Introduction

The world is changing rapidly, and the diverse challenges the engineering industry is helping to solve are extremely complex. The solutions we develop will offer us a world that will work better than it does now, for more people.

Urbanisation requires evolutionary change as we seek to adapt the vast majority of our existing assets as well as creating new infrastructure that must cope with challenges we cannot yet fully predict. This is, I believe, the first driver for high speed rail around the world.

Rail infrastructure must enable cities to work smartly, have excellent connectivity and become drivers for the growth of wider city regions. High speed rail will be a vital component as it has the ability to link large population centres over vast distances, quickly.

However, designing transport infrastructure capable of meeting the growing urbanisation challenge will - as has been discussed over the course of this conference - require a new kind of design, engineering and delivery.

It is also important that we understand the economic drivers. Cities act as hubs of activity, promoting business interaction by bringing people together physically and by the use of technology, and they also bring lots of companies into a well-defined economic ecosystem. High speed rail can help with this growth.

Finally, we need to ensure that we can deliver adaptable and smart solutions, which prioritise materials and energy efficiency and yet still meet the highest standards of quality and safety. It will mean industry tackling problems in a more holistic way, modelling and dealing with interdependencies between risks.

In short we need to be smart. We need to be innovative. We need to help explain the solutions we’re proposing, as engineers, as scientists – and why there’s a need to change the design paradigm.

We can break this down in four areas on which to focus:

- First, the scale of the urbanisation challenge
- Second, can we make high speed rail economically attractive?
- Third, what are the main technical hurdles we need to clear?
- And finally the need for a collaborative approach.

The wider context – urbanisation

Let’s look at urbanisation. The global population is expected to reach nine billion by 2050 and by then 75 per cent of people will live in cities.

It is a most acute challenge being faced everywhere but especially in the developing world. Perhaps it’s not surprising that regions such as Asia Pacific and Africa are responding with investment in rail networks as one key coping strategy.

It’s one thing to hunger after new fast rail connections – many countries are doing that, including the UK where Atkins is headquartered. The trick is making sure that the investment case is appealing.
**Economic case**

Gazing forward we expect the world market demand for high speed rail to grow rapidly. Investment could reach a value of 100’s of billions worldwide in the next 15 years.

However it is notoriously difficult to predict the economic benefits, and one of engineering’s roles will be to provide engineering solutions which deliver confidence to the client that their investment will be realised.

Indeed, the UK Government has described the development of high speed rail as the “most significant transportation infrastructure project since the building of the motorways… laying the groundwork for long-term, sustainable economic growth”.

High speed rail will be key to delivering that vision because connectivity enables cities to evolve into city regions.

Example – Birmingham, the UK’s second most populous city, will extend its reach as a city region with HS2 – both north to Leeds and Manchester as well as south to London. All the cities on the route will benefit from economic rejuvenation, as will their hinterlands.

We have seen how the Lignes Grande vitesse have joined up the great cities of France, and delivered connectivity with northern Europe, the UK, Belgium, Holland and Germany – including my hometown of Frankfurt - as part of the high speed rail network.

Elsewhere, Atkins’ work on Gautrain in South Africa is helping grow the province’s economy by eight per cent by 2014 and it is estimated that 40,000 jobs will be created by new developments in the vicinity of the line and stations – that’s on top of the 63,000 jobs created directly and indirectly by the project itself.

The Hong Kong Express Rail Link will provide high speed rail services between Hong Kong and Guangzhou (Chinese mainland) and a connection to the national high speed passenger rail network. This project is a great example of where the increased property value on or around stations has helped to fund the railway.

It’s easy to see how connected cities can quickly evolve into city regions and even mega regions – delivering some very specific and short to medium term economic benefits.

Add in telecommunications, bringing people together in virtual meeting rooms across the world, and we have the ability to connect all of the world’s big cities.

**Technical challenges**

However compelling the case for high speed rail, the challenge will be to ensure that we understand the technical challenges required to safely run trains at high or even ultra high speed.

Reports from high speed developments in China and France record failures to run the trains at their intended speeds due to the impact it causes on the track structure. Trains can now run at very high speeds; the issue is whether current track technology is able to support them in the long-term.

Significant research is required to develop design guidelines on which track type is best suited for a particular application and speed. Advancements in track technology would also have the ability to improve noise and vibration, the documented problems of high speed rail.

The required train speeds for future railways will be significantly greater than the first phase of high speed railways, with speeds of 400km/hr being anticipated to accommodate future train technology.

This presents a number of engineering challenges in the ground – the effect of Rayleigh waves in low stiffness soils, clay heave and how earthworks will need to be reviewed to deliver appropriate embankments.
In addition, the available design standards (such as UIC719) can only be used for guidance and Atkins’ geotechnical engineering team is playing a key role in developing the strategy to meet these requirements.

Mathematical modelling of new materials and construction methods has to assume certain behaviours; certain interactions may not be modelled correctly and there are difficulties with predicting how these change with repeated load applications because we do not have the evidence and experience of running at these high speeds over a long period of time yet.

Experimentation with new materials and construction processes could also bring about savings in construction and maintenance of high speed track, whilst providing a solid validation of the solution’s long-term performance and buildability. It allows a much more informed trade-off between construction and maintenance costs to be made.

The dynamics of high speed rail could affect areas tens of metres from the rail, particularly in the context of vibrations induced in nearby properties. By testing high speed running on test rigs we can reduce this risk - this sort of validation of the vibration risk and mitigation measures around noise could provide a huge benefit in winning support for HS2 in the UK, for example.

It is clear that a holistic approach is required for high speed railway design that encompasses trains’ suspension systems, track form, ground conditions, drainage and operational maintenance regimes, so that ballasted track technology can address the challenges that the industry will face in future.

Collaboration - Atkins and Heriot-Watt University

Because of the complexity of the challenge the final point we must address is that of collaboration. Partners help us to drive innovation.

A good example is the memorandum of understanding we signed recently with Heriot-Watt University to establish a High Speed Rail Centre of Excellence. Working together with Professor Woodward we recognise that combining the talents of highly skilled individuals who can deliver high speed networks technically brilliantly and at best cost, is essential.

The aim is to create a platform that shares that academic approach and practical innovation to push boundaries as well as develop real solutions that will work worldwide.

Heriot-Watt is leading the way on railway geotechnical engineering and 3D modelling of ground dynamics and interaction for high speed trains. The university has already built a laboratory track bed testing rig which simulates the effects of train wheel loads in a range of situations and on a range of track beds. The team can model the behaviour of rail tracks in real life situations and under full-scale conditions.

The next step is to build a new, large-scale test rig which will enable experimentation with these new materials and processes. It will use sophisticated monitoring to produce direct evidence of performance and predict with greater accuracy the lifetime performance of trackbed and earthworks for high-speed rail, helping to improve the long term asset management for lines.

As an industry we need to ensure that we have the resource and talent to meet the next generation of challenges as I have outlined. Atkins and Heriot-Watt’s partnership is just one step towards helping to make sure that future engineers have the skills needed to design and build high speed networks around the world.

Conclusion

I’ve covered a lot of ground but I want to leave you with some parting thoughts.

The scale of the challenges we face around the world cannot be underestimated - they require us to look beyond the traditional boundaries of engineering.
Urbanisation is an opportunity for high speed rail, and equally high speed rail is an opportunity to accelerate the economic growth of new and existing cities.

Delivering high speed rail will be challenging but the technical knowledge and understanding of how we deliver it is where the engineering sector can help explore and explain its benefits.

We must ensure we are sitting next to the politicians, the economists, the scientists, informing robust decision making and helping putting everything in context.

Explaining and solving the technical challenges will help deliver transformational railways that people actually want to use. It will also address other issues such as how to reduce the carbon footprint of the railway or decreasing the land take needed for new and existing lines.

Both could drastically improve the business case for high and ultra high speed lines.

Collaboration is vital. The cities and routes high speed rail serves are complex we need a broad spread of expertise in order to deliver smart design. The key is to have common goals and create central coordination methods.

As HS2 Ltd recently highlighted, today’s work on high speed rail will be judged by future generations - improving connectivity is vital to the future-proofing of society and managing urbanisation.