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# HS2 is a **reality**

The first major new railway to be built in the UK since the 19th Century will open in only nine years' time. With it brings the opportunity not only to enhance capacity and encourage economic growth across the UK, but also revolutionise the way the UK rail and construction industry operates with regard to skills, innovation and supply chain. HS2 is not just a mechanism for faster journey times between London and Birmingham, and later to the North. It is a driver for growth across Britain. It offers transformational opportunities for Britain, with new stations and infrastructure giving towns and cities the chance to create development that will benefit both residents and businesses.

High Speed Rail Industry Leaders (HSRIL) recognises the significant opportunities for industry that the development of high speed rail in Britain can provide. The HS2 project comes at a time when investment in the country is vital in the wake of the Brexit vote. High speed rail has the capability to bring efficiency gains across the economy and increase productivity – giving UK plc the ability to grow as the project helps to stimulate investment in the private sector and connects people with jobs and opportunities for education.



This brand new railway offers a new way of thinking for industry, in terms of innovation, design and recruitment. Designers are working up plans for how new stations can be considered differently, and designed in a way that makes them destinations in their own right. The way that Joint Ventures are formed and operate is changing as a result of HS2, as companies look at different ways of not only bidding for contracts, but how they work collaboratively to support SME's, and engage with the communities that will be affected by the project. And the creation of a series of exciting new colleges will ensure that the next generation of engineers are ready to build the most advanced railway in the world. These colleges will have a significant impact on the ability of the UK rail supply industry to deliver HS2 and other infrastructure projects in the future, providing industry-led training for up to 1,265 students a year<sup>1</sup>; school leavers, career changers and rail professionals. At least 20% of learners will be from under-represented groups, bringing a wider, and more diverse and representative pool of talent into the rail and construction sectors.

And it is not only the large companies that benefit from HS2. As well as providing the country with a new world class transport link, the project provides opportunities for thousands of businesses, big and small, all over the UK. HS2 Ltd, the company responsible for ensuring the successful delivery of the project, has a continuing programme of stakeholder, community and supply chain engagement, as well as using the procurement opportunities that the project offers to set the highest standards around health and safety, workplace wellbeing, and to drive greater diversity in the industry.

Our focus is on the delivery of a national high speed rail network and the strengthening of the UK's rail infrastructure and systems supply chain that this will enable. As industry leaders, we strongly support the completion of HS2 and envisage a long term plan for high speed rail in Britain that will extend the network across the north of England and to Scotland, and will include Crossrail 2, HS3 and Northern Powerhouse Rail. This is a project the UK needs. It is perhaps the country's most important infrastructure project in decades.

1. https://www.gov.uk/government/publications/hs2-changing-britain

# 1. Skills

HS2 is the biggest investment in the UK's skills base in generations. The HS2 project affords the UK an unrivalled opportunity to enrich its skills base and act as a catalyst to widen the knowledge and capability of its workforce. Following the award of £6.6 billion of civil engineering contracts, the project will create some 16,000 jobs initially, affording industry the opportunity to invest in training, research and development and skills. Skills developed by the 100,000-plus people expected to work on the scheme can be transferred to any number of engineering projects in the coming years, enabling UK-based firms to benefit from an export business that stands currently at £400 million, and has an initial target of doubling to £800m.



#### Interview with **Professor Felix Schmid** PhD FIMechE FIRSE FPWI, Birmingham Centre for Railway Research and Education (BCRRE)

#### Q. How does High Speed Rail differ from the conventional railway?

High speed railways share most, if not all, characteristics of conventional mainline railways, metros and even trams: they run on rails and are usually powered by electricity; they require structures and control systems; they are subject to variability in their environment; and they must satisfy ever increasing customer demands in terms of journey time, convenience and comfort. However, there are very significant differences in the way that these characteristics express themselves in high speed railways. The operating speeds (v) of high speed railways are between 50 and 150% greater than those of earlier types of railways, resulting in a kinetic energy level that is between 2.25 and 6.25 that of the 'older' systems.

#### Q. What does this mean for research and education?

Research into adhesion and aerodynamics at high speeds is a priority for researchers at the Birmingham Centre for Railway Research (BCRRE), at Huddersfield's Institute of Railway Studies (ISR) and at the University of Sheffield. While operating, the rolling stock, infrastructure and control systems of modern railways require and produce continuous streams of data that must be processed, analysed and stored. Given that high speed trains move at up to 100 m/s, there are great challenges in communicating this data accurately and reliably between the various subsystems, with minimum latency. Sensor systems and actuators for high speed operations must be fast, accurate, reliable and repeatable.





#### Q. How is BCRRE contributing to this?

BCRRE's new digital railway research centre, part of the UK Rail Research and Innovation Network (UKRRIN), will specialise in the management of these systems and the associated data flows, with a focus on data analytics and data mining. BCRRE also educates railway engineers and operators to understand and make best use of the resulting information, both in its taught programmes, such as the MSc in Railway Systems Engineering and Integration, and in its research programmes, namely, the MRes in Railway System Integration and in its doctoral training.

#### Q. How is BCRRE collaborating with other UK institutions?

The manufacturing and maintenance requirements of high speed railways are exacting, since the safety of the system depends on a high integrity infrastructure, dependable rolling stock and the total absence of obstacles. Research in these areas is conducted by the Institute of Sound and Vibration at Southampton University (ISVR), within the BCRRE, by the IRS and at the University of Nottingham.

#### Q. How will this benefit HS2?

Experience and expertise gained with trams, metros and conventional mainline railways are relevant to high speed railways like HS2. However, system standards and the level of availability have to be much more exacting, resulting in a need for high quality research, education and training by universities and other relevant bodies.

### Case Study National College for High Speed Rail

The National College for High Speed Rail is the largest of five national colleges being created by Government to ensure British workers learn world class skills. The college has two campuses in Birmingham and Doncaster, with state-of-the art facilities such as virtual reality learning and a BIM cave in order to provide students with an industry leading work environment. The college's curriculum has been developed in partnership with employers and leading industry specialists who will provide teaching and mentoring at the college so that leaners are able to hit the ground running with their new employers once they finish their training. To succeed, and deliver the next generation of talented workers for the rail and engineering industries, the college has developed a leadership pledge and has been asking for support from as many employer partners as possible. To date, the college has received support from a number of leading industry businesses, with highlights including:

- Commitment from several businesses to send apprentices to the college.
  Amongst those sending apprentices are the Fusion Joint Venture, a partnership between Morgan Sindall, BAM and Ferrovial, which has a successful track record of delivering large infrastructure projects, having previously collaborated on projects such as Crossrail and Thames Tideway Tunnel;
- > The delivery of two newly refurbished Eurostar power cars to each of the college campuses in Birmingham and Doncaster. The 25-tonne power cars have been generously donated to the college by Alstom and Eurostar, after being retired from service. The trains will now have a new lease of life at the college, by playing a critical role in educating Britain's next generation of engineers. The two power cars have undergone extensive refurbishment by Alstom, which has included an overhaul to the original livery to incorporate the colourful branding of the National College for High Speed Rail;
- Colas Rail has donated and installed the Overhead Line Equipment catenary system at the Birmingham campus, where it will be used to provide practical experience alongside the classroom theory sessions;
- > The donation of a 700-metre length of rail track by British Steel. The 41 lengths of 18 metre steel were installed at the college by Rhomberg Sersa rail group;

- Donation of a bogie (the wheel set for a carriage) by Lucchini Unipart Rail Limited. Businesses Van Elle and Rhomberg Sersa were instrumental in providing and arranging the transportation of this piece of equipment;
- Official backing from more than 30 businesses for the college's specialist High Speed Rail and Infrastructure Apprenticeship, also known as the 'trailblazer'.
   Businesses in support of the trailblazer include ALIGN Joint Venture (JV) (Bouygues Travaux Publics, Sir Robert McAlpine, VolkerFitzpatrick), Alstom, Arup, ASL JV (Acciona, Sisk, Lagan), Atkins, and Balfour;
- > The creation of the UK's first Certificate of Higher Education in High Speed Rail and Infrastructure, developed in partnership with employers in the rail industry. The new level 4 qualification will ensure that students of the college learn the transferable higher-level skills that employers need to kick-start Britain's new high speed rail industry and other major infrastructure projects. High Speed Rail Industry Leaders is financing two students to attend this new course in 2017;
- The development of a new trailblazer apprenticeship standard for Management of Digital Information, by a dedicated industry group, chaired by Atkins.
   Promoting best practice across engineering sectors, it will culminate in a common industry standard for digitally managing information;
- The Rail Automation and Rail Systems businesses at Siemens UK are aiming to support the college by placing up to seven learners on the 'Systems' specialism (paid through Siemens' levy funding).





Our members have invested significantly in the UK ahead of the arrival of HS2. Alstom's training academy opens shortly in Widnes, and will deliver 15,000 training days per year when fully open, upskilling people to develop some of the most advanced engineering anywhere in the world. The academy will focus on Level 3 and 4 Engineering apprenticeships initially and will collaborate with other companies to develop a strong curriculum-based on digital technologies and lean manufacturing techniques. It will also reach out to local schools as a way of encouraging the next generation of students to consider the industry as a career.

Similarly the National Training Academy for Rail (NTAR) based in Northampton acts as an international Centre of Excellence for skills development and collaborative working in the rail industry, and was developed through a public/private partnership between government agencies and Siemens.

The government has an ambition for three million apprenticeships in the UK by 2020 – 20,000 of which will be delivered in the rail sector. More than 2,000 apprenticeships are expected to be created around the HS2 project, offering people from all backgrounds the chance to work in a sector that is growing not just nationally, but globally. The apprenticeship roles will cover everything from engineering, planning and project management, to finance, procurement, communications, HR and IT. The commissioning environment created by HS2 Ltd ensures that the project will facilitate people already working in transport to gain new skills, as well as returners to the industry and those looking for a career change, with investment in jobs and skills written into contracts and rail franchise agreements, driving greater diversity in the industry.

HS2 offers a fantastic opportunity to change the quality and breadth of skills available while at the same time diversifying the make-up of the workforce. And the whole country will benefit from the skills uptake, and not just London, as some 70% of all roles created will be based outside the capital. Our own analysis<sup>2</sup> shows that in less than four years' time more than 26,000 people will have worked on HS2 throughout the supply chain, and that two-thirds of these jobs will be in construction. By 2020 HS2 will employ more people than any other UK infrastructure project, with 700 businesses supported nationally as a direct result of the railway's arrival in the West Midlands. The value of this is put at around £14 billion for the Gross Added Value for the UK.

The HS2 project has created a renewed interest in the rail and construction sector, with our members reporting significant interest in opportunities to work in the rail and construction sector and design and build the next generation of high speed trains. HSRIL members continue to commit to creating a sustainable skills pipeline, with traineeship schemes, secondments and cooperation with global specialists allowing today's trainees to become the driving force behind Britain's high speed rail network.

The scale of opportunity that the development of high speed rail offers to UK business is huge. And these opportunities are not only spread across the country, but across a diverse range of businesses and sectors.

<sup>2.</sup> http://www.rail-leaders.com/hs2-jobs-analysis-report/

#### Case Study Colas Rail

High Speed Rail Industry Leader member Colas Rail is a world leader in the construction of high speed lines, having built their first High Speed line over 35 years ago. Since then Colas has constructed over 3,000km of line across Europe, Asia and most recently Africa.

On its current Moroccan high speed rail project, Colas has placed a major emphasis on investing in people and skills, taking the decision to invest in the workforce locally through engagement with the local schools and colleges. In establishing their own training school they have targeted the development of local resources in courses ranging from safety awareness, to more technical catenary & track techniques onto overseeing the movement of rail vehicles and people management. This new facility trained over 1,400 people, of these 85% had no previous experience in the rail sector. The overall resource statistics show that 95% of those who worked on the scheme were Moroccan nationals.

This project has delivered a direct benefit for the UK, with staff seconded across from Colas Rail UK to gain invaluable first-hand experience in training and working on the project. This mix of local highly skilled professionals, working with UK apprentices and graduate counterparts, is creating a knowledge sharing environment with potential to provide significant benefit in the ongoing delivery of HS2.



### Case Study Jacobs

Jacobs graduate geotechnical engineer, Laura King, shares her insight of working on the multi-billion dollar California High-Speed Rail project, and what she's looking forward to bringing to her next role on High Speed 2.

The \$64 billion California High-Speed Rail (CAHSR) project will provide a 220 mph train service over 65 miles of new track linking San Francisco and Sacramento in the north with Los Angeles and San Diego in the south (source: www.hsr.ca.gov). The high speed rail (HSR) will provide a crucial energy-efficient link between these cities with a journey time of 2 hours 40 minutes. The project will also act as a catalyst for further high speed rail development across the United States, linking to a proposed HSR network spanning the country.

The Jacobs team provides design services for two construction packages on the project, and collaborated with CEDEX's Transport Research Centre – the specialised technical laboratory in Spain, where high speed rail simulation and other testing takes place. I was offered the opportunity to work on this project as a graduate engineer – starting as a geotechnical advisor for a specific area of groundworks, I developed into my current role as the assistant project manager of the U.K. geotechnical team.

I worked closely with U.S. colleagues, contractors, industry experts and academics to collaboratively determine the direction of the geotechnical aspects of the project, developing innovative geotechnical solutions for the construction of embankments suitable for high speed rail. As a combined international team, we overcame technical and constructability challenges to develop a novel method of embankment design – where a lot of the lessons learned will directly apply to the work for HS2. We also fostered a culture in which colleagues at all levels were empowered to put forward good ideas, and excellence at all levels was rewarded and supported. This enabled junior members of staff, such as myself, to have considerable responsibility and development over the course of the project. I think it is this culture, even more than the technical and commercial knowledge gained, which I will bring most strongly to working on HS2.



### Case Study Stephenson Harwood

Legal advice is critical to ensuring communities are fairly treated, procurement processes are done right, and the system is ultimately delivered in a way which benefits everyone. One of the great advantages of advising on projects in the rail industry is being able to point to a rail line that wouldn't have been built without the clients' understanding the risk and rewards of doing so; identifying the rolling stock that you finalised the contract and financing for; and being able to travel on a railway service that you helped make happen. Specialist legal advisors have geared up and are providing advice on the HS2 hybrid bill and its implications for the project and landowners affected by it. As HS2 moves firmly into the implementation phase, there is a role for lawyers advising both the public and private sector on complex construction contracting arrangements ensuring a balanced risk and reward to deliver the rail infrastructure, as well as the flow down arrangements to the supply chain.

The rolling stock procurement process has also been launched – with specialist legal advice required in relation to the manufacture, supply and maintenance of the expected £2.75bn of rolling stock required in order to bring the HS2 service to life.

The Department for Transport is looking for a partner to operate a franchised rail service on the West Coast who will also be the first operator of the new HS2 line – a unique opportunity and a departure from the usual franchising structures that we have previously seen. Just as it is important for HS2 to select its partners to build the infrastructure or trains or to operate the service, as firms seek to work on HS2, it is important to get the right legal advice from the right lawyers, people who know the industry, and understand the complex political and regulatory environment.

# 2. Enabling Works

Members of High Speed Rail Industry Leaders are already on the ground delivering HS2. Phase 1 of the project is off to a great start, with enabling works underway, almost £7 billion of contracts let to date and major works beginning early next year. Preparatory work is already underway in London and along the Phase 1 route and soon orange jackets will be visible along the route of HS2 as work begins on building Britain's newest and most advanced railway.

Long before the main construction starts, months – and in some cases, years – of detailed planning and preparation takes place to ensure all of the necessary permissions have been granted, and studies and investigations have been completed. As well as construction of the various structures on the route, knowledge of the ground is vital to the project. Site investigations are needed for the collection and verification of engineering and design data associated with bridges, tunnels, cuttings, and the 140 miles of track which will enable the fastest trains ever to run in the UK. And of course there are the four new stations to be completed during Phase One of the project.

Major infrastructure construction in the 21st century is far removed from the procedures and processes of old. Cost and timescale are now considered to be only part of the selection mix, and the levels of community engagement, scientific study, workforce diversity, and the mitigation of construction impacts are key determining factors in assessing value for money.

The enabling works of any project are often the most critical. Not only do they prepare sites for major infrastructure development but, importantly, they set the tone to the local community of the future work to come. They often occur with new teams coming together, and without the construction infrastructure and behaviours having been established. The HS2 project has provided the opportunity to look at this aspect of construction in a new light, and explore new partnerships and collaborative models of working within the industry.

High Speed Rail Industry Leaders members have invested in skills and capabilities throughout the development period of the project, and have been working with the Railway Industry Association, the Rail Supply Group, and other industry related bodies to help build capacity within the UK supply chain.



## Case Study Atkins

In April 2016, Atkins, as part of a joint venture with CH2M and SENER, was appointed as the Engineering Delivery Partner (EDP) for Phase One of HS2. The EDP is currently working with HS2 and the recently appointed main works civils contractors during their mobilisation and integration. The EDP is providing engineering, planning and environmental services to support HS2 Ltd with the coordination, integration and assurance of engineering and environmental design, planning consents and stakeholder management, environmental and construction management, systems integration and interface management, BIM compliance and other ancillary services across civil engineering, rail system engineering, stations, depots, control systems and architecture. This includes the provision of project engineering and environmental resources to supplement the HS2 team, with subject matter experts supporting the technical assurance and design.

Atkins has been responsible for preparing Hybrid Bill submissions and for supporting the successful Hybrid Bill process, and having won a place on the Professional Services Consultants (PSC) framework for Phase One (London to Birmingham and Staffordshire), secured the lead engineering role in April 2012 for the 90-kilometres long Country South section of HS2 (from the M25 to the Warwickshire border) and the lead environmental role for the 70-kilometres long Country North section (from the Warwickshire border to Handsacre in Staffordshire).

In addition, Atkins developed and has implemented the BIM strategy for HS2, including the development of an e-learning platform to bring all of the supply chain up to the required level of competence. Atkins also developed the route-wide mass haul strategy for Phase One, undertook the route-wide utilities design and coordination for Phase One, and the offsite build design for bridges, viaducts and green (cut and cover) tunnels.

In 2014, Atkins led the HS2 Growth Task Force for the Department for Transport to support the city regions in maximising the regional potential of HS2. Atkins continues to work with key stakeholders, ensuring HS2 is fully integrated and enabled, and that development and regeneration is secured. Committed to creating a sustainable skills pipeline, Atkins has supported the formation of learning and training opportunities to optimise the employment and export potential of HS2.



#### Case Study Siemens

Euston is the London terminus for HS2 services and in order to facilitate the HS2 project construction related activities by January 2019, the HS2 station site requires operational space currently occupied by Network Rail platforms and lineside infrastructure. Achieving this target date requires the decommissioning, removal and relocation of existing operational assets from the west side of Euston station approach to the east side of the station. Network Rail has been instructed by HS2 to undertake this work on its behalf. Due to the project's complexity and the proposed timescales, the project has been divided into several work packages with Siemens Rail Automation awarded the following:

- Work Package 3a: Westside Clearance and PSB de-mobilisation
- Work Package 4b: Up Sidings Extension
- > Work Package 4c: Camden Carriage Sidings Extension.

The initial contract is to survey the existing assets on both sides of the station to establish what needs to be moved. A follow-on stage will design and implement the equipment moves as a series of staged commissionings. The surveying is expected to take less than three months and the Siemens Rail Automation team is looking forward to being part of this major transformation.

### Case Study AECOM

AECOM has worked on the environmental and engineering aspects of HS2 for over five years – their consultants who worked on the environmental investigation and assessment are involved in the engineering design and its impact before they then move into the construction management teams. AECOM has significant capability in environment consultancy, engineering design and construction management, which allows a seamless link to be established between these three elements, which have historically been disconnected. AECOM has been advising on many environmental aspects of HS2, but of particular interest are the ecology and archaeology disciplines. Having investigated sections of the route they have established the type and location of existing flora, fauna and heritage sites. This information has been assessed in conjunction with the engineering design to understand the impact of the scheme, and to develop measures that protect and enhance the natural and historic environment. Some of these measures will require habitat removal and construction at new sites. AECOM has developed this capability to lead all aspects of this, including construction management with the same staff being involved throughout.



#### Case Study Railway Industry Association (RIA)

RIA members Fugro are an international site characterisation specialist – one of nine contractors selected for the Phase One ground investigation framework. Site investigations (SI) for HS2 phase one are being undertaken to demanding standards, providing vital ground engineering and design data for the construction of bridges, tunnels, cuttings and four new stations, as well as 140 linear miles of track carrying trains at up to 250 mph. Experienced and skilled personnel, together with a versatile range of equipment, are being mobilised to undertake the challenging site investigations. This has entailed not only intensive programmes of geotechnical and geophysical site work, but also high volumes of sample analysis, testing and data processing to help keep the client on track with design and construction planning. Investment has been made in new equipment, while some tasks are relying on specialised technology. An example is the testing of soil samples at very low strain levels using highly specialist equipment at the company's state-of-the-art laboratory in Wallingford, one of just a handful of UK laboratories with this facility. At a time of high demand for geotechnical services but a shortage of skills in the UK, the depth and integration of their global resources and logistical mobility have come into their own for a national infrastructure project as large and critical as HS2.



#### Case Study LM Joint Venture

A good model of such a unified strategy in action can be seen in the northern section of HS2 phase 1, where the LM joint venture (comprising Laing O'Rourke and J. Murphy & Sons Limited) is conducting enabling works in and around Birmingham ahead of construction of the new high speed line. One example of an important community and environmental initiative is taking place at Finham Brook, not far from Stoneleigh, Warwickshire. Here, construction work has started on an extensive nature reserve, that will form the new home for many mammals and invertebrates which will be affected by the main construction earthworks. The reserve has been designed so that it will become an environment where the creatures can establish themselves and thrive.

At the other end of the spectrum, in the centre of Birmingham, detailed preparations are under way at the site of the new Curzon Street station. Covering a substantial area close to the city centre, much of the area will require detailed thorough ground investigations, to make sure that the ground conditions match expectations. In this particular location, these will need to be handled with the utmost sensitivity, as part of the footprint was a burial ground dating back several hundred years, and a large number of bodies will need to be exhumed before any further studies can take place. Far from being a negative issue for the wider project, a collaborative approach involving all interested parties will ensure that this presents the city with a unique chance to learn more about a previously hidden period of its past.



# 3. Innovation

The introduction of high speed rail in the UK offers a huge opportunity to innovate across a wide variety of capabilities, from cutting edge technology and design, to the development of improved partnerships and new ways of working. From station and train design and accessibility, to ticketing and signage, to passenger entertainment, the prospects for innovation are significant for HS2, and provide a platform to revolutionise the rail and infrastructure space in Britain. Large-scale infrastructure projects are often drivers for change, but few offer the scale of transformation that HS2 does. In addition to the economic benefits it offers, it meets three criteria that are crucial to aencourage innovation:

- Vision an ambition not just to build something new, but to change the way that customers and communities use and benefit from the project
- > Lead-in time because inevitably large-scale projects take time to realise
- Resources to invest in the new bigger budgets provide more scope for research and development.

Our members are committed to ensuring the UK's delivery of major infrastructure projects is achieved efficiently and effectively. Innovative techniques and technologies can range from large scale infrastructure design right down to the use of materials. Even basic tasks such as the pouring of concrete can be completed in more innovative ways, thus improving efficiency, reliability and delivery of the project. Passing on good practice from projects such as Crossrail is an essential part of raising the bar in the delivery of major projects, to ensure that the UK continues to build on its reputation for delivering safely, on time and on budget.

Innovation does not always have to be brand new. It can be proven elsewhere and adopted for the UK. Trains on HS2 will be 400 metres in length, the longest passenger trains in the internal UK network. Innovative mechanisms for ensuring passengers' needs are met must be created. This affords businesses the opportunity to lead the way with design innovation to create the ultimate railway experience that can be delivered, replicated and exported.

High speed rail offers the opportunity to completely rethink station design in the UK, both in terms of customer experience and urban context. For example, longer trains makes the conventional approach of walking the length of the train from one end no longer seem appropriate, exacerbating the challenges many large stations face in integrating themselves with the fabric of the city. It is these design challenges that mean HS2 stations could present a paradigm shift in station design in the UK. However the station should not be thought of in isolation from the system itself, with the HS2 project offering the chance to apply the best in British design to true end-to-end thinking. This means designing the experience from the moment the decision to make a journey is made, which includes making buying tickets, allocating seating, getting to the station, the carriage and seat and onward travel arrangements to a final destination intuitive, convenient and pleasurable.

### Case Study Hitachi

In Hitachi's case this means designing a train that will set new standards in passenger experience, while being light, fast, green and reliable – all at the right price. As part of their work, Hitachi's engineers are assessing the lessons that can be drawn from leading projects across the globe, from Japan's Shinkansen to Europe's fastest high speed train, the ETR1000. They are looking at what do they do well, and how can they be made even better.

The UK's own Javelin HS1 train is also worthy of review, as Britain's fastest domestic service and one of its most popular. Our designers are doing some serious thinking about what 'next generation' really looks like. What will redefine the comfort standards on British tracks in 2026? Italy's ETR1000, nicknamed the Red Arrow, introduced a premium look and feel on-board by having the interiors designed by Bertone, the company behind iconic style of Aston Martin and Lamborghini.

There are other simple innovations such as rotating rows of seats, already used in Shinkansen, which mean that everyone can face forwards, thereby helping alleviate the motion sickness that some people experience when they travel backwards. Yet, we recognise that comfort depends on more than just seats, so we're looking at smoothness of ride too. One example is Shinkansen's trademark long-nose shape that has been designed to smooth the flow of air over the train, particularly when it enters tunnels at high speeds, resulting in less vibration and a more comfortable ride for passengers.

We're also looking beyond rail at other industries and at what is leading the way in cuttingedge technology amongst the world's leading designers. Our journey of discovery will leave British engineers with greater knowledge and the ability to apply their experience to the trains of the future. Offering an environmentally sustainable solution is important for the new train design. The ETR1000's construction offers a lesson here, with it being made from 85% recyclable and 95% renewable materials. Furthermore, the noise caused by trains travelling at 360 km/h could be one of the most challenging issues to overcome, affecting not only the environment, but residents living near the line. In Japan, custommade pantographs are already in use on the E5 Shinkansen trains, which reduce the noise produced at high speeds to around 75dB, well below European limits of 90dB. There may be learnings here for the UK.



### Case Study Alstom

Alstom specialises in innovative high speed rolling stock. The Avelia high speed platform is very broad and flexible, including the fastest double deck trains in the world, the Euroduplex, single deck distributed traction trains like the AGV in Italy and the Pendolino which we know well in the UK. The newest in the family is the Avelia Liberty for Amtrak, the world's first tilting very high speed train. But innovation doesn't stop with the design of the trains. High speed trains require careful maintenance, and here in the UK, Alstom has developed innovative new 'predictive maintenance' solutions to keep them running smoothly.

In 2014 Alstom installed the first ever TrainScanner in Manchester. Using technology soon to be exported all around the world, the diagnostic portal hosts laser scanners and cameras that enable real-time 'health checks' of the Pendolino trains as they glide through an arch at the depot on their way in to the facility. The scanner has an ID reader that identifies the train as it approaches and will only let the laser shutters open if it detects a Pendolino. It then runs a scanner and high speed cameras to measure the components of the train. It is capable of complex automatic assessments of the wheel profile and dimensions, the brake pad thickness and the pantograph carbon profile.

This new TrainScanner is part of Alstom's HealthHub solution. HealthHub integrates and analyses the data gathered by TrainScanner and other monitoring systems to provide asset health information. Using advanced algorithms it can predict the remaining useful life of these components and a user-friendly interface provides actionable predictive maintenance and diagnostic information directly to depot staff. Before the train leaves the depot, the scanner can also run a final confidence check on the body and shell. It converts all the data into 2D and 3D images, which staff can easily understand, picking up any final problems before the train leaves the facility. High Speed 2 can look forward to proven innovations like TrainScanner delivering more reliable and more efficient trains. Increasingly, TrainScanner will allow component waste to be reduced, the efficiency of maintenance teams to increase and safety to be improved even further. This will mean fewer delays and problems for passengers, something everyone who uses the new railway will welcome. Alstom Avelia AGV, a distributed traction single decker train that runs in Italy.

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#### Case Study Weston Williamson + Partners

As one of the world's leading specialist rail architects, Weston Williamson + Partners has been involved in HS2 for over four years. We understand how innovative technology will play an important part in the intermodal connectivity of HS2 stations and how a flexible and adaptable approach will be fundamental to accommodating other future developments in transport. With trains up to 400 metres long the conventional approach of walking the length of the train from one end no longer functions. Much like the ubiquitous technology enabled digital networks which now surround us, the key to approaching HS2 station design may reside in decentralisation and dispersal. Through approaching the high speed trains from above or from below, a number of vertical circulation cores could be distributed along the length of the train getting passengers as close to their allocated seat as possible without having to walk the full length of the platform. Innovative lift-centric solutions could improve efficiency and remove the safety issues associated with escalator use and cater for changing demographics and passengers with large amounts of luggage. Biometric technologies could rethink the traditional gate line and further enhance the passenger experience.

In order to deliver this sort of innovative design thinking, the industry will need to move away from siloed thinking to a much more collaborative model. WW+P has long championed this kind of collaboration and, for example, on our award-winning Paddington Integration Project a number of different clients including Network Rail, London Underground, Crossrail and BAA were brought together as a single client board to rethink the project brief. This allowed the delivery of a fully integrated solution which met the immediate needs of all while enabling the future integration of Crossrail and over site commercial development.



### Case Study Bechtel

Bechtel is transferring its experience from the Crossrail project, where it pioneered the use of 4D planning, to the high speed rail environment. On Crossrail the 4D approach was initiated during the detailed design phase. On HS2 our 4D tools and processes will be applied during the earlier development phase to identify innovations and opportunities to drive value even sooner. This early adoption will be key to the construction industry, and high speed rail in particular, realising the full benefits of 4D planning in the delivery of mega projects.

On Crossrail the 4D approach enabled a much higher level of understanding of the planned works. It significantly improved collaboration by bringing engineers, planners and construction professionals into the same space to coordinate activity and avoid time and space conflicts. As the project shifted into the construction phase there were very tight and complex schedules for fit out (MEP&A) of the main stations and this work was on a time-critical path. Project teams found it challenging to keep track of the progress of construction works using traditional 2D plans so the Bechtel team worked collaboratively with Synchro Software to develop an app that extended the 4D model into the field. A new innovative work process was developed and implemented so that progress updates recorded in this app were instantaneously reflected in the main 4D model containing the construction schedule. This provided near real-time updates to the whole project team and allowed planning to become more proactive. The tool enabled the realisation of significant cost savings and process improvement across multiple project sites.



### Case Study National Grid

National Grid's job is to connect people to the energy they use, safely. For HS2 that means we have a statutory role to build three new substations to power the trains. In addition, we need to rebuild 8.5km of our electricity network and 4km of our gas pipelines so that the track can be built without obstruction. We'll also replace wires along 24km of existing pylons. This is just for phase 1. They'll be more to come in phases 2a and 2b.

We know from developing and building our own new infrastructure the importance of relationships with communities and landowners. We place a priority on being a good neighbour and are acutely aware of the difficulties of building on the landscape. We're focussed on exceeding the expectations of our customers too. For HS2, that means recognising that we're a small part of a huge project and focussing on how we can deliver value.

Our team of experts co-locate at HS2 Ltd's offices and take a proactive, agile approach to responding to HS2's needs. With this, we're better able to understand their challenges and how we can contribute to solving them. As a result we've found better ways to drive performance. This has resulted in multimillion pound savings through design optimisation and resequencing our construction timetable to keep the overall HS2 programme on schedule.

With phase 2a beginning its Parliamentary journey and phase 2b coming down the track, we are continually developing how we work with HS2 as its organisation evolves. What won't change is National Grid's commitment to delivering operational excellence and meeting the needs of our communities, customers and stakeholders.



### Case Study IDOM

The philosophy and project-based culture at Idom ensures that its UK team collaborates in international IDOM Group rail projects. For example, the team seeks to bring international expertise to the UK – being actively involved in railway innovation and research, which will provide new rail technology and designs that will benefit Britain's railways, covering all the required specialisms including civil engineering, superstructure (track, electrification, signalling and comms), rolling stock, operational plans, maintenance and RAMS. One example is in relation to the challenge of viaduct design. The Almonte Viaduct Idom's design, with a 384 metre span, uses a single octagonal arch that forks into two hexagonal legs creating structural efficiency, and features out-of-plane stability as per high speed rail deflection limits requirements, while improved wind response are included in its design. Key features include structural efficiency as well as aesthetics; both of which are vital considering its environment. Sustainability of the bridge is one of the design's key points and maintenance costs have been reduced, despite the fact it is of a singular design.



# 4. Conclusions

Large-scale infrastructure projects are often a driver for change, yet few offer the scale of transformation that HS2 does. This report has sought to demonstrate that the delivery of High Speed 2 is well underway and that the members of HSRIL are leading the way in this process.

**Skills** – With membership spanning both industry and the education sector our members are working with government to create programmes that ensure we are able to develop the necessary levels of skilled resources that will see the UK build on its reputation as a world leader in railway engineering.

**Enabling Works** – The delivery of HS2 is now well underway. Our members are at the forefront of this and the recent award of enabling and civils packages for Phase 1 will see a real ramping-up, both in the pace and scale of our involvement. Alongside these welcome developments, HSRIL members will continue to provide support for the ongoing development of phases 2a and 2b, which we see as crucial in maximising the overall benefit of HS2 to the UK economy and addressing the challenge of rebalancing the country.

**Innovation** – Our members are continuing to innovate, sharing examples of high quality word class innovation, both developed here in the UK and from our experiences delivering around the world to the wider international market.

We are committed to working with HS2 to help deliver this project and believe we are uniquely placed to provide UK expertise across the range of specialisms that they will require. Furthermore we recognise that beyond HS2, £1 trillion worth of potential export is available to 'Brand Britain' through high speed rail. More than 15,000 kilometres of high speed rail is planned around the world in what is a global growth sector and HSRIL is pleased to be working with Government and other industry bodies to help maximise the UK opportunity in this area through our membership of the RSG UK Rail Exports Leadership Group. The aim of High Speed Rail Industry Leaders is to support, promote and champion the principles of high speed rail in the UK. Our members come together to coordinate and share the expertise and experience within the industry and help assure that Britain's national high speed rail network is delivered successfully to world class standards.

A list of our current members, and details of how to join can be found here: www.rail-leaders.com

You can follow us on Twitter here @RailLeaders



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