**Railways need disruptive innovation**

Andrew Nash
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## Introduction

In 2008 this author presented a paper titled "Europe's High Speed Rail Network: Maturation and Opportunities" at the TRB Annual Meeting. The paper argued that "high speed rail needs disruptive innovation to create attractive and new services tailored for today's transport demands".

The paper described several projects completed in 2007 that could serve as seeds for that disruptive innovation, and possible innovation paths. Unfortunately, the hoped-for increase in railway mode share has not happened. Furthermore, the worsening impacts of climate change have made shifting transport to rail even more critical. This article assesses the original paper's "seed" projects and uses this assessment to help sketch a new set of possible disruptive innovation paths based on current social needs and technology.

## Disruptive Innovation

The disruptive innovation called for in the original paper meant using new technology and organizational change to significantly increase railway transport's mode share. The term disruptive is used to both define the degree of technical and organizational change as well as magnitude of the result (significant change in market share for a mature industry).

Unfortunately, as shown in Table 1, railway mode share in Europe has only slightly increased in the last 15-years (figures for goods transport are similar). This indicates there has been no disruptive innovation.

**Mode Share (in Percent) and Total Passenger Kilometers – 2005 vs 2019**

| Transport Mode | 2005 | 2019 | Change |
|---|---|---|---|
| Passenger Cars | 73.2 | 71.6 | -1.6 |
| Passenger 2 wheels | 2.2 | 1.9 | -0.3 |
| Bus and Coach | 9.5 | 8.1 | -1.4 |
| Railway | 6.5 | 7.0 | 0.5 |
| Tram and Metro | 1.4 | 1.4 | 0 |
| Air | 6.9 | 9.7 | 2.8 |
| Sea | 0.4 | 0.3 | -0.1 |
| Total Passenger Kilometers (Billion) | 5,247 | 6,038 | 15% |

Source: European Commission, Statistical Pocketbook 2021, EU Transport in figures, 2021.

The relatively minor growth in railway mode share is very disappointing for a technology expected to help Europe achieve its climate goals and environmental objectives. Therefore, acknowledging that it is much easier to recommend disruptive innovation than to implement it, the paper repeats the earlier recommendation: railways need disruptive innovation.

**Creating a European HSR Network: 2007 Innovations**

The original paper's thesis was that creating a "true" European HSR network would facilitate development of a fully integrated railway-centered transport system by providing new service to an important market niche (400-600 km cross border trips). Increasing rail's potential market by adding this important segment would initiate disruptive innovation including adoption of new technologies and changes to long established business processes and systems throughout the railway sector.

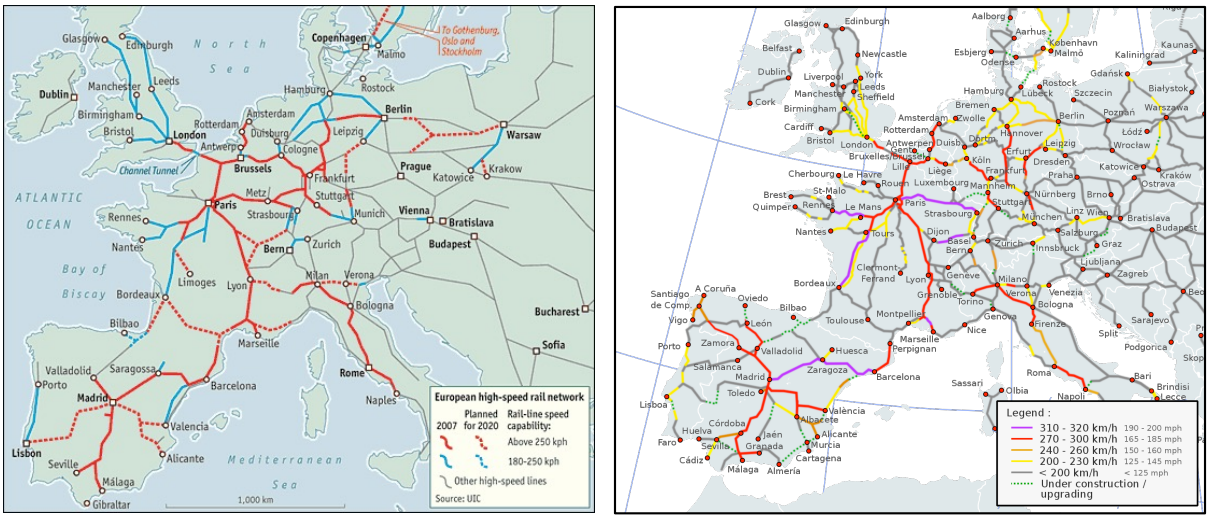
The original paper described four projects completed in 2007 that could have been seeds for jump-starting this European HSR network:

- LGV Est (infrastructure project and new market entrant)
- Swiss Alpine Basis Tunnels (Loechberg 2007 and Gotthard 2017)
- Channel Tunnel High Speed Line (London to tunnel entrance)
- Railteam (an airline-like alliance of HSR operators)

The infrastructure projects were all expensive, as well as being difficult and time-consuming to plan, finance and build. But by making substantial reductions in travel times, they all had the potential to significantly increase market share for cross border trips. Today all three projects are successful, but they haven't had the hoped-for network-building effect.

Railteam was included in the list of seed projects because it directly addressed creating the perception among travelers of a true European HSR network by establishing an airline-like alliance of railways designed to make international HSR travel more seamless and attractive. By directly addressing traveler perception Railteam is an excellent strategy, however today it has faded from public consciousness.

In addition to describing the seed projects the paper presented a map of Europe's planned HSR network for 2020. Comparing the original map with an up-to-date version shows that most of the planned HSR lines expected by 2020 have been built, and, in some cases more (and/or faster) lines have been built (e.g., in Spain).




HSR Network 2020 (Projected in 2007) HSR Network 2020 (Actual 2021)

Figure 1: Comparison between 2020 European HSR Network planned in 2007 versus actual in 2021 (Sources: 2007: The Economist; 2021: Wikimedia Commons https://commons.wikimedia.org/wiki/File:High_Speed_Railroad_Map_of_Europe.svg ).

However, a close look at the 2020 map still shows gaps between national networks (i.e., border crossing sections with lower speeds or capacities). These types of international gaps are also widely recognized problems for the Swiss Alpine basis tunnels and LGV Est project.

Finally, the European Commission's 2011 Transport White Paper formally recognized the need for a true HSR network by adopting a goal of tripling Europe's HSR network by 2030. In 2018 the European Court of Auditors concluded this goal would not be met due to the long period required for planning, financing, and building HSR lines. Key problems included high costs, a lack of funding, insufficient strategic planning, and nationally oriented infrastructure planning.

In summary, the objective of creating a European HSR network has not yet been achieved and, more importantly, railway transport's mode share has not significantly increased despite the pressing need created by climate change. More than ever railways need disruptive innovation. The following sections sketch some possible innovation paths.

**Disruptive Innovation Paths for the Railway Sector 2022**

The disruptive innovation paths recommended below apply new technologies and changes to established business processes and systems to support creation of an attractive and efficient European railway network. As mentioned above, this involves not only infrastructure, but institutional and business culture changes needed to create a strong perception among customers that they can rely on railway transport to meet (most of) their transport needs.

- *European HSR Network*

Creating a true European HSR network would have two main benefits. First, it would encourage cross-border rail travel in the 400-600-km market thereby reducing the number

of short flights. Second, by increasing rail travel, it would support making further improvements to national, regional, and local public transport networks (a benefit also cited by proponents of the California HSR project).

The European Court of Auditors, in their 2018 assessment of HSR development, called for improved strategic planning, prioritizing funding for critical projects (e.g., cross-border routes), developing processes for facilitating cross-border projects, simplifying international railway operations, and implementing programs to support more seamless travel (e.g., ticketing). The report also recommends carefully considering maximum speeds, recognizing that higher speed track is more difficult and expensive to build, and may provide only marginal travel time benefits.

Two disruptive innovations that could supplement these highly pragmatic recommendations are better targeting European funding and significantly improved inter-organizational coordination of projects and operations (rail, air, public transport, urban development). Both have been recommended for many years. What's different now?

First, climate change has started to motivate changes in funding policy as evidenced in Europe's recently developed green new deal. Second, new digital technologies are making the nuts and bolts of coordination easier. In both cases what's needed is strong political will to force implementation. Here the recent entry of the Green Party into the German and Austrian national governments bodes well.

- *ETCS – Digital Strategy*

The European Train Control System (ECTS) is a digital system supporting railway interoperability by providing a common signaling system. It is also expected to reduce signaling system costs and increase railway capacity.

ETCS deployment has been disappointing. In 2017 the European Court of Auditors found that ETCS has suffered from similar problems as HSR, namely lack of strategic planning and funding. The main problem is that much existing signaling infrastructure and on-board systems still have useful life and therefore it is not economically beneficial to replace it. Therefore, ETCS is mostly being implemented piecemeal on new or upgraded lines.

Up to now ETCS illustrates a common problem for well established businesses, the application of new technology to old processes problem. More specifically, if ETCS simply replaces existing signaling, there is little business case for aggressive implementation. If, on the other hand, ETCS digital data could be used to significantly improve railway service and efficiency, then it could pay for itself many times over.

Several European programs are researching and developing technologies to better use ETCS and digital data including the Europe's Rail Joint Undertaking (replacement for Shift2Rail). Importantly, the new research program will take a more structured system approach that considers the full concept of operations and deployment, arguably addressing a criticism of Shift2Rail by considering the broader changes to established processes and systems needed to take full advantage of new technology.

Another potential disruptive innovation is Denmark's work on developing a traffic management system (TMS) that combines ETCS digital data and process changes to improve railway operations and quality. Denmark's economically justified decision to install ETCS on

the entire national network gave it the impetus for thinking more broadly about how ETCS could be used for more than just signaling. Norway is taking a similar approach as part of its recently adopted national ETCS deployment program.

Finally, the EULYNX effort represents an excellent opportunity for facilitating ETCS deployment, but more importantly for railway digitalization in general. EULYNX is a coalition of railways working on the development of common standards for digital equipment such as interlockings. The goal is to create a plug-and-play environment where railways are not tied to company-specific software and equipment (a problem that has plagued ETCS deployment).

- *Regular Interval versus Metro Timetables*

Switzerland's Bahn-2000 program created a nation-wide multimodal transport network with highly coordinated timed transfers at interchange stations (Taktfahrplan). This timetabling strategy, also used in The Netherlands and now being adopted more broadly (e.g., Deutschland Takt in Germany), has been extremely successful in attracting passengers.

Switzerland's adoption of the Taktfahrplan, and associated planning strategy: "not as fast as possible, but as fast as necessary" (to support the Taktfahrplan) was a disruptive innovation brought about by defeat of a national high-speed rail plan by voters.

The key to the regular interval timetable's success is that it fully supports the unconscious perception that one can take the train pretty much everywhere, relatively quickly, from early morning to late in the evening. Rail transport is transformed from something that must be planned to something that's always available (i.e., like an automobile).

Now, the impact of rapidly increasing demand on capacity has led Swiss planners to study alternatives to regular interval timetables. Recent modelling has shown that operating metro-like timetables (frequent all stop trains) could be better for passengers, especially considering the delays that occur in a system operating at near capacity. Interestingly, operating metro-like timetables also further reinforces unconscious network perception.

- *Time and Travel*

Transport costs time and money. Up to now technology has focused on reducing transport time because this is simple physics. Today new technology, especially communications, provides opportunities for taking a more nuanced view of time that railways could use to support disruptive innovation.

Using travel time productively is a well-established advantage of public transport (e.g., working on trains). The significant improvement of digital communications technology, and especially its rapid adoption and widespread acceptance during the COVID pandemic has significantly increased opportunities for productively using travel time, but also opens completely new possibilities for thinking about transport and time.

For example, the re-emergence of night trains shows clearly that quality can be preferable to speed. What if railways used digital technology to create products enabling passengers to break-up long trips with stops in attractive intermediate destinations. These personally tailored products could include services like lounges, showers, food, and intermodal

connections. They would be changeable in real-time increasing perception of network reliability (e.g., air-rail trips) and allowing for serendipity.

Another opportunity is creating systems that allow scheduling activities around transport. This sounds like the tail wagging the dog, but the time flexibility enabled by digital technology could make it possible to, for example, schedule dental appointments around the public transport timetable; patient waiting time is reduced, dentists generally don't care who comes first, and real time rescheduling can help patients and dentists make best use of their time.

Another, arguably time-related, strategy is railway based urban development. These strategies are well known, but as more of these "15-minute cities" are created and more people experience their attractiveness and economic benefits they should become easier to justify and build. Widespread transformation of railway stations into multimodal hubs in diverse mixed-use neighborhoods would significantly increase railway mode share.

One of the key advantages of these three ideas is that they could reduce travel by supporting trip chaining (e.g., combined business – pleasure trips). Reducing total travel (itself good for sustainability) would lower the mode share denominator helping boost the impact of railway improvements on railway mode share.

**Conclusions**

Many believe that new technologies like electric cars or airplanes are the solution to climate change. However, batteries have very significant environmental and social impacts. Furthermore, electric cars don't solve urban congestion and will likely increase sprawl. Finally, it's hard to see how these technologies can be deployed equitably to provide a rapidly growing world population with a level of transport like that enjoyed by Europeans or Americans today.

That's what's interesting about the disruptive ideas discussed above. They are also based on technology, and, in fact support electric cars and airplanes, but they involve changing established systems and processes for a transport mode that is more "naturally" suited to solving today's serious environmental and social problems. The objective is more railway transport with less driving and flying (not none). The best quality of these ideas is that they all achieve this goal while at the same time improving quality of life.

**Note**

Andrew Nash is a Senior Researcher at the St. Pölten University of Applied Sciences (Austria), a lecturer at the ETH Zurich and is formerly Executive Director of the San Francisco County Transportation Authority. This article is a work in progress and the author welcomes criticisms, comments, and suggestions. andy@andynash.com