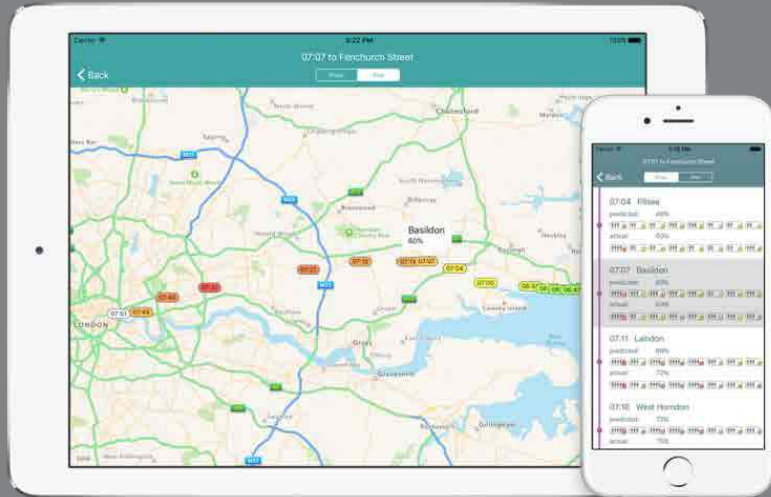
OpenCapacity is a system that aims to provide real-time and predictive information on train capacity. In a similar way to the existing technology showing us congestion on the roads, the OpenCapacity system uses a variety of sensor information to establish current loading on a particular train. This utilises existing technology including weight measurements, CCTV, sensors in the doors, Wi-Fi locating of mobile devices and 3D sensors. These measures are cross-referenced to validate the data.

But the power for the passenger is in giving more information than the current loading of an arriving train. The value comes in predicting how crowded it will be on departure. Here the data gathered over time is fed into an algorithm that is cross-referenced with other data including live diruptions and delays, the

weather and event calendars to predict the likely capacity during the rest of the train journey and on future days.

The information can be displayed, in real-time, inside the trains, at stations and on mobile devices[x] to inform passengers, and foremost to provide operators with a data-driven management tool to plan, manage and optimise train capacity utilisation.

In early 2016, the team released a demo app on iOS that uses data from the c2c network to demonstrate the concept.

OpenCapacity is a UK-based start-up that is funded by RSSB/FutureRailway. For more information, visit www.opencapacity.co.uk

THE PASSENGER

If we need to focus more on the passenger in addressing capacity how can we understand the enormous range of views, needs and wants. The engineering elements of the problem are largely definable and quantifiable. The passenger is more of an unknown quantity and their behaviour is unpredictable.

The objective is to improve passenger satisfaction with rail travel. Satisfaction or dissatisfaction can be thought of as the gap between expectation and experience. So there are going to be a number of drivers of passenger expectation which will include passengers pick up from the industry, from Government, and from the press and media. Individuals will develop their own perspective on value for money and cost and this will be partially defined by their previous experience of transport in general. So if the expectation of a passenger is that they should be able to sit in comfort for their journey and they are forced to stand, then they are likely to be dissatisfied.

❝❞

Overcrowding is cited by Transport Focus as the 3rd biggest driver of dissatisfaction[xi]

However, understanding the relationship between expectation and experience is not always as obvious at it may seem. Human psychology plays an important role as it brings in natural biases which influence our perception and decision making.

Houston Airport were getting a huge volume of customer complaints about long waiting times at baggage reclaim. Their initial response was to increase staffing to reduce the wait time. But this only brought down the complaints by a small amount. So they took a closer look at the system and discovered that the passengers only had a short walk from the gate to reclaim. They tried moving the gate further away and moving the baggage to the furthest carousel. The walking time increased by six times but complaints disappeared to near zero. The lesson, in this case, was that it is was the psychology of waiting rather than the actual time spent waiting that was important: occupied time feels shorter than unoccupied time.

We also have to understand the behaviours of different passengers within the system. Some of these act as a blocker to the efficiency of the system. A better understanding of the variety of passenger needs, wants and mental models at different stages of the journey can be useful in predicting behaviours. This can be used alongside the various psychological models of perception, decision making, etc. as well as consideration for social and cultural norms.

For many passengers the stress of a journey comes from confusion and not knowing how things work. But often it is about a loss of control and there are lessons rail can learn from the airlines. For example, flight information is, for some passengers intrusive, difficult to hear and confusing – instead, you could create a more empowering solution using the inflight entertainment system to put this information at their finger tips[xii]. Giving passengers control over information like when the meal service will begin or if the toilets are engaged helps them to know what is going on.

Of particular importance in looking at how we can help passengers use the system efficiently is understanding those people who are likely to have more problems navigating the system.

CHALLENGE #6

How to deliver passenger experiences they can create so that they feel in control?

So a particular focus on those with mobility or sensory impairments is critical alongside those, for example, travelling in groups perhaps with children or travelling with luggage.

Customer experience is a significant marketplace. The Transport Systems Catapult estimates that customer experience within Intelligent Mobility is a £334bn market.

If the railways are to continue to attract more passengers over the long term and remain the successful transport system that it is, it needs to be paying more attention to the passengers and less to the infrastructure that they use. We need to be very clear on the kind of experience we think passengers should get for their money and ensure that we deliver that from the start to end of their journey and do it day in, day out.

MANAGING DEMAND

The strain on the rail system comes from the need to support so many people needing or wanting to travel in and out of our cities at the same time of the day. The demand is increasing as businesses increasingly migrate to the cities and the workers are forced, for a variety of reasons, to live further away and commute.

Levers to Influence Behaviour

At the same time as looking at these macro issues we also need to understand better who is making up this peak time travel population and what controls might we exert to try and manage or spread the demand. For this we will need better, bigger and faster data. The DfT does currently publish national travel habit survey information, but these are large, census-type surveys which take significant time and effort to collate. To help tackle capacity we are going to need closer to real-time information which will need new technologies to unlock.

Price and Ticketing

Pricing and ticketing are key levers in influencing passenger behaviour, their perception of value and subsequently their satisfaction. The current ticketing structure has long been identified as a barrier to improving passenger satisfaction. For example, across London & the South East, for only 40% of journeys do passengers feel the cost of their ticket is good value for money according to Transport Focus.

The question now is whether ticketing and pricing needs to play a stronger role in helping to manage demand. There are two separate questions in here: one is whether pricing can help spread demand; the other is whether pricing can help manage demand for a different service level such as standing.

> **"**
> We know that around 20% of the peak time passengers are non-regular travellers. Why are they having to use peak services?
>
> Marcus Mayers, Open Capacity

Of course we already have a pricing mechanism for this in the differential between peak and off-peak fares with the increasing trend for different fares for the shoulder-peak period. In 2014, MTRC in Hong Kong, trialled a 25% discount for off-peak travel for holders of its Octopus smart ticket over a 9-month period[xiii]. However, research suggests that this is not a strong tool for the industry to be able to manage the demand into the future and new options are required.

The opportunity is for ticketing and pricing to become more dynamic and more flexible. It may be that pricing needs to respond more quickly to the actual demand on a service as it is running. This could be similar to the pricing model used by organisations like Uber where the cost of a journey varies by demand which can be driven by events going on or the weather or any number of other factors.

The other opportunity relates to whether pricing can be used to change the expectations of passengers around their travel experience. For example, if to optimise capacity we need passengers to stand, then part of getting their acceptance of this might be through a reduction in their ticket price. Perhaps the first barrier to overcome is around revenue protection and how do you ensure someone who has paid for a standing ticket isn't then taking a seat. Research has shown the role of fares and pricing in setting expectations: for example in aviation, economy and business class passengers may have very similar perceptions of comfort quality, because of their expectations, which have been influenced by cost[xiv].

So we need new models of pricing and to be able to see how they might impact passenger behaviour and help spread the demand. We need the regulatory system to become an enabler not a barrier to innovation in this area. We need new technologies to help develop systems that can work to deliver dynamic ticketing: this can possibly feed off the growth of Mobility as a Service.

How else can we influence behaviour? Cialdini, in his classic psychology text on persuasion, identified six basic phenomena that favour positive reactions: reciprocation, liking, commitment & consistency, authority, scarcity and social validation. Reciprocation is interesting as it requires an organisation to give something away first before the service is received – historically the railway industry doesn't work like this and is still some distance from always treating passengers as valued customers.

Commitment and consistency demands that an organisation delivers on its promises – again the railway often falls short at the moment when delivering on the basics, day-in, day-out. Social validation is about following what others do – an example, was a study at a hotel on reuse of bathroom towels: the study found a much higher rate of guest reusing towels when the information in the bathroom was framed around the majority of other guests reusing the towels rather than signs which asked people to participate.

There has also been much debate about so called Nudge Theory in recent years. Nudge is a concept in behavioural science that using reinforcement and indirect suggestion can be a better way to encourage people to behave in new ways without forcing them in a more direct way. Whilst the theory is gaining ground in business, the main area of adoption has been in government and social policy: hence, the often cited example being workplace pensions in the UK. The scheme automatically enrols employees in the scheme whilst giving them the option to later opt-out. Doing it this way round results in far greater levels of take-up. The principle here is making it easy for people – it is easier to go along with being enrolled rather than opt-out.

Back in 2010, there was a debate in aviation circles about the potential for "standing seats" on planes. Whilst there were many safety and regulatory issues in the discussion, the question of passenger acceptance was a strong line. Ryanair conducted an online poll of its customers asking whether they would be prepared to stand for a one-hour flight if the fare was free or half of that of a seated passenger. 66% said they would stand if it was free and 42% said they would if it was a half-fare. A separate poll around the same time taken in China found similar results.

CHALLENGE #7

What other levers can we find to influence passenger choices and behaviours beyond pricing? How can psychological and behavioural science concepts like Nudge make a difference?

System Influences on Behaviour

Viewing the wider transport system is a useful approach to seeing how other parts of the system impact on demand. One key part of this is the interchange with different transport modes. For example, how the demand for a particular train service might be influenced by the timing of a bus service that feeds passengers in.

The second part of this is seeing how other parts of the system influence, and indeed, control the behaviour of passengers. An obvious example of this is car parking at stations. For many commuters into cities, the first part of their journey from home to station is made by car. But it is a common refrain that "I have to be at the station before 8am in order to get a space in the car park". **So a lack of car parking becomes a behavioural driver for some passengers, who might have no other need to be on a peak train, travelling at that time.**

CHALLENGE #8

How can we best map the wider transport system to understand the external drivers of demand that we need to include in design solutions? How can we understand how they influence passenger choices and behaviours?

Social Influences on Travel Behaviour

There are wider drivers behind the choices that passengers make as to if and when they travel. Many of these more social factors are not in their control and nor are they under the control of the railway industry. But they are worth examining and considering how they might be influenced. Two of the strongest

factors are working hours and working location: our businesses are moving increasingly into the cities and we are still largely built around a 9-5 working culture.

As a consequence, for many travelling by train at peak time is analogous to a "distressed purchase" where the customer has a desperate need to buy a particular product, at a particular time, with limited personal choice.

What incentives can business be given to change any of these? Or can there be incentives around more marginal changes – for example, would it help if companies were better at not organising meetings to start at 9am so everyone had to travel in at peak time?

Part of this discussion is also the continuing debate about flexible working and enablers to workers being able to work in different locations and to change their travel pattern. Technologies like video conferencing have been at the heart of this argument for the last 30 years with only marginal changes in our need to be working in the same physical space as others. Arguably the digital revolution will only increase the opportunities for more flexibility in the future but it is difficult to determine which path this might take.

CHALLENGE #9

How can we get businesses to take a lead in driving changing travel behaviours?

Influencing Behaviour with Information

The final part of the question of managing demand is how we can better help passengers to help themselves. Better information is at the heart of any solution. If we want passengers to use the less busy services, then we need to tell them which trains those are. Some of the train operators, such as London Midland, have started to address this with posters at stations. In Japan, on their metro systems,

graphic posters are used to show the level of crowding on different services.[xv]

Currently these are all on the basis of historic data – what passengers need is a more dynamic system that will tell them which services are busy now and over the coming hours. In time the technology will benefit from better algorithms that integrate with the passenger location and other data sources.

The other approach to using information is to help people make alternative choices about their mode of transport. Of course this might challenge the natural desire of the industry to attract as many passengers as possible. But there might be situations where it is appropriate to provide more information on options in a similar way to the example below of the London walking tube map.

It has long been known that the walking distances between many parts of London are not very big but for lots of visitors their understanding of the geography of the city is driven by the Tube map. The Tube map is schematic so gives no sense of relative distance resulting in many people taking train journeys for easily walkable journeys. Over recent years, there have been a number of people producing maps that provide this information but it is only recently that Transport for London has issued its own map showing the walking times between stations. This information can help people make better decisions – in this case, possibly not taking a train at all.

Walking times between stations

TRANSPORT FOR LONDON
EVERY JOURNEY MATTERS

CASE STUDY

CLoSeR

The CLoSeR project is one of the winning projects receiving funding from Innovate UK on Enhancing Customer Experience in Rail Travel[xvi] competition. Innovate UK and the FutureRailway programme are investing up to £6 million to support business innovation in digital technologies that improve the customer experience in UK and international rail markets.

The Customer Loyalty and Dynamic Seat Reservation System (CLoSeR) is a joint project led by Unipart Rail and includes TrainFX Ltd, Loyalty Prime Ltd, First Great Western, The University of Warwick and Cranfield University. It is one of eight projects to receive funding under this Innovate UK competition.

The project seeks to develop a system that will personalise the relationship between the passenger and the train operator before, during and after travel. A combination of in-seat instrumentation, mobile applications and back office systems integrated with a customer loyalty platform, will enable a customer's experience to be substantially enhanced through the delivery of individualised information, services and rewards by the train operator to the benefit of rail travellers.

The project will benefit the train operator by enabling operating efficiencies and associated cost savings, creating a foundation upon which an almost endless range of opportunities for personalised passenger communication and engagement can be built.

GETTING MORE FROM WHAT WE HAVE

Whether it is now or in the future, part of the equation has to be 'how do we get the most capacity out of what we have already?'. The answer to capacity is not about just waiting for big infrastructure projects to deliver improvements. We have to squeeze everything out of the whole system - not just the infrastructure.

Innovation in Operations

The operational environment in UK rail is a product of 150 years of trial, error and refinement. When combined with the age and complexity of the infrastructure, this is arguably its strength and its greatest weakness. If you were able to start from scratch, with a focus on optimising capacity, the current organisation may not be where you would get to.

Where is the innovation in operations? Where are the services providing, say, a rapid shuttle service between critical points? Or looking at a baseline, off-peak service that runs every day with variable services to meet daily additional demand?

Can we operate a more flexible timetable that makes more space for passenger trains at peak times with, for example, less freight traffic? Do passengers need a timetable or is it too rigid a structure for getting more capacity into the system? What other models could we try?

Timetabling is difficult and the organisational complexity of working in this area means that those developing the timetables are often in silos and do not always benefit from good feedback from the operational staff on the frontline on the success or otherwise of the plan. More focus on these feedback loops could bring some opportunities: there are some research projects into technological tools to aid this[xvii].

Could we change some operational processes to make them faster and less disruptive? For example, could we split or join trains while they are moving?

One key area is the approach taken to capacity & operational modelling. There are a number of ways to model capacity based on theoretical, practical, used or available capacity. The problem with the most common modelling techniques is that they fail to take sufficient account of passenger demands including punctuality, connectivity, comfort and information needs. What is needed is a new model of capacity that equally considers the system requirements and passenger satisfaction.

CHALLENGE #10

So how do we start again and re-design and re-design something fit for our needs with a live railway still to run?

Leaking Capacity Through Unreliability

To get the most from the system we have to optimise reliability. Every time a train runs late we are sacrificing capacity. There is a growing consensus that the railway industry in the UK needs to move to a more proactive, predictive asset maintenance approach. There is an opportunity through technology themes like the Internet of Things to deliver cheaper sensor technology for remote condition monitoring etc. There are already a number of programmes being implemented or in development to deliver better asset management: for example, LADS, I-RAIL, PCIPP and the RSSB Future Railway programme on condition monitoring. But there is still further potential to look at applying these and other programmes in a more integrated way with better industry-wide benefits.

Another major cause of delay is suicide and trespass. Projects such as Restrail[xviii] have been undertaken to look at the causes, prevention and mitigation of the effects of suicide.

Our ability to recover from those failures determines how quickly we get capacity back into the system. For example, can we rethink the use of speed restrictions to help increase capacity whilst maintaining safety?

Optimising Passenger Flow Through the System

Part of the complexity of creating a highly efficient railway that can optimise its capacity is the passenger. As discussed earlier, the passenger is highly variable in their behaviour. Lots of work is currently done trying to model people flow through stations and on and off trains using various computer simulation tools. However, the unpredictability of people can disturb this when individuals behave differently

– for example, the person that arrives at the ticket barrier with their ticket still buried in their bag; or the person that gets off the train and immediately puts all their luggage down whilst they orientate themselves.

To address people flow through the railway system, it is necessary to examine all of the steps and identify the pinch points: the system will only move as fast as the slowest point. This can benefit from a focus on human-centered

The theory of marginal gains is all about small incremental improvements in any process adding up to a significant improvement when they are all added together. Perhaps the most well known example is the approach adopted by Sir Dave Brailsford when he became performance director of British Cycling. He saw it was possible to break down the objective of winning races into its component parts and that if it was possible to make a 1% improvement in a whole host of areas, the cumulative gains would end up being hugely significant. For example, he found in the mechanics' area that dust on the floor was impacting on bike maintenance. So they painted the floor white so they would notice any impurities. The result has been that British Cycling has gone from also-rans to dominating the last two Olympic games and events like the Tour de France .

design approaches.

Part of the problem is getting passengers to understand how the system works and the value in behaving in a way that helps everyone, even if that seems at odds with their personal objectives. This can be seen in the recent resistance to the message from TfL that in some Underground stations the people flow would be more efficient if everyone stood on the escalators rather than most people standing to the right and leaving space for a small number of people to walk past. So there is a challenge in communication, motivation and psychology. Some of the approaches need to be explicit whilst others are likely to more nudge behaviour – an example being moving power points away from the aisle seats in an airport departure lounge to encourage people to sit in different spaces[xix].

Getting passengers moving efficiently and effectively around our stations is in part, a wayfinding task; and is one where there is substantial room for improvement. There is a role for greater consistency around signage in stations – whilst the major stations have a similar look based on the Network Rail standards, the remaining stations have a variety of signage under the TOC branding.

Dwell Time and the Platform-Train Interface

Getting passengers on and off the trains quickly and consistently is a key component to the efficiency of the system. There are three parts to the dwell time question as far as optimising capacity is concerned. The first is minimising the time that the train is stood still at the station. The second is ensuring that all the passengers can alight and board consistently within that time allowing the train to always depart on time. The final part is helping passengers to board the right parts of the train to optimise the use of space.

Minimising the dwell time is actually quite a complex interaction between the engineering of the train and a series of human processes. Two significant parts relate to the design of the train and these are the braking and acceleration

performance of the vehicle. Within the tolerances for passenger comfort, the faster the train can brake and then accelerate out of the station, the less impact stopping at the station has on the service. For passengers, this performance has to consider that, especially for coming into a station, many passengers will be standing at this time ready to alight.

The other important element is the opening and closing of the door. Again this is an engineering issue that also relates to the aerodynamics and structure of the vehicle. But the time difference, for example of the opening and step deployment for a Class 373 Eurostar is vastly longer than a Class 332 used, say by Heathrow Express. In thinking about the concept of marginal gains, this door opening time, spread across the service, adds up to a significant amount of time that could be used for boarding or for the train to be moving.

The major human process is obviously the passenger movements of people alighting from the train and then other passengers boarding. There are numerous design variables including the number of doors, the width of the door and how that influences the passenger movement through the space, the layout of the vestibule setbacks, the presence of steps from train to platform and any gap between train and platform. These are explored in more detail in the next section looking at building in more capacity.

There are two elements of the people movement that can be looked at now in order to help optimise efficiency. First, the people getting off the train and second, those getting on.

The first element, or problem, is getting the passengers already on the train ready to alight and how to get them dispersed and away from the train as fast as possible. We have all experienced trying to board a train when the train arrives and only then do some passengers start getting their bags and personal items together and hold up the boarding; or the person, probably new

to the station, who gets off the train and stops in the doorway whilst they work out which direction to go in. How can better information influence this kind of inefficient behaviour? Would more specific arrival information, such as a countdown, help encourage passengers to be ready to alight? Would information before the train arrives on which direction to go when leaving help encourage more efficient people movement? Would better signage immediately in front of the train doors on how to exit help passenger to disperse quickly? At the moment, these performance inefficiencies are largely ignored.

In recent years, Transport for London has been trialling countdown clocks at pedestrian crossings. The objective was to optimise use of the 'green light' time, improve safety and help pedestrians, especially those with mobility impairments to feel less rushed. The time between the 'green man' and 'red man' has a visible countdown clock showing the time until the light goes red and traffic starts to move. This gives the pedestrian certainty over how long they have to clear the crossing. The trial has met with a very positive reception[xx] from pedestrians – especially the mobility impaired of whom 95% liked the system. Notably pedestrians felt less rushed and yet there was an increase in overall walking speeds. The results suggest that providing this kind of information can have a positive influence on behaviour. Could there be something similar to get passengers ready to alight on the train or be used during a station stop to show when the doors will close?

It should also be noted that if, in the interests of capacity, the thought is to accept more standing passengers on a train then this will have an influence on dwell time. A UCL & Arup research project[xxi] identified that crowding in the vestibule area had a noticeable impact on the achievement of target people movement and dwell time.

The second element of people movement is around the behaviour of those waiting to board the train. Can we get gains out of better organisation of passengers on the platform, especially at busy stations with already crowded trains? There is little research that has been done in this area to show what kind of performance benefit might be accrued from this[xxii]. But what the research does show is that the performance of boarding is an interconnected series of events[xxiii] from the platform, movement through the door, movement through the vestibule (assuming the passenger is heading to an available seat), finding a seat (which takes longer if this is a service with seat reservations) and storage of any luggage and other personal effects. There are examples of interventions to influence this, notably in Japan, but many are very specific to the cultural and behavioural norms of that location.

The aviation industry has played with different solutions to help speed boarding[xxiv]. In most cases, airlines prefer to try and board by seat row starting at the back. This is complicated by the fact that there is an expectation that First and Business class passengers board first and they are invariably at the front of the aircraft. However, trials have been run on different approaches including the 'outside in' where you board window seats before aisle seats and pre-boarding preparation where passengers stand in a seat-based grid at the departure gate. Designers have also come up with sliding seat solutions which help widen the aisle during boarding. Of course the aviation boarding conundrum is not the same as boarding a train, which has multiple doors, existing passengers in seats and unreserved or reserved seating. But it raises the question of what could we do on particular services to maybe help speed boarding?

The Role of Staff

An area often ignored is the role staff can play in helping passenger movement and flow. In most railway stations, staff are present to respond to questions from passengers and dispatch the train. Rarely are they more proactively used to help passengers move around a station. An extreme example of human input to people movement was the role of the volunteers at the 2012 London Olympics; **a more common example is the work of the station staff on London Underground to get passengers ready for arrivals, leave space for alighting passengers, quickly board the train and keep the doors free when the train is ready to depart.** In New York, the Metro is including a major increase in platform staff as part of a range of measures to try and improve service and reduce overcrowding.

The challenge is in changing the role of staff in the station and overcoming the natural resistance to this. A more proactive assistance role is a different skill set which may threaten some of the existing jobs. But it also means that the operators have to equip the staff to be mobile – they need better ways of receiving information that they can disseminate, for example. The key is an organisation that empowers staff to provide better help to passengers where the rules and regulations don't hinder the assistance.

The opportunity is for more real-time and predictive data on passenger movements to help them anticipate problems better and be in position to offer the right kind of assistance.

Outliers and Trends Changing Boarding

There are other factors influencing the dwell time performance some of which are having an increasing impact and others that have a less frequent but more significant impact. Two growing influences are the presence of more bicycles on trains during the peak as cycling to a final destination becomes more popular[2] and an ageing population introducing increasing mobility issues in the travelling population.

Bikes, like luggage, present a problem for the efficient use of space on trains. The volume of personal items carried on trains is not well researched or understood. But clearly they take additional space and, notably with fold-up bikes, are usually stored in a place that obstructs the doors and vestibule areas. Storage areas might work but in crowded conditions they are likely to be underused. The system view would also think about providing more encouragement to alternatives such as using the Santander Cycle scheme in London.

Less frequent, but with a more significant impact on individual train dispatch, is the need to provide boarding support to wheelchairs and other mobility aids through the provision of ramps. These are slow to deploy and operate and create small delays in the system for a number of trains.

CHALLENGE #11

How can we develop better research to move us to a more informed design practice to optimise dwell time including both engineering and human elements of the system?

Information and Passenger Decisions

At the moment, passengers are largely in the dark on the likely crowding on the train they are about to get on. They don't know how busy it will be and whether the whole of the train is the same or not. So their choices on which carriage they ride on are more driven by where they enter the platform, their initial perception of groups of crowds already on the platform, and most critically for many people, where do they want to be when they get off.

This would suggest that in many services there is overcrowding in some carriages with more capacity in others. How do we better encourage passengers to use the free space, moving to different parts of the platform or moving down the train itself once on-board? There might be physical prompts of this like ensuring that the platform is covered for its whole length (who wants to wait in the rain for the end carriages when you can stand undercover?) or they might be supported by better information.

Recently some train operators have started to try and provide more information on the usual level of crowding on some services – for example London Midland[xxv] produce posters at their stations showing the number of carriages on each service and the likely level of crowding (seats available, only a few seats left, standing room only). This is a useful starting place in helping passengers make better decisions about which train to catch if they want to avoid the crowds. The next step is making this information dynamic and real-time. As data sensor technology improves, giving us better passenger counting information, this is getting easier to achieve and there are already trials and initial systems that are taking this forward. Furthermore, the development of wearable technology is giving rise to devices that can deliver targeted information but can also track the emotional state of the user. This gives further potential to tailor the information to improve usability and meaning.

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[2] Cycling in London has increased by 117% since 2000. As an example of a manufacturer, Brompton has had annual sales increases of 25% for the past 6 years.

CASE STUDY

**PLATFORM PASSENGER INFORMATION TRIAL
DUTCH RAILWAYS**

To accommodate the future expected growth in rail services and an increasing frequency of trains, Netherlands Railways recognised that the platform environment was going to become increasingly confusing for passengers. The complexity was consequently going to introduce more delays into the train service as getting passengers on and off would be slower than it could be.

This situation led to a very collaborative project to look at a system that would improve crowding on the platform, would help passengers optimise the use of all available space on the train and would help the operator optimise the use of

the platform resulting in shorter dwell times. Netherlands Railways, in collaboration with ProRail and design agency edenspiekermann, ran a trial project to test new technology to address these objectives. Firstly, they needed to find a technology that would help them understand exactly how many people were on a train and where they were at any point in time. The trial was run on 11 trains using infra-red sensor technology at the doors and at key locations in the carriages. They looked at different scenarios where this information could usefully be provided to passengers which included directing people to accessible doors, finding the right class and, more

interestingly, loading information on each carriage. The information was delivered to passengers via an app to their smartphone. This personalised information was supplemented by large digital displays which were trialled at Den Bosch Station. These displays were used to provide information on the next train including the location of the doors on the platform as well as where services were located on the train. It also provided the loading information to show which carriages were busier than others.

The Netherlands Railways team observed an instant behaviour change in the passengers with more people moving down to get on the

emptier carriages. The information on the app and the platform was clearly immediately understandable and useful. Their qualitative research showed the system had a positive impact on passengers, conductors and drivers. In particular, passengers welcomed indications of the location of specific door types. Their quantitative research was less clear. **There has been a measurable impact on reducing delays around dwell time at the trial stations** but the contribution of the new system is hard to extract.

The trial was positively received and is now being rolled out in a limited form to other trains and parts of the Dutch rail network.

The High Performing Passenger

Regular commuters are often thought of as the most highly adapted passengers. For the services they know, they know it all inside-out. The quickest way to the platform, all the shortcuts, when to arrive to get a seat, where to stand on the platform, which seat is away from the broken heater, etc.

In Japan, there has long been a concept of the passenger as a "player" in the system. For example, passenger orderliness around alighting and boarding is not just a product of a more cooperative culture but is also a consequence of the needed behaviours being driven into passenger minds since the 1920s.

As was noted earlier, part of the challenge in the UK is dealing with a more ego-centric culture where passengers are less likely to conform to some of the "rules" if they think it will negatively impact on their journey. **We need to find new ways to help passengers to help themselves. Which does, at times, mean new behaviours that help everyone.**

We probably need to try a range of different behavioural interventions – for example, Volkswagen has sponsored an initiative under The Fun Theory. It is based on the theory that making something fun is a good way to change behaviour. A widely circulated example was encouraging people to use the stairs rather than the escalator by making them into a giant piano.[xxvi]

CREATING NEW CAPACITY

Getting more out of what we have is an obvious approach given the potential cost and time taken to add new capacity. However, all of the efficiency mechanisms will probably not be able to keep pace with demand over the longer term. So there is a need to add more capacity into all parts of the system.

In any discussion over a potential solution, consideration has to be given to the level of impact it might make, the cost and the time it will take to implement. What is needed is a range of solutions that fit into different parts of this equation. To meet demand we can't wait for solutions that might deliver a step change in capacity but will take years to implement. We need these but they need to be supplemented by other solutions that might not deliver the same level of change but can have an impact sooner. The UK has long been a world leader in adapting, modifying and enhancing existing infrastructure: this just requires a shift in the focus.

Running More Trains

In reference to capacity, this means adding new services, which probably need new infrastructure or running more trains on the existing track. There are plans in progress for the former, with projects on different timescales going from Crossrail through HS2 to Crossrail 2 and HS3 in the longer term. Each of these projects will bring additional capacity to parts of the network but they are some way off (Crossrail opens in 2017 but there is no planned timescale for HS3 as yet).

Running more trains on existing infrastructure is a product of the train performance (acceleration & braking largely) and the signalling & control system. Again, the outcomes in this area take time to come through with the existing system. Trains need to be designed and procured which takes significant time and investment (for example, the new Virgin Azuma trains unveiled in March this year[xxvii] won't be improving the capacity for another two years when they are introduced into service on the East Coast Mainline). But a focus on elements like the size of the braking curve alongside infrastructure changes to help braking and acceleration could help to deliver incremental capacity change.

One approach is to look to reduce the headway between running trains. The Headway project (an RRUK feasibility project) has looked at the opportunities and practicalities of a number of methods. These included 'the fully automated railway', 'the conveyor belt railway', and 'the just-in-time railway'. Perhaps the most interesting was the 'risk-based' approach which took a more dynamic look at stopping distances of trains based on actual speed, current loading as well as the braking characteristics.

CASE STUDY

DIGITAL RAILWAY
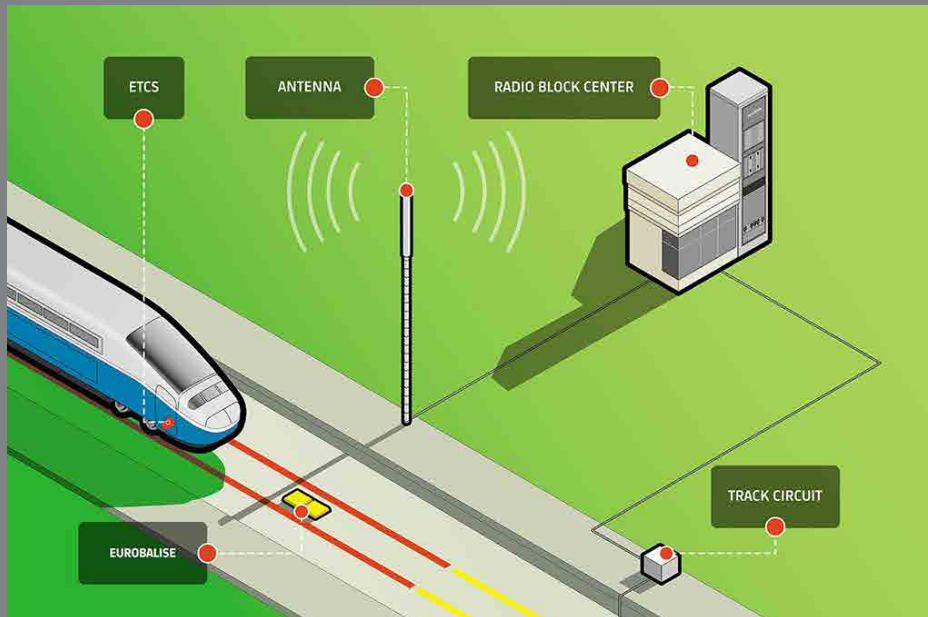
The railway in the UK is still largely controlled by equipment that pre-dates the digital revolution. The equipment was proven and safe but advances in technology have rapidly overtaken it. The principles by which the current control systems operate hasn't significantly changed since the Victorians built the railway.

Systems now used in other parts of the world have demonstrated that modern technology can control the railways, delivering far higher density of traffic whilst not compromising safety. The same technology has also been proven in other safety critical fields such as air traffic control.

The main part of the Digital Railway is adopting 'in-cab signalling'. This uses the European Train Control System (ETCS) to allow trains to run much closer together but maintain a safe

distance. It also uses a Traffic Management system to optimise the speed and movement of trains to deliver the most efficient flow of traffic. These systems are in development in the UK and some elements are being trialled and subject to initial roll-out.

The Digital Railway has great potential. It could unlock a further 40% in capacity from the existing infrastructure. It can do this whilst maintaining safety and increasing reliability and delivering better information to passengers.

It brings great impact and great value but it is high cost and will take a long time to fully realise the benefits – at the moment it is a 20 to 25 year project. Hopefully, some of the benefits will start to come through earlier as the various programmes roll out.

The introduction of new digital signalling & control systems is probably the main 'game changer' in this area.

There is also evidence that a more user-centered approach to the design of our infrastructure could produce dividends. An on-going RSSB project is researching route learning and drivability[xxviii] – that project has highlighted how, in Germany, driveability is a much more central part of the design considerations. It forms a fundamental part of the approach rather than a focus on engineering and cost, which is more prevalent in the UK. The project opens up the potential to find ways to assess the drivability of routes at an early stage in design – this can help with the capacity issue as better drivability can result in fewer driver errors, more predictable driver behaviour, helping better utilisation of capacity.

Get More People on the Train

For those returning to their crowded commuter journey having just travelled by train on the continent, the refrain is often "surely we would be better off with double decker trains?". However, it is generally recognised that, **in their current design**, they are more suited to long distance travel than urban, metro style services. The increase in capacity is offset by

the difficultly of getting passengers quickly on and off due to negotiating the stairs. More capacity has been introduced on many routes in the last few years by adding more carriages to existing services. The barriers to overcome here have generally been having to create longer platforms and dealing with issues around safe dispatch.

Part of rethinking this area is to examine the design practices in use and how they could be changed. Design practices often make use of full-scale mock-ups to assess layouts to optimise capacity (for example, Thameslink used this successfully in the design of its new rolling stock) and such experimentation should be further encouraged in all programmes. But we need to continue to develop new method as well. For example, some research has been done on using social models of agent movement and interaction to test designs[xxix] and these are showing potential.

CHALLENGE #12

How could we rethink train design to significantly increase the passenger capacity or station design to accommodate bigger trains and more passengers? Or should we totally re-think the station concept?

CASE STUDY

MOVING PLATFORMS CONCEPT

Sometimes it requires a more radical view to challenge the status quo. Whilst the idea itself might not be the answer, it can prompt different thinking and other new ideas which can be taken forwards. A great example of this is the Moving Platforms concept developed by PriestmanGoode. They were addressing the fact that whilst billions were being invested in railways around the world, there has been relatively little change in the design of the infrastructure required to run them.

Moving Platforms was developed as an idea to support high speed train travel that would enable a faster train service and allowed passengers to get from local stops to destinations without having to make the high speed train stop.

The concept is built on a transport network where high speed train lines pass across continents and remain outside of the major cities. They are joined up with a deeper network of local train services that feed passengers from and into the city. But rather than using 'hub stations' where passengers interchange between trains, the transfer is done on the move. The high speed train would slow slightly and the local train draw up alongside it, at which point the two trains would connect by a physical docking. Passengers would then move between the two trains before they separated again. The high speed train would then speed up again, while the local train slowed down and moved into the city. The principle is that the local train effectively becomes a moving station.

This concept would remove the inefficiency of high speed rail that is slowing down and stopping in stations. It would reduce the inefficiency of passengers waiting in stations for connections between local and national networks.

It is a big idea that challenges the existing views of stations and track infrastructure. Maybe now is the time for some big thinking.
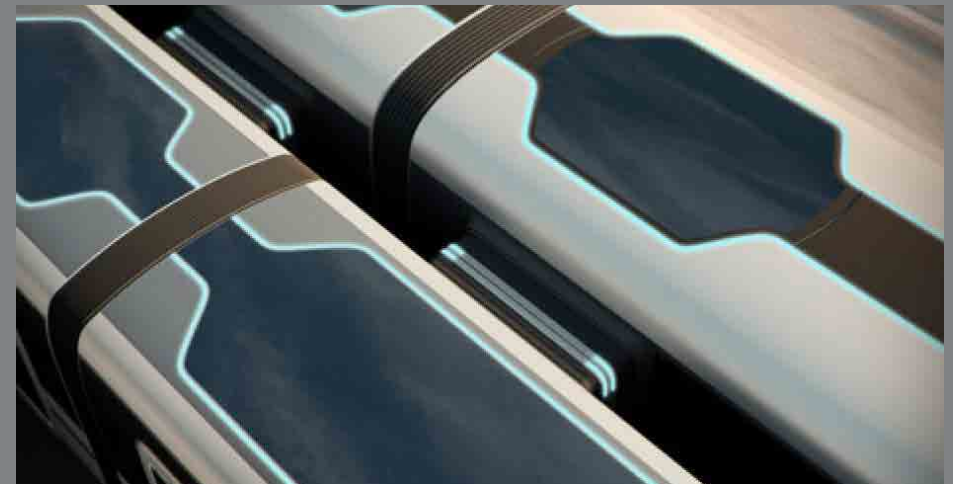
To sit or to stand?

As has been discussed, the natural preference of all passengers is to be able to sit for the duration of their journey and on all services. We all want to travel in comfort and be able to use the travelling time usefully either working or relaxing – these are clearly best done sitting. When is a seat not a seat? Most passengers have a rough hierarchy of needs – first they want a proper seat with a table and lots of space, then they just want any seat, next is probably some sort of tip-up or perch seat, then there is supported standing (i.e. with a grab rail in reach, then standing freely (when the train is so crowded) and finally not getting on at all. They also want a degree of personal space whether they are sitting or standing – in the extensive traveller needs study conducted by the Transport Systems Catapult last year, 20% of passengers complained of a lack of personal space due to overcrowding on public transport[xxx].

However, in light of the capacity problem we need to decide if this is realistic as an ambition or whether there are times when we need to be setting the expectation that a number of passengers will stand? If we are going to do this, then we probably need to pay greater attention to designing for standing passengers. How can we make standing more comfortable? How can we design it so it is still possible to do some of the activities the passenger had planned now they are standing? Can we make it safe enough?

The problem is that comfort is complex. In the report, 'Comfortable Sardines'[xxxi], researchers noted that there was relatively little research into passenger comfort in relation to physical proximity for boarding, travelling on or alighting from trains.

One important aspect is to provide support especially during acceleration & braking. Generally, passengers don't stand freely but in contact or reach of grab handles, straps etc or leaning on bars, carriage walls etc. The research evidence suggests that a loss of stability contributes to discomfort but things like leaning on the side of the carriage can increase the transmission of vibration which also increases discomfort. This vibration can also invoke involuntary changes in stance and passengers may alter their stance in an attempt to reduce the effects of vibration: this can also increase discomfort. Increasingly important with an aging population.

The problem with holding things like grab handles is that it restricts you from doing things with your hands like reading. This is where standing is not only less comfortable but also fails to allow the passenger to use their time in a way they value. So solutions like perch seats can be explored. Back in 2012, a Newcastle University research project was done into what an all-standing rail carriage might look like[xxxii] using perch seating throughout. Or there can be greater use of flip-up seats. However, the problem with flip up seats is that once they are occupied as a seat, people rarely stand to give that capacity back again when the train fills up.

At the moment, the response of many passengers is to sit on the floor (if there is enough space). This is understandable for comfort reasons but is definitely not the experience the industry should be providing. It also degrades the usage of the interior as passengers on floor obstruct aisles, slow down reorganisation of space after a station stop and is an inefficient use of space. We need to aim for supporting passengers without a seat that doesn't mean they have to resort to the floor.

A further issue is thermal comfort in crowded carriages. Higher density of people requires better ventilation, air conditioning and climate control. The UCL research found that current standards do not recognise occupied carriages sufficiently. This is important as when a train is crowded it is harder for passengers to remove clothing as the carriage warms up. The problem around passenger perception of thermal comfort also gets worse the longer the journey.

If we do want to provide more seating, then we probably need more creativity to deliver this in the confined space of a railway carriage. And we have to recognise that there is a physical limitation to what can be achieved so it isn't going to deliver a step change. In the aircraft industry, many efforts have been made to look for different configurations of seats and at new space-efficient seat designs[xxxiii]. This has extended to modular toilet designs that save space and squeeze a little more room for seating.

To help there might be options to explore to make more space. If we improved the number and quality of station toilets could we lose toilets on the train (or reduce them)? Is it worth keeping 1st Class on all services? First Great Western explored this option a few years ago. How long is it before we are happy with driverless trains and we can lose the space required by the driver's cab?

In recent years there has been more use of open carriages which have notably been seen on some London Underground lines. MTA, who run the New York Subway, are also exploring this option[xxxiv] having seen the London lines add an additional 10% in capacity. According to some, articulated bogies are a useful engineering solution to support this approach to increasing capacity[xxxv]. **Anecdotally, it seems open carriages are better at encouraging more movement within and between carriages.**

The main problem area for operators managing capacity with their trains is what do they want their trains to be designed for? Should they make the off-peak passengers as comfortable as possible or should they focus on the more crowded peak? Or do they compromise and try and cover both? None of these are truly attractive as each fails to fully meet the needs of passengers at any particular point in the day. Operators are constrained as to optimise the use of their fleet, they would rather not have different trains for individual services.

How can we develop innovative solutions that adapt the interiors of the trains or enable different interiors to be provided that respond to the needs of passengers at different times of day?

Getting a faster flow of people

Through changing the infrastructure, we might be able to add capacity through getting faster movement of passengers. Can we find new ways to use more of the doors on a train? In India for example, some of the major cities use bay platforms to enable passengers to use the doors on either side of the train.

Certainly there are often incompatibilities between the train and platform that are barriers to increasing capacity as they introduce inefficiencies to dwell time. Can we make infrastructure that adapts to the train design so we get gap-free, level-access?

For trains being used in the peak we might want to revisit the width of the train doors and the number of doors. If we are thinking about designing particular trains to deliver more capacity, then they might have to start from considering peak conditions. The research evidence points towards wider doors helping passenger flow although there seems to be a sweet spot of width where going wider stops providing further advantage[xxxvi]. Equally the number of doors in a carriage is important – research shows that for high capacity metros worldwide, doors are approximately 29% of the total train length. On the UK railways, the standard is more like 14%[xxxvii]. So for our inner-urban services it might be time to rethink our design standards and philosophy.

Implications of more people

If we design our trains to carry more people, then there are knock-on implications for the rest of the infrastructure and wider transport system. Larger trains carrying more passengers will have a significant impact on the layout and design of terminating stations especially who will now have to disperse more people. This can also have an impact on interconnecting modes of transport such as buses, trams, taxis and cycles.

The value of taking a system approach to looking at design interventions is its support to recognising these wider impacts and being able to assess and address the impact at an early stage.

Integrated / alternative transport concepts

The final part of considering adding extra capacity is the extent to which this is a transport problem not just a railway problem. Therefore, the capacity issue might need to be addressed through a wider integrated transport philosophy. In a similar way to Transport for London, the city authorities in Seoul have integrated metro and bus services to consider easier transfers and an integrated fare structure.

The increase in other and emerging modes of transport around the railways needs to be taken into our thinking. This might be new models like Bridj, the impact of disruptive providers like Uber, future technology such as autonomous vehicles or just social trends in travel. For example, the current rise in cycling is putting pressure on the provision of space at the station as well as resulting

in more commuters taking their bikes onto the trains. As an illustration, to meet rising demand Cambridge Station has just opened a huge purpose-built cyclepark building that accommodates nearly 3,000 bikes.

The introduction of the Airbus A380 had a significant impact on both the main airports it would service but also the alternate airports the A380s might be redirected to in case of an emergency. The A380 produces a significant increase in passenger numbers per aircraft movement: about 40% more passengers than a Boeing 747 for example.

This required airports to make significant modifications if it wanted the airlines planning to operate A380s to use them. This included the demolition and rebuilding of nodes and airbridges, upgrades to runways and taxiways and providing different access for support vehicles.

A number of airports had concerns, before the introduction of the aircraft, that they could actually result in an overall reduction in efficiency and airport capacity. The size of the aircraft would impact on the availability of adjacent stands. The surge of passengers each A380 would deliver would impact each touchpoint through the system including check-in, security search in Departures, Immigration and baggage handling. Whilst they clearly mitigated all of these potential problems, it demonstrates the potential knock-on impact of greater volumes of passengers arriving on a single vehicle on other steps of the journey and transport system.

CASE STUDY

BRIDJ

Returning to the question of leadership and vision, should we be looking at this as a railway problem or a transport problem? If this is a transport problem, then we should be looking for other transport options that can work alongside rail to share the burden of mass transit. We should also be exploring new and alternative models.

Bridj is an example of a new transport model that is gaining wider adoption in some cities in the USA. It brands itself as creating pop-up infrastructure to make it easier to move around cities. It claims that travel via Bridj is twice as quick and the same cost as existing transport systems.

Bridj is essentially a personalised bus service. Using the app, you tell Bridj where you are and where you want to go. They then look at their services that are running and route one of them to include your journey.

The trip is direct – rather than figuring out which bus stops are nearest to your location and destination.

The service runs to a flexible, demand driven timetable – you tell them when you want to make your journey.

It is a guaranteed-seat service – they provide the number of buses required to meet the demand.

ACCESSIBILITY AND INCLUSIVE THINKING

The conversation around capacity is generally about mass people movement, crowds and trying to get people moving as quickly and efficiently through the system as possible. Increasingly we have to recognise that a growing group of passengers are less able to meet this need.

As with all parts of our society, the railways are duty-bound to make the system accessible to those with mobility impairments. At the moment this is done in a way that meets some of the operational needs of the industry but provides a poor experience to those wishing to travel. Their experience is restricted, reliant on significant support and far from that enjoyed by more able-bodied passengers. We should be aiming to empower mobility and allow all passengers to have the same journey experience as that currently offered to able-bodied passengers.

This is an issue that is not going to diminish – the impact of the aging population trend is likely to increase the proportion of mobility-impaired passengers in the future. Furthermore, the impact of mental health amongst passengers is a far less understood aspect but one that must surely impact on the railway.

As examples, the following are real-life stories from three mobility-impaired travellers using the UK rail network.

Personal stories from MAR

Tony, power wheelchair user

Rarely face capacity issue. Inaccessible toilets a problem. Was on 5hr train journey from Scotland to London in first class and no accessible loo. Wish trains had built in ramps that passengers could deploy and stow at the press of a button.

Joseph, manual wheelchair user

TFL has newly designed trains that operate on Metropolitan and the District Line. These trains are very spacious and I can cross from one carriage to another (I can't do that with mainline trains). When travelling with my kids, it is important to be able to transfer from one carriage to another freely (sometimes my kids just run off and I have to catch them). Trains don't have to be like TFL trains but at least a space (for small wheelchair) to fit in between seats to get to next carriage. TFL have plan to replace all old underground trains.

Many trains do not have wheelchair space and this is because train companies would prefer to have more seats especially on rush hour times. But as wheelchair user it is unsafe to travel sitting between the doors especially with kids.

Wheelchair space is usually located opposite bikes/buggies space and the toilet. This makes the wheelchair space area very busy and you usually have to ask someone to move a bike to let you out.

It is important to have more than one wheelchair space in one carriage to enable disabled people to travel together and with luggage and other mobility aid like hand cycle. I have a wife, 3 children and am a keen cyclist. None of them are disabled but we obviously want to sit together. Many of my friends and colleagues are wheelchair users and we can't travel together at the moment.

Northenrail and other companies refuse small scooters (Class 2) and this is because some of their trains have narrow doors to get to wheelchair space. Some companies say this is because of the turning circle of. New trains need to accommodate scooters too (big enough wheelchair space and wider doors or maybe no doors at all).

Joanne, mobility scooter user

Sorry I am not going to be very good at this one. I feel completely unable to travel by train, as my nearest station Clandon, is of the old Victorian type, so long staircase up/down and hard to access at ground level too. Then of course I would need to be got onto the train, I am not certain my chair will fit in the space between the seats, so think I would probably need to stay in the space for boarding and alighting the train. Does not make me feel safe to be honest. Then of course this would need to be reversed at Waterloo.

If I travel to Woking station, I think they use a goods lift to move you between platforms, which scare me, then the trains themselves will have the same issues, I will feel dumped into the area for boarding and alighting the train. Prior to my disability I used the trains and underground all the time, it was necessary with my job to enable getting to clients etc. I have absolutely no idea how I would cope with the underground now and to be honest I feel rather panicked just contemplating the idea.

I am currently working with people who will require me to go to London quarterly to their offices near Liverpool street, obviously this would be a fairly easy trip using trains and the tube, but I have already told them I would need to drive in and they will have to sort out parking. Before telling them this I had to think through how I might make the journey on public transport, the idea has caused me to have severe anxiety again.

So the risk is that we approach design for capacity in a way that makes some parts of the network, at some times, even harder to access. This is in opposition to the ambition which should be to make our transport system more inclusive and accessible.

CHALLENGE #14

How can we design the railway to enable more capacity at the same time as making it more accessible?

UNLOCKING INNOVATION

The capacity problem we have in the UK railways is not going away. Demand shows no sign of dissipating in the short term. The broader social trends in work and living suggest that the need for travel may increase. But the railway industry will only reap the rewards of that potential demand if it continues to make an attractive offer to its customers as new alternatives appear in the market – in the longer term, it should not be complacent.

Addressing the problem in the short and long term requires innovation. The railway system is complex and busy, so doing new things or implementing new technologies is not straight forward. But the historic slow evolution of improvement seems unlikely to be able to keep pace with the potential demand. So the question is how do we unlock innovation in this difficult area?

System Thinking

In simple terms, the issue of capacity is a relatively straightforward equation of the number of trains running and the number of passengers that will fit on each train. In reality, of course the railway system is far more complex and capacity becomes a function of how all the different elements work together.

The clear message from this research is that for interventions to be effective, industry has to take more of a systems approach to developing solutions. As an illustration, the potential of a systems-approach was demonstrated in a recent RSSB study led by TRL on increasing capacity on the Woking to Waterloo line[xxxviii].

The capacity issue can only be successfully addressed if the engineering and technological solutions are developed alongside thinking about the passenger as a human with all their inherent variability and unpredictability.

A systems approach enables industry to address the engineering capacity of the railway (e.g. signalling systems, rolling stock design, etc) whilst aligning this with the human element of capacity. A central aim should be improving passenger satisfaction with rail travel through, in part, improving capacity and reducing overcrowding. Higher levels of satisfaction will not be achieved if the method of increasing capacity reduces the experience of passengers.

The value of a system-model comes from taking a wider view in relation to passenger experience that goes beyond just the physical design of the train. System-models can be highly effective in looking at comfort and satisfaction in a way that also influences long term perceptions of passengers to accept and adopt modes of transport. The system view can look at the different phases of the

passengers' experience: it can map out the setting of expectations, the initial response to the station and train and the longer term experience during the journey. This can be beneficial in ensuring that expectations are met at all stages of the journey.

The systems view is also critical to delivering the joined-up thinking that is clearly required to make sure capacity solutions deliver. As was mentioned in the Managing Demand section, there is no point making interventions around ticketing and trains to help spread the demand if the number one factor making passengers take the peak train is the limited car parking at their local station. Organisations addressing capacity have to look outside of their world and see the interaction with other services and operations around them.

Providing the right incentives

In many parts of the country, the railway currently has a captive market. For commuters into major cities there is often little in the way of viable transport alternatives to reach their place of work. In addition, there is usually no choice over which train operator the customer can use. This does not provide an incentive for operators to improve capacity in a way that meets the kind of travel experience that passengers desire. For many organisations, in the privatised structure, the commercial imperative trumps service quality. Because of the captive market, the usual competitive drivers that might result in the railways needing to improve passenger experience are not present. To unlock innovation, the franchise agreements, policies and regulations need to adapt to require operators to make the necessary investment to provide more capacity and improve the experience for passengers.
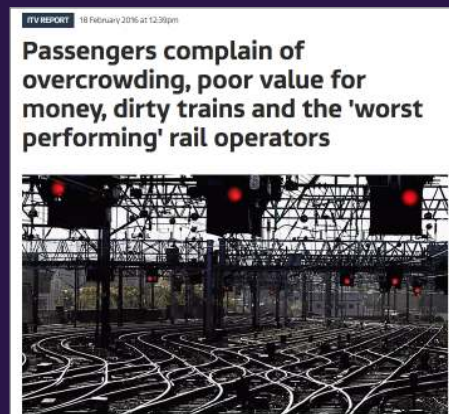
Space to Innovate

The railways do not have a positive reputation in the UK. Despite the major success that is running a railway of the scale and complexity of our system, the public does not have a high

estimation of rail travel. This is due to a wide range of issues and is reinforced by the coverage of the railways in the press and media.

The problem this creates for innovation is that it normally requires some degree of trial and error of potential solutions. But that means sometimes what is tried won't work and will probably inconvenience passengers. The potential negative reaction of the public and press is enough to deter prototyping and experimentation. So care has to be taken about the potential outcomes and public communication around any trial.

There are other constraints that need to be unlocked to create this space. The railway industry is, as a safety critical environment, understandably a very conservative and risk averse sector. Getting approval for a piece of technology or a new way of doing something is not straight forward or quick. If the sector is to innovate more in this space it probably needs to find ways to cut through these processes.

The other area of resistance is likely to come from staff and the Unions. Some of the solutions to capacity are likely to require change and new ways of working. Some of these will affect the current jobs and roles of railway staff. The Unions' role is to protect those jobs. Consultation and collaboration are often successful at finding a route through this but again it takes time and doesn't create an environment where innovation is encouraged.

ITV REPORT   18 February 2016 at 12:39pm

Passengers complain of overcrowding, poor value for money, dirty trains and the 'worst performing' rail operators

Understanding the passenger

The main source of intelligence for the railway sector on the passenger comes from organisations like Transport Focus who conduct extensive consultations and market research activities with passengers. They provide invaluable insights into what passengers say they like and they want.

However, this research suggests that new insights and analysis of passenger needs is going to be required if we are to translate the concept of "passenger experience" into something more tangible. Market research needs to be tied together with other design research techniques to try and establish some of the unspoken needs of passengers. This approach could be combined with more use of user consultation using new and different channels (e.g. social media, crowdsourcing, etc). From this the industry would benefit from establishing a clearer vision of what kind of passenger experience it is trying to provide and what it needs to enable to get there.

Sharing the Outcomes

There is currently no single body or organisation who collates and shares research, trials and interventions in capacity across the industry.

Bodies like RSSB sponsor and share the outcome of the research it commissions. Other industry bodies share good practice between their members. But addressing capacity needs a focus point which may be a space that the Transport Systems Catapult, or a similar independent technology and innovation centre, should occupy.

Forget the business case

Thinking and planning in the railway industry is driven by the business case for investment. To make an intervention there needs to be a realistic return on the cost. But this is often a limit on implementing the solutions that are needed to resolve the problem as some might be effective in reducing overcrowding but provide little direct financial benefit. There might be times when there needs to be leadership and structures that allow schemes to proceed where the return on investment is limited but the benefit to the passenger is significant.

The other part of the business case thinking is the need for quick results to demonstrate value. Some of the interventions that are likely to be needed will take time to have an effect. Especially those that are seeking to influence passenger behaviour. So projects need to be realistic on the timeframe for results and have some patience.

CASE STUDY

TOMORROW'S TRAIN DESIGN TODAY

Innovation often needs the right environment and some seeding for it to happen. Companies need time, space and financial support to explore new ideas.

An example of this in action is the recent 'Tomorrow's Train Design Today' collaborative competition supported by RIBA, FutureRailway, the Design Council and the DfT.

The competition had two challenges: 4CS Train Challenge, which covered long-term designs for trains to meet objectives around reducing costs, cutting carbon emissions whilst increasing capacity and passenger satisfaction; and the Next-Gen Train Interiors Challenge, which looked at medium-term designs for interiors with a focus on flexibility and adaptability.

Competition entries were reviewed and sifted and a rigorous judging process ended up with three finalists. The finalists are being given further funding to develop their ideas. The competition supporters have created a pot of £2.2million to fund the next stage development. The three finalists were:

42 Technology – Adaptable Carriage

The concept is a flexible-purpose carriage achieved through the automatic stowage and movement of seating. The key enabling technologies are:

1. A novel seat that enables flexibility of orientation as a seat and perch, forward and rearward facing, as well as in a stowage position.
2. A system for driving and controlling the movement in a safe and efficient manner.
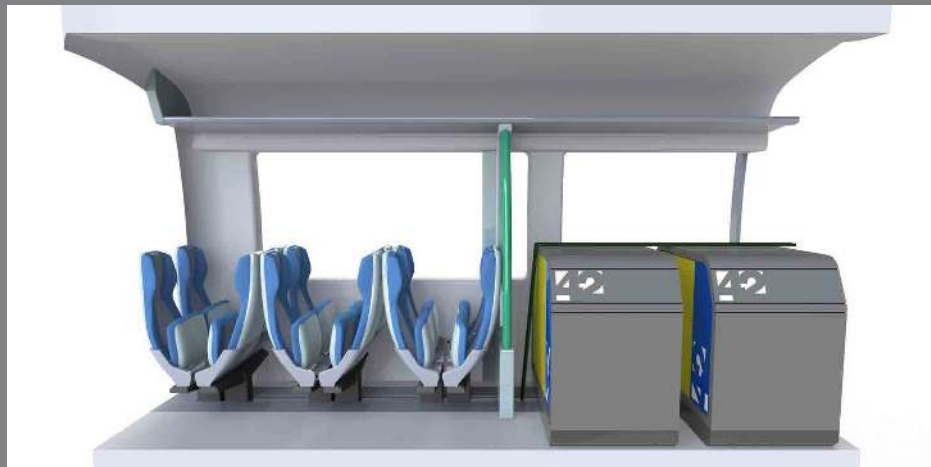
More information on the competition, including the other shortlisted entries, can be found at http://www.ribacompetitions.com/ttdt/index.html

PriestmanGoode – Horizon

The Horizon train increases capacity and improves the passenger experience. The design includes developing a seating concept that can flex between peak and off peak periods to offer a standard seat during off peak to a commuter seat in peak hours. This allows firstly greater capacity but also offers an enhanced environment with table, power and connections for working whilst in commuter mode.

Andreas Vogler with the German Aerospace Center DLR – Aeroliner 3000

AEROLINER 3000 follows the consequent application of light weight thinking into the train world. The development of a combination of many singular elements concerning aerodynamics, locomotion, structure, interactive control systems and even passenger psychology will be orchestrated under the umbrella of a modern design and engineering culture informed by consequent lightweight thinking.
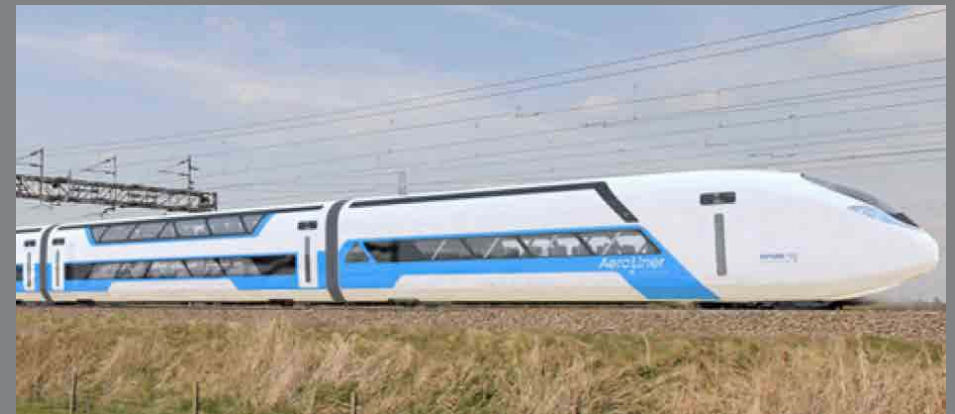
KEY MESSAGES

The increase in demand for rail travel presents an unprecedented challenge to the industry. Can we provide more capacity and deliver it in a way that improves the experience of passengers? If we fail to meet the passenger needs, then we risk undermining the potential demand as they seek alternatives. We should be wary of Leroy Demery's observation of rail in the US[xxxix]:

" Long before crowding levels … reached New York levels, prospective passengers would choose to travel by a different route, by a different mode, at a different time, or not at all

To find the right solutions we need joined-up thinking and integrated ideas. To facilitate this, we need leadership and a clear vision across the industry. The complexity of the railway as a system means that solutions and innovations need to be considered in a wider context to understand the impact on other parts of the network. Importantly, we need new pathways to share thinking, ideas and the outcomes of trials and implementation.

To promote new thinking and new ideas we need to find a way to reduce some of the risk-averse hurdles that are present on the UK railway. We need to maintain our safety standards but we need to find new approaches so that we can experiment and try new things.

We can't wait for the big, step-change infrastructure projects to come along. Demand is moving so rapidly they might not actually be providing that much additional capacity when they are eventually delivered. So we need to pay attention to the little things, the incremental changes, the marginal gains.

Perhaps the biggest challenge is around flexibility. The capacity issues are temporal and only impact a certain number of trains on any particular day. What new thinking can we bring to make our infrastructure and our services more responsive to meeting the passenger needs more fully as these needs change?

The main message from this research is that capacity is only partly an engineering problem. It is actually largely a people problem. Understanding the psychology and behaviour of the passenger is critical in shaping solutions and their likely impact.

PROJECT APPROACH

The following industry experts were interviewed as part of this project.

Tom Williamson, HS2
Chris Kimberley, HS2
Ann Mills, RSSB
Dominic Hayzelden, DfT
Christian Bocci, Weston Williamson
Nigel Harris, The Rail Consultancy
Chris Hoskin, Steer Davies Gleave
Dan Taylor, Transport Focus
Ian Wright, Transport Focus
Neil Tinworth, Unipart Rail
Dr Luis Olivera, University of Warwick
Simon Vasey, DfT
Charles Greenway, Atlantic Design
Andrew Crawshaw, Design Triangle
Johannah Randall, DfT
Julia Christie, DfT
Syd Scrace, Hitachi
Jon Wackrow, Transport for London

Graeme Clark, Siemens
Jo Binstead, Siemens
Phil Hinde, Crossrail
Christopher Nuttall
Stuart White, DfT
Trevor Bradbury, RSSB
Chris Ainsworth, RSSB
Martin Phillips, HS2
Mary Anne Rankin, Mary-Anne Rankin Associates
Joe Grey, DfT
Geraldine Lundy, Virgin Atlantic
Brian Freemantle, DfT
Kirsty Dias, PriestmanGoode
Ben Orson, JPA Design
Hans van Uden, NS Dutch Rail
Ramon Lentink, NS Dutch Rail

WORKSHOP OUTPUTS

A one-day workshop was held at the Transport System Catapult offices in Milton Keynes on 24th February 2016. The workshop was facilitated by the CCD team with the purpose of getting expert input into the definition of the problem, opportunities, blockers and enablers under six themes: Managing Demand, Better Operations, Designing Trains, More Efficient People Movement, Changing Infrastructure and Policy, Industry & Regulation.


The following people participated in the workshop:

Dominic Hayzelden, DfT
Dan Taylor, Transport Focus
Neil Tinworth, Unipart Rail
Dr Luis Olivera, University of Warwick
Simon Vasey, DfT
Andrew Crawshaw, Design Triangle
Johannah Randall, DfT
Phil Hinde, Crossrail

Joe Grey, DfT
Howie Ripley, DfT
Peter Salkeld, Transport for London
Steve Grisag, Bradford Council
Gerrit Boehm, Open Capacity
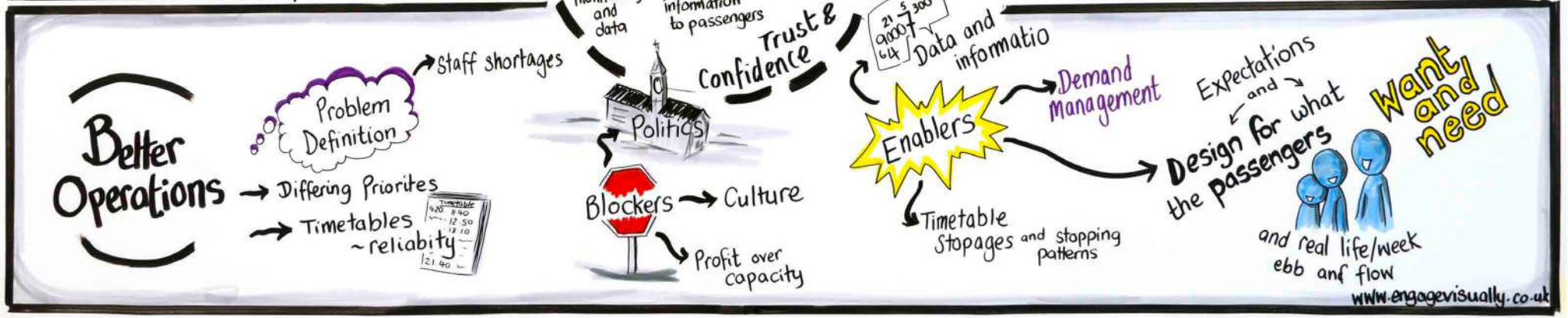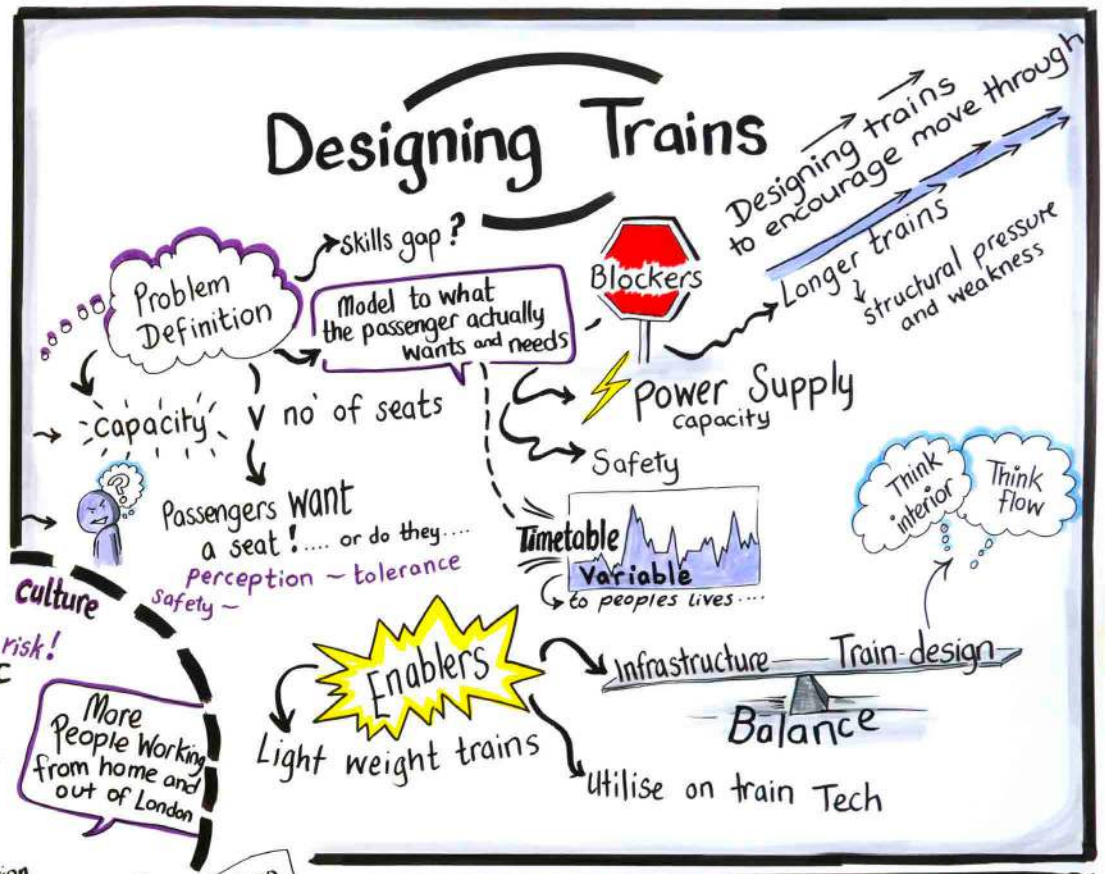Marcus Mayers, Open Capacity
Paul Corney, Virgin Trains

The workshop was graphically recorded by Debbie Roberts of Engage Visually. The outputs of the graphic recording are on the next pages.
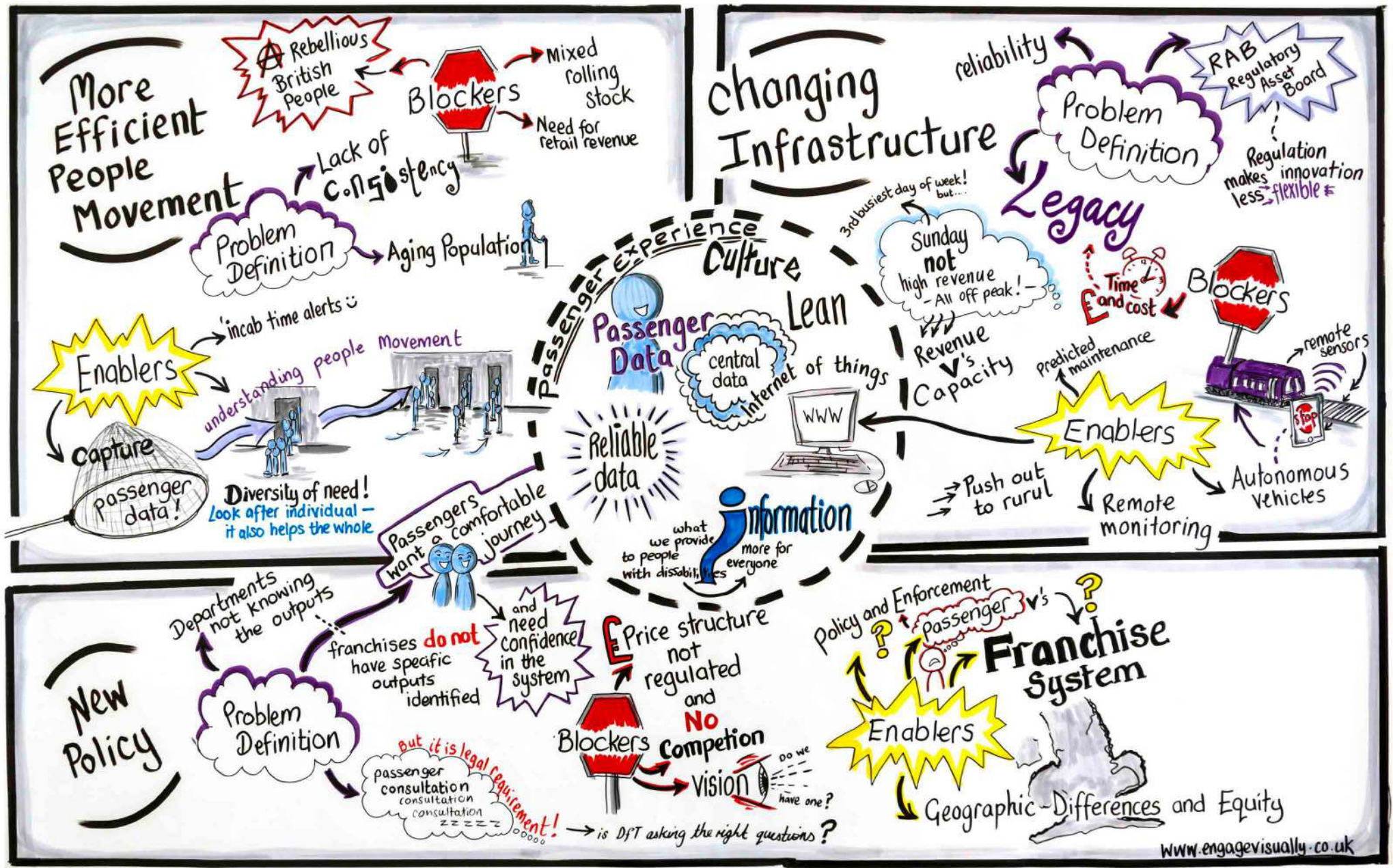
Workshop outputs for themes of Managing Demand, Designing Trains and Better Operations
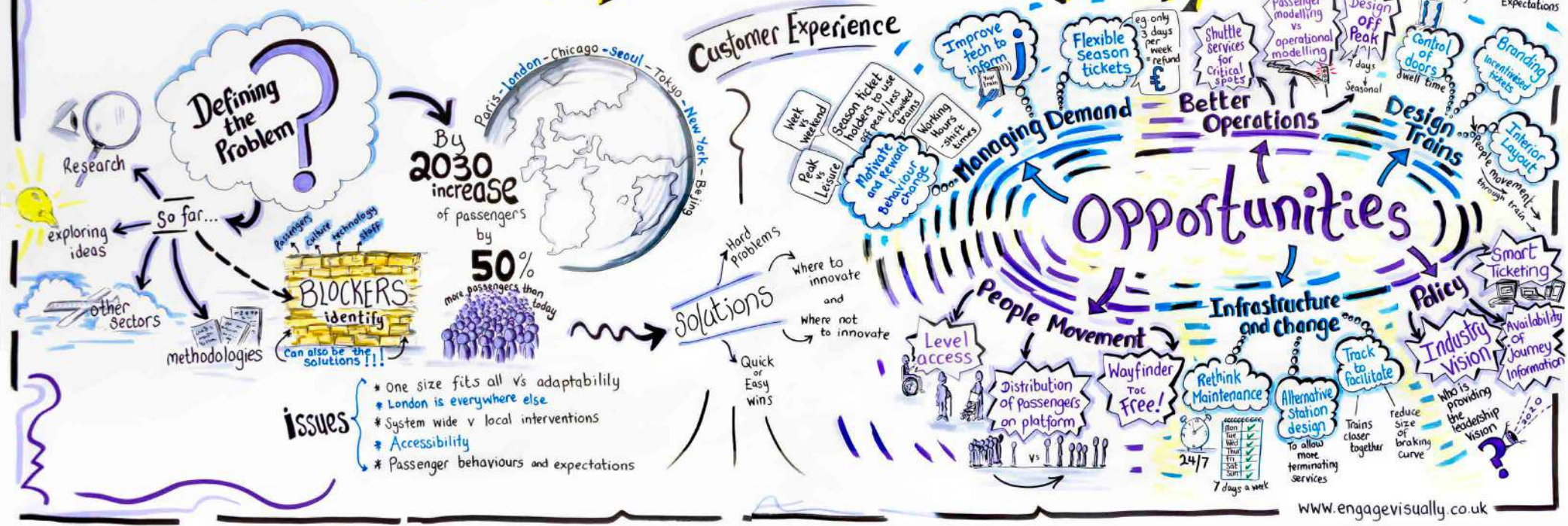
Workshop outputs for themes of Efficient People Movement, Changing Infrastructure and New Policy

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