# THE HS2 SPEED PARADOX

One feature of the HS2 project, that has never been adequately explained, is the decision to design HS2 for a future maximum speed of 400km/h (250MPH). Given that this speed would make HS2 the fastest railway in the world (and given the obvious parallels with Concorde), it would be reasonable to expect a rigorous structured process, by which every aspect of cost, technical risk, environmental impact and commercial/ community benefit would be taken into account, to show 400km/h to be the optimum speed for a UK high speed railway. Yet extensive review of HS2 Ltd documentation reveals no such structured process; instead, 400km/h is simply presented, without supporting rationale, as the design standard for HS2.

With no hard information to the contrary, the suspicion must exist that the decision to adopt 400km/h was driven by a 'Brunelian' desire to push existing high speed rail technology to its limits in pursuit of extreme speed. Indeed, senior figures at HS2 Ltd are reported to have put the question in reverse: "Why would you *not* want to design the fastest railway in the world?"

The arguments against extreme speed are already well rehearsed:

- Journey time benefits are almost negligible. Calculations show that HS2 London-Manchester services running 11% faster at 400km/h maximum, rather than 360km/h as currently planned for 'Day One' operation, would arrive in Manchester only 2.3 minutes earlier – a saving of 3.3%.
- Energy costs – and therefore $CO_2$ emissions – will rise with the square of speed. So for a speed 11% greater, energy consumption and emissions will increase by 23%.
- Maintenance costs, and related aspects of wear and technical risk, will tend to rise at an even higher exponential.

On this basis alone, it seems impossible to justify 400km/h as the HS2 design standard; and indeed, even the lesser (but still very high) speed of 360km/h must be questioned. However, it is only with the emergence of the High Speed UK 'exemplar alternative' that the true costs of HS2 Ltd's ill-considered adoption of 400km/h begin to emerge:

1. Design of HS2 to accommodate future 400km/h operation has dictated near-straight track alignments, and this has tended to force HS2 away from existing transport corridors – where it might be integrated with the existing rail network – and instead onto intrusive rural routes – where integration is not practicable.
2. This leaves HS2 only able to offer reduced journey times between the primary cities at each end of the route; by contrast, the intermediate 'M1 corridor' cities

of Luton, Milton Keynes, Northampton, Leicester and Coventry will be bypassed by HS2, and all will see reductions[1] in their intercity services along the existing West Coast and Midland Main Lines.

3. Design to the lesser maximum speed of 360km/h has allowed HSUK to follow existing transport corridors, in particular that of the M1. This has the immediate effect of vastly reducing HSUK's environmental impact, but more crucially it has also allowed HSUK to be fully integrated with the West Coast and Midland Main Lines, both of which follow the M1 corridor.
4. On a local level, this integration enables HSUK not only to accelerate journeys between London and Birmingham, but also to bring improved high speed intercity services to all major intermediate communities i.e. Luton, Milton Keynes, Northampton, Leicester and Coventry.
5. On a national level, HSUK's full integration with the existing rail network allows high speed services to extend to all major communities served by the present intercity network. It allows all existing intercity routes to be greatly accelerated, and it also fills in gaps in the existing rail infrastructure to create new intercity rail corridors (for instance South Coast-Oxford-Milton Keynes-Northampton-Leicester-Nottingham-Yorkshire-Newcastle-Scotland, or direct services from Heathrow to the Midlands, the North and Scotland).
6. HSUK has developed a 'Demonstrator Timetable' to describe how the UK intercity network will operate, with HSUK in place. This timetable covers 32 principal UK cities and airports (including all the M1 corridor communities noted above) and it enables journey times to be calculated for all of the possible 496 journeys between the 32 centres.
7. The timetable shows that HSUK, operating at a maximum speed of 360km/h, could offer an average of 46% journey time saving across the 32-cetre network.
8. The timetable also shows that if HSUK were to operate at progressively lower speeds, step-change journey time reductions could still be achieved.
9. Exactly the same exercise has been undertaken for HS2. Taking into account the very few 'primary to primary' journeys that HS2 will accelerate, and the much greater number of journeys to second-tier cities that HS2 will *not* accelerate (or make worse), HS2 will only offer an average journey time saving of 9%.
10. The paradox between HSUK's and HS2's performance in reducing national intercity journey times is illustrated in Figure 1. HSUK, designed for the maximum speed of 360km/h, and fully integrated with the existing network, can offer 46% average journey time reductions. By contrast, the segregated HS2,

[1] Projections of reduced intercity services along existing main line to cities bypassed by HS2 are given in Table 23 on pp91-92 of *HS2 Regional Economic Impacts*, HS2 Ltd, September 2013.

also operating at 360km/h but with infrastructure designed for the higher speed of 400km/h, can offer only 9% average journey time reductions.

11. The paradox becomes still more extreme if different operating speeds are considered. Even when operating at the current maximum network speed of 200km/h, HSUK can still offer 39% average journey time reductions. Whereas HS2, when operating at twice the speed (i.e. at its design speed of 400km/h), will achieve average journey time reductions only fractionally above 9%.

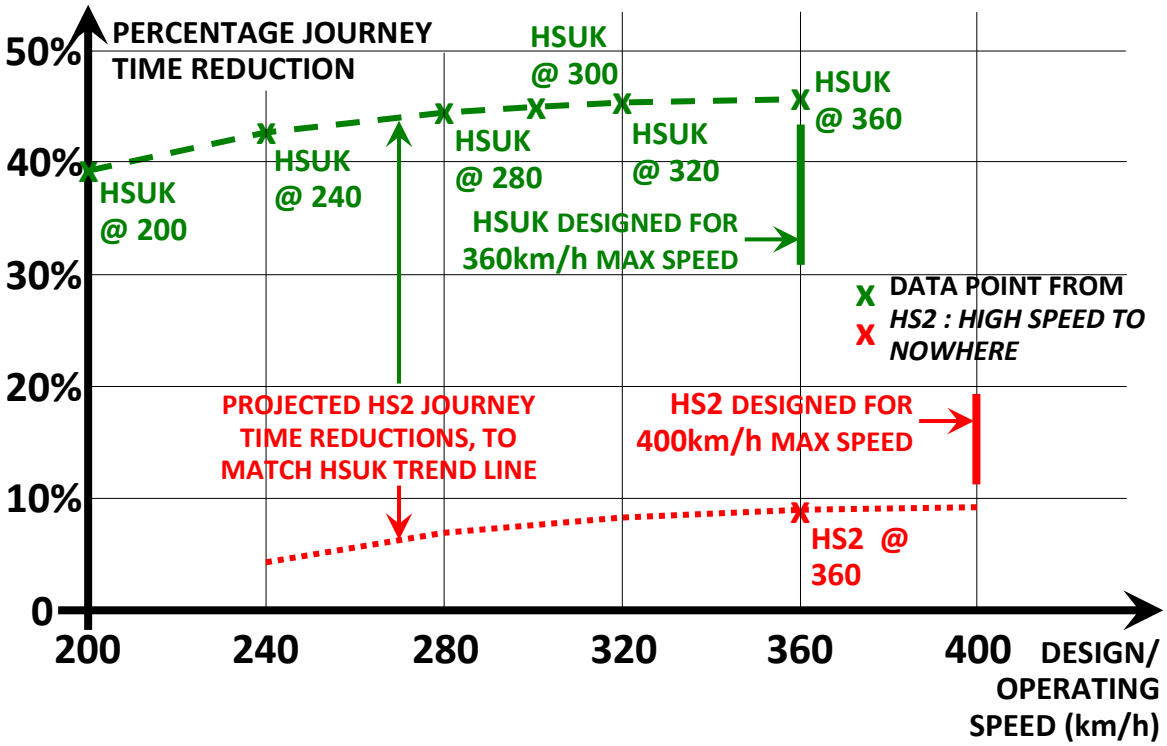


**Figure 1 : Relationship between %age Average Journey Time Reduction and Operating Speed (data from *HS2 : High Speed to Nowhere*)**

The stark difference in HS2's and HSUK's journey time performances offers the perfect indication of the technical failures at the heart of the HS2 process, and of the inadequacy and incompetence of its technical leadership. A mistaken assumption has been made, that design of HS2 as the fastest railway in the world will lead naturally to the desired outcome of "hugely enhanced capacity and connectivity[2]". No-one appears either to have understood, or to have bothered to check, that full integration between new high speed line and existing network has a far more powerful effect, both in reducing journey times and in achieving the required capacity and connectivity.

All this contravenes every possible aspect of standard scientific and technical procedure. The people of the United Kingdom deserve better.

[2] On 30th November 2015, HS2 Ltd Technical Director Andrew McNaughton stated, in evidence to the House of Commons HS2 Select Committee: "The aim of the HS2 project is to deliver hugely enhanced capacity and connectivity between our major conurbations."