Chapter 10
Innovation in Rail Freight and Interchanges (or How to Stop Rail Freight Hitting the Buffers)

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10.1 Introduction

Historically the term “innovation” with the actual meaning was used for the first time by Schumpeter at the first half of the twentieth century defining as product, process or organisational changes, stressing that they do not necessarily originate from new scientific discoveries (Schumpeter 1934). In modern society the need to “innovate” has become a routine common currency in numerous reports, studies, papers, policy statements, projects and reviews (EC 2013a, b, Van Binsbergen et al. 2013; Klitkou et al. 2013) focused on the future of the rail freight sector in Europe. Innovation appears to be offered as some sort of panacea and that by “being innovative” will somehow magically transform the capabilities and capacity of the rail freight system to become more attractive, more competent, more competitive and cost-effective. It will not! Innovation can take many forms including better use and management of existing resources, technology sets, systems and methods. “Better” has to be a measurable benefit in terms of enhanced operational and commercial performance, increased revenue and profitability, reduced cost and resource inputs, enhanced reliability, availability and responsiveness to users immediate and longer term requirements. It has to be measurable in terms of relevant KPIs and competitive measures. Gibbons et al. (1994) definition of innovation emphasised that the technology must satisfy the market needs.

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If quantifiable benefits cannot be derived from the innovation measures proposed or adopted, then they will count for little or be seen effectively as novelties with little chance of making any real and lasting market impact.

Innovation can and does take many forms. It can be incremental, with modest enhancements in technical, operational and commercial activities and this is the type of innovation which has generally typified the rail freight sector. It might simply include enhancing and integrating existing methods, systems and technology applications and ensuring they are applied in a more consistent or robust manner to that for which they were originally intended and bringing synergistic competitive advantages or it can induce breakthrough innovation, leading to disruption in the market. Considering the need to strengthen the competitiveness of the railways to improve their logistics performance, increase capacity and provide more reliable rail services the European Commission (EC 2013a, b) is tripling its financing for rail research and innovation from €155 million to €450 million (2014–2020).

The rail sector has benefitted from wider generic initiatives within the railway domain including modern track (cwr) and signalling systems (UIC 2016) and traction technologies although the true cost-effectiveness of these often remained opaque (EC 2001, 2004, 2007, 2013b) within the railway administrations when these new technology sets were implemented. Compared to the competing trucking sector rail has, however, routinely and regularly retained technology sets and assets well beyond their commercial and economic limits. Trucks, by comparison, are turned over in front-line service in 5–7 years and then replaced with new upgraded assets. Rail appears to be locked into the unquestioning retention of assets for 20+ years with the obvious negative implications on operational suitability and commercial relevance to evolving freight transport requirements. Road freight technical development has consistently been a major driver in terms of increasing the weight and volume capabilities of trucks and trailers and their increased levels of sophistication. Rail has not responded partially because of complex and time consuming hierarchical certification and inter-operability rules but also because of an increasing level of risk aversion as the sector has moved from being state sponsored into a more commercially driven situation. Who now encourages, sponsors and supports innovation at a generic and detailed level within the rail sector is unclear. One of the negative consequences of the longer life cycle of railway rolling stock is the time taken for the implementation of the technology. A locomotive for example, with a useful life of 30 years will have to compete along its useful life with several versions of truck technologies which will have been improved with lower operational costs and emissions of carbon and other gaseous emissions. This long life discourages technological development on the part of manufacturers concerned about the return of investment in the development of technology and partly harms operators. The Rail Research UK Association workshop (RRUKA 2012) looking at the train design and specification for reduced whole life system cost considered the economies of scale and also addressed some of the obsolescence strategies.

Generic innovation can and should be disruptive in terms of the impact of a particular concept, initiative or adoption of new technologies and operating regimes. By the same token the adoption of new technology sets (e.g. new traction technologies) or management methods may catalyse further initiatives leading to the attainment of much higher levels of reliability, capability and availability for enhanced service delivery and revenue generation on a lowered cost base not previously deemed feasible. The key is to identify the impact of innovative initiatives and to secure their fullest exploitation to commercial and competitive success in a recognised and identified market sector or sectors. Of equal if not more importance is the need to assess the impact of innovative measures being considered or developed on the shippers and wider cargo interests including current non-users of rail freight services. Rail also has to abandon the "not invented here" constraint and to seek cues and options in terms of innovative systems, operational methods and technologies from other sectors and domains where these can be productively deployed. The slavish retention of existing technical, commercial, operational and management models is unlikely to allow the sector to successfully re-position itself and to compete head on with competent, aggressive and near universal road transport services.

10.2 Innovation within the Rail Freight Sector

This section sets the scene for the development of a broad strategy for innovation within the rail freight sector. This strategy should simultaneously include commercial/economic, technical, operational and managerial aspects of innovation and not be a series of disparate random shots in the dark in the vague hope that something positive might be achieved.

The integration of innovation as an integral component of management activity and focus is essential. It is not an optional binary function. It needs to be continuous, active, commercially focused and not an exercise in purely technically led activities. The rail sector is littered with far too many false starts surrounded with triumphalism that have yielded little. Innovation and its application need to be an integral part of a wider and credible commercial strategy including much more in the way of contact with the market about its current, medium- and long-term requirements of transport service providers. Ferreira and Sigut's (1995) paper described a model using discrete-event simulation in intermodal freight terminal comparing the performance of conventional intermodal terminals with Road-Railer terminals.

The rail sector cannot continue to support a supply-side position with a "take it or leave it" attitude to shippers and their requirements. To maintain this would be an arrogant and ultimately untenable approach to new and developing markets for rail freight transport services. Unfortunately, this has been the stance the rail freight sector has assumed in Europe by indifference or design and paid the price in terms of the loss of market share (ECA 2016) to more flexible, cost-effective and agile competing modes. An ORR survey (2010) looking at the main barriers to using rail for domestic movements identified a strong relation between the modal decision and access to the rail network as can be seen in Table 10.1.

Rail has lost its contact with the growing and demanding markets for high-value time-sensitive products and commodities and preferred to support the movement of

Table 10.1 Barriers to using rail for domestic movements

	%
Overall	
Access to the rail network	71
Total costs	69
Route availability	55
Availability of suitable rail equipment (e.g. wagons)	51
Producers	
Access to rail network	78
Total Costs	67
Availability of suitable rail equipment	50
Logistics company	
Total costs	69
Route availability	69
Access to rail network	63
Port/Rail terminal operators	
Total costs	71
Access to the rail network	71
Route availability	65
Users	
Total costs	71
Access to rail network	67
Route availability	52
Non-users	
Access to rail network	89
Availability of suitable rail equipment	78
Route availability	67
Bulk	
Total costs	60
Access to the rail network	60
Availability of suitable rail equipment (e.g. wagons)	40
Non bulk	
Access to the rail network	79
Route availability	79
Total costs	68
Location of logistic hubs	68

Multiple response—respondents could provide more than one answer—totals sum to more than 100 low-value bulk commodities in the naïve belief that this is something “it does best”. Wrong! The abrupt and precipitate loss of major market volumes, particularly coal, in response to climate change and carbon emissions concerns and legislative restrictions, exposed the weaknesses in rail’s strategic positioning and excessive reliance on high-volume commodity flows which have now been dramatically cut back. This over dependence has ripped away significant levels of traffic volume and revenue leaving rail poorly positioned to approach and attract other traffic governed by wholly different imperatives. It faces strong competition from very competent, aggressive and near universal road transport. Road vehicles have become progressively larger and more sophisticated in response to shipper’s needs, which were recognised and responded to quickly. Rail failed to follow this path, yet its inherent characteristics should have allowed it to respond adequately and compete by exploiting speed, volume, weight and energy efficiency endowments. In addition, rail cannot rely on the discomfiture of its primary competition in the form of restricted driver hours, driver shortages, fuel cost escalation and increasingly constrained access to cities to regain markets.

Rail has also systematically failed to convert its inherent and much vaunted endowments in terms of energy efficiency, speed, weight and volume capabilities within a controlled and secure operating environment to commercial success and market share gains. Rail has surrendered traffic in the face of competition such that it is deemed or deems itself to be uncompetitive particularly over short and medium distance sectors. Whilst some of this traffic loss has resulted from rapidly changing geographical and commercial location options and the massive development of government-sponsored road infrastructure rail has not responded by seeking to exploit its inherent advantages. This has been a strategic weakness. It has not fundamentally addressed its high-cost base and low asset productivity and the need to move significantly from these weak positions.

What rail freight needs to address are issues focused on the development of attractive and competitive service offers to a much wider range of shippers and cargo interests. Rail has shied away from the complexities and demands of the high-value time-sensitive logistics sector because it was unable or unwilling to design and deliver the sort of products and services shippers demand. Shippers have used road transport because rail largely failed to adapt and to innovate to succeed within this market segment, which is driven by continuing pressures on cost, performance and relevant and appropriate products. 24/7 capabilities are an essential requirement for domestic and international traffic and have been accommodated by road transport but these imperatives have not been fully recognised or reflected within the rail freight sector.

Shippers now demand unfailingly high levels of reliability and consistency linked to the delivery of attractive services and products on a cost base that has to be competitive with road transport on a relevant KPI (e.g. cost per pallet delivered). This has to be supported by transit security and tracking from the point of loading to the end delivery point. Shippers and receivers need to know with certainty where their cargo is and its planned arrival time. Any delays or disruption need to be advised to the relevant parties such that any terminal and final delivery activities can be modified and updated. Disruption response is something rail has been poor at yet it operates within highly controlled information-rich environment. It needs competent and interventionist management to support 24/7 operations, rapid responses to cargo enquiries and offers linked to asset management and status systems. These are basic requirements, yet rail has largely failed to move towards them on a systematic basis.

The innovation focus must be driven by the constant and forensic monitoring and recognition of shipper's operational and commercial needs and requirements in the short, medium and long term. These will include hardware, software and management disciplines. There will be a need for the adoption of a continuous process of product and service development to support strategic and customer-specific traffic applications as an integral component of rail freight management. This also needs to be supported by the development and maintenance of much more focused and well-founded continuous active traffic solicitation to secure and retain business.

E-freight project (2011) propose a multimodal National Single Window (NSW) that provides a common interface for all regulatory information in a standardised format and an information exchange framework to sharing of information between the stakeholders (BESTFACT 2015). This sort of initiative should assist in rail becoming perceived as a more user-friendly option.

Rail faces competition within its own domain in terms of priorities for appropriate train paths, schedules and routes. The retention and advocacy of larger freight trains compounds these problems given the huge differentiation in power–to-weight ratios, acceleration and braking and need for appropriate passing loops if the big train model is retained and reinforced. This is not a credible option for widespread adoption and deployment. For the evolving time-sensitive high-value freight market, trains with wholly different characteristics and configurations will be needed. Regular unfailingly reliable replenishment is required rather than irregular large deliveries. This fundamental point seems to have completely escaped railway administrations.

At a generic level it needs to be looking at a rail equivalent of the near universal tri-axle semi-trailer for unitised traffic applications where an intermodal option is a real and credible option. The tri-axle semi-trailer is often the preferred or mandated module of choice for shippers for domestic and international traffic within Europe so rail needs to match this either in the form of adequate container sizes or the ability to transport trailers between terminals without compromising the trailer size and the available railway infrastructure. This would perforce need to link to the movement of such modules through terminals to minimise handling time and cost to maintain competitiveness with mono-modal road freight. Terminal operations need to be seamless with train to truck movements and vice versa reflecting shipper's priorities rather than the train operator's preference. The focus needs to be on transport and not trains per se.

For cargo which does not lend itself for commercial, technical and operational reasons to the use of intermodal technologies, the use of smart hi-cube rail vehicles optimised to accommodate pallets, roll cages or stillages could be a fruitful option.

These would need to be actively managed for example on point to point and hub and spoke applications to maximise their revenue earning potential. The operation of such hi-cube vehicles possibly on a push-pull basis perhaps in shorter formations (8–10 vehicles plus traction) at passenger train speeds for high-value time-sensitive traffic between highly automated terminals could potentially be a very competitive option. The key to this option is to maintain the "churn rate" of the assets with minimal unproductive time or application into revenue earning service.

Going beyond this into purpose built short, fast, self-propelled bidirectional trains for unitised cargo (containers and swap bodies) or configured for high-value logistics traffic may point the way to securing a major share of business governed by demanding imperatives beyond the capabilities of conventional train technologies and their application. Rail cannot realistically continue to promote the retention of technical, commercial and operational models which have limited application or minimal relevance to markets.

The rail freight sector may also have to consider innovative means of developing direct rail access for unitised and wagon-based traffic and commodities to replace or reactivate infrastructure which has been deleted or abandoned. The complexities of electrical power supplies and signalling systems currently make splicing into these very expensive, disruptive and time consuming which could prevent rail from capitalising on new traffic opportunities. The development of a flexible "tool box" of components able to facilitate access to new sidings and spurs without compromising the operation of trains on the main line could underpin this concept and give rail a huge advantage in terms of accessing cities increasingly bereft of rail freight facilities.

The concept could also be used to allow new and simple logistics terminals and facilities to be rail liked on a more cost-effective basis thereby allowing rail into active traffic participation and competition. Many new logistics sites have been developed and continue to be developed without a rail link on the basis of cost and implied complexity. If rail is to offset the huge losses it has sustained as coal traffic has fallen away, then it needs to access growing markets on an innovative cost-effective and efficient basis.

10.3 Case Studies

10.3.1 TruckTrain®

The availability of statistics portraying the steady erosion of rail's market share in terms of originating tonnage, tonne/km (production and revenue in national and the pan-European market), provided the catalyst to consider what alternative technical, commercial, operational and managerial models the rail sector would need to develop if it was to arrest and reverse the decline in market relevance and also to address the needs of evolving markets at a national and international level within

Europe. The cost base of existing train services and competing road transport was examined to identify the scale of the underlying negative difference and how this might be addressed in terms of a different train size, configuration and productivity capability. Where large and consistent flows of cargo are required to be routinely operated then the present train technology, operational and commercial models may be entirely adequate to fulfil shippers' requirements. Even here road transport can be and is a competitive option and rail cannot rest on its laurels on the assumption that this type of traffic will always remain within its gift. Increasingly rail will need to secure and retain market share on merit including reliability, consistency in service, cost competitiveness and appropriate products and services, which endow measurable benefits and advantages to shippers. To achieve this and to secure a relevant long-term market position rail needed to bring down its production costs to levels comparable to inter-urban road freight and to drive up asset productivity and utilisation by factor and not modest incremental levels as can be seen in Fig. 10.1.

For the growing market in inter-urban freight and logistics, rail's existing product and service offers were quickly identified as being largely irrelevant or non-competitive for segments of the market driven by wholly different and more demanding imperatives than rail was able to provide. In effect rail had to reinvent a commercial, technical, operational and managerial model which was able to provide and sustain a rail/intermodal option that was attractive, competitive and relevant to shippers. The key to securing this ambitious target was to drive up rail asset productivity and revenue earning time through much more intensive service application and minimal down time for servicing and maintenance. Locomotive

Fig. 10.1 TruckTrain® concept vehicle

Fig. 10.2 IRIS project proof of concept trial at barking terminal

hauled trains for shorter formations (<10 wagons) were identified in an economic analysis as *not* being a cost-effective option.

For shippers and cargo interests, shorter trains supporting regular and routine replenishment rather than large and intermittent deliveries were identified as the basis for a credible response. Deleting the locomotive became the obvious corollary with train formations being self-propelled, bidirectional and capable of speeds to allow operation within fast moving streams of passenger trains without inflicting delay on any following traffic. Figure 10.2 illustrates the rapid turnaround in terminals (<60 min from arrival to departure) that was proved to be feasible under a series of trials under an EU sponsored project (IRIS 2001).

High daily mileage and minimal down time for servicing and any re-fuelling through the use of innovative to rail measures widely adopted and routinely used in the aviation and trucking sectors is a requirement backed up by remote condition monitoring of the train's technical and commercial vital signs. The train becomes effectively "self-aware" leading to greater levels of availability, revenue generating time, and achieves parity with road transport through this enhanced mix of capabilities and competence. The trains would make maximum use of existing certificated components but also introduce high levels of innovation in relation to main structural components, running gear and support systems. This type of train is not designed to displace conventional locomotive hauled trains where these are appropriate, cost-effective and attractive to certain categories of user. For traffic operated under much tighter imperatives in relation to unfailingly high routine levels of service, the use of the short fixed formation train concept endowed with high power and speed capability together with bidirectional performance emerged as a credible option for development.

Fig. 10.3 IRIS proof of concept trial train in transit from Birmingham to Southampton

Demonstration trials, as can be seen in Fig. 10.3, were undertaken as a proof of concept in the UK as part of an EU-funded project (IRIS 2001) using modified track maintenance vehicles and container wagons. This was successful and had the added advantage of pointing out key technical, operational and engineering issues which would need to be addressed for a purpose built train. Ongoing work to validate the concept and examine in detail requirements in terms of design, materials, engineering certification, component integration as well as specialised studies into ride and suspension have all been undertaken to the point where these are well understood. The core design lends itself to use in domestic applications in Europe for unitised cargo and in a modified configuration for palletised traffic with both designed to operate at high levels of productivity and reliability.

Further work on means of identifying train paths at short notice within national and international systems is a current focus of attention together with simulation activities to enhance the train–terminal–truck–shipper/receiver interfaces and the ability to respond in the event of delay and disruption.

10.3.2 TopHat®

This is a wholly separate project designed to make rail a more attractive option for the intermodal movement of tri-axle semi-trailers and to secure the modal shift option set out in the EU White paper of 2011 (EC 2011). Road transport dominates domestic national and international/cross-border traffic within Continental Europe. It has achieved this on the basis of agility, responsiveness, flexibility, availability on a near universal basis as well as cost-effectiveness. It has completely outperformed rail particularly in the growing high-value time-sensitive market segments which rail has been unwilling or unable to retain and develop. Road transport's success has come at the expense of emissions, congestion, high levels of accident involvement and attrition of urban and rural landscapes. It is still almost exclusively dependent on relatively cheap and available liquid hydrocarbon fuels. The external costs to society flowing from this are high but they are not reflected in the cost base of the sector or in pricing offers to the market largely driven by bottom-line considerations as the key requirement.

Of the $\sim$800,000+ trailers in operation in Europe only a small proportion ($\sim$5%) are rail capable. These rely on the use of a grapple arm system to lift trailers complete with road wheels on/off trains. The cycle time using this equipment is longer than that for a comparable container and requires additional terminal manpower to execute the transfer. The grapple arm system for lifting the trailers can and does inflict damage to trailers and the cargo contents resulting in large claims and also the loss of earning time whilst trailers are under inspection and repair. Recently developed sling systems allow the use of un-modified semi-trailers to be lifted on/off trains but the cycle time is slower than the grapple arm and requires more manpower to affect the transfer.

Whilst containers have been strongly advocated as the intermodal solution in Europe, they have not found the wide levels of acceptance or routine use for domestic and intra-European traffic their advocates had hoped for. This partially reflects the rapidly evolving capabilities, sophistication and capacity of semi-trailers and the hugely expanded road/motorway infrastructure where they have been widely deployed to capture traffic rail appeared unwilling or unable to compete for. Containers require chassis pools at the loading and arrival terminals. Deep-sea shipping containers are limited in internal volume compared to tri-axle semi-trailers. The use of a larger module (45′ long × 9′6″) European dimensioned container partially offsets this limitation but for traffic mandated to move in trailers are not relevant.

For cargo interests, forwarders, shippers and hauliers involved with high-value time-sensitive traffic and commodities, the use of tri-axle semi-trailers as an industry workhorse is nearly universal. Much of this traffic is beyond the reach of existing rail services and operations on technical, operational and commercial grounds. If rail is to secure the level of traffic the 2011 White Paper (EC 2011) aspires to then it has to compete for traffic that at present is road-borne and secure it on merit. Rail cannot rely on the discomfiture of road transport through issues such as congestion, driver skill shortages, increasing constraints on access to cities and enforced compliance on emissions. To break this deadlock the ability to move full-sized semi-trailers much more readily between road and rail modes is essential. The present technology to transfer trailers poses real limitations on the likely level of take up.

The notion of using a top-lifting solution emerged from various projects and studies as a credible option and after consultation with equipment manufacturers including trailer builders, lifting equipment manufacturers and European rail vehicle owners/lessors. In addition, contact was established with shippers, forwarders and hauliers to gauge their response to the concept and to identify what advantages it confer. Various EU/EC sponsored intermodal projects (SAIL 2002) seeking to develop integrated corridors for the movement of cargo across borders in Europe were used to identify major potential traffic and commodity flows where top-lifting tri-axle semi-trailers could be deployed to positive effect.

The key identified gains come from the ability to use semi-trailers as a more versatile cargo module in both all-road and rail/intermodal applications. Terminals will be able to use existing container (ISO) lifting equipment and dispense with the need for incremental equipment required for grapple arm lifting. Trailers will be able to be operated much more freely and effectively on mixed configuration trains including containers, swap bodies and trailers. The top-lifting trailer, as can be seen in Fig. 10.4, provides an intermodal option for hauliers at a very modest capital cost at the time of manufacture. Rail benefits by being able to participate in traffic flows for which, at present, it has no realistic product or service capability. The top-lifting trailer acts as a catalyst to secure positive modal shift to rail and to secure wider energy efficiency, economic and environmental gains. It is an example of incremental innovation that potentially yields much more.

Fig. 10.4 Mock-up of a full-sized top-lifting tri-axle semi-trailer using 40′ ISO lifting points

10.4 Rail Freight Terminals and Strategic Rail Freight Interchanges

Rail freight terminals play a crucial role in the rail system concentrating flows and optimising the rail operation throughout the network, and therefore they need to be efficiently managed to reduce unnecessary cost and minimise potential delays in the daily service provided by the freight trains. According to Bontekoning and Priemus (2004), in Europe, shunting operations in conventional terminals take 10–50% of the total train transit time. Crainic and Laporte (1997) argue that the freight wagons spent most of their lifetime in rail freight terminals. The impact of freight shunting operations on yard performance has been studied in detail by Marinov and Viegas (2009) who used mesoscopic simulation modelling methodology which was implemented using SIMUL 8 computer package. A similar methodology has been developed and implemented in order to understand freight train performance in a railway network (Marinov and Viegas 2011). Scheduled vs unscheduled operations have been studied in particular. The simulation models confirmed that the impacts of the unstructured operation (unscheduled) are significant higher in the rail yards, suggesting that scheduled operations have a positive impact in the rail efficiency.

Due to changes in operating patterns and in the international freight market the requirements of the clients and yard activities indicate needs and demands for new terminal concept. The land-terminal concepts have been previously proposed in the literature (Frémont and Franc 2010; Woxenius and Bergqvist 2011); however, the strategic rail freight interchanges concept (SRFI) introduces new features and services, working as a multi-purpose structure; the SRFI not only operate as the previous land-terminals providing the link between rail/road, but also offering additional service (e.g. warehousing, monitoring, container handling facilities, manufacturing and processing activities). The BILK intermodal terminal in Budapest is an excellent example of closely located cargo-related terminal functions.

DfT (2011) point out that the main advantages of the SRFI are the potential reduction in road congestion and carbon emissions, contributing to a greener transport system. Also it was pointed out that the SRFI enable more efficient rail freight logistics supporting economic growth and employment generation. The Strategic Rail Authority (SRA 2004) suggests a likely size of and requirements of different interchanges (Table 10.2 adapted from SRA 2004).

Significantly, the SRA categories omitted the option of small austere terminals for intermodal exchanges between road and rail with a minimal level of provision and possibly using trailer mounted cranes for lifting and delivery/collection services between train-related activities.

Table 10.2 Rail freight interchanges requirements

Type of RFI	Function	Likely size	Transport requirements
Strategic	Major interchange with significant intermodal warehousing, located at nationally strategic sites proximate to major conurbations	100–400 Ha	Requires high-quality links to motorway and trunk road network. Rail links need high capacity and good loading gauge
Non-strategic subregional	Large interchange with significant intermodal and warehousing, located at important sites within regions	20–250 Ha	Requires high-quality links to motorway and trunk road network. Rail links need sufficient capacity and good loading gauge
Intermodal only	Interchange handling only intermodal traffic, often located at key points in urban areas	10–30 Ha	Requires good links to urban road and trunk road network. Rail links require sufficient loading gauge
Rail linked warehouse	Single warehouse unit providing rail services	10–30 Ha	Requires good links to urban road and trunk road network
Bulk terminal	Bespoke terminal for single bulk product types such as aggregates and minerals often linked to a manufacturing or processing facility. Also includes car automotive terminals and waste terminals	5–10Ha	Road and rail links need to be appropriate to bulk commodity often heavy loads. Aggregates and minerals terminals often require urban location to serve construction industries and road maintenance

10.5 Reshaping the Network for High Value: UK Study

The changes observed in the global market for freight suggest that there is a need to redesign the rail freight operating model. The conventional rail cargo is declining in most European countries and the railways are struggling to compete with the road in the time-sensitive market. Therefore, significant changes are required to satisfy the customer requirements, specifically for finished and semi-finished products.

Solutions for seamless intermodal logistics are crucial to improving the rail competitiveness. The Innovation towards new logistics' models include accessible and fast trans-shipments, new vehicle designs and materials and new business models. The focus of the solution presented in this section is on terminal operation and technologies looking at the British railway system. However, the same methodology can be applied to other rail networks around Europe.

We first analyse the commodity trend to understand the changes in the rail freight market. According to ORR (2016) the total of freight lifted fell from 110.5 million tonnes in 2014–15 to 86.0 million tonnes in 2015–16. The decline of the freight transported has been influenced by the massive and precipitated decrease of

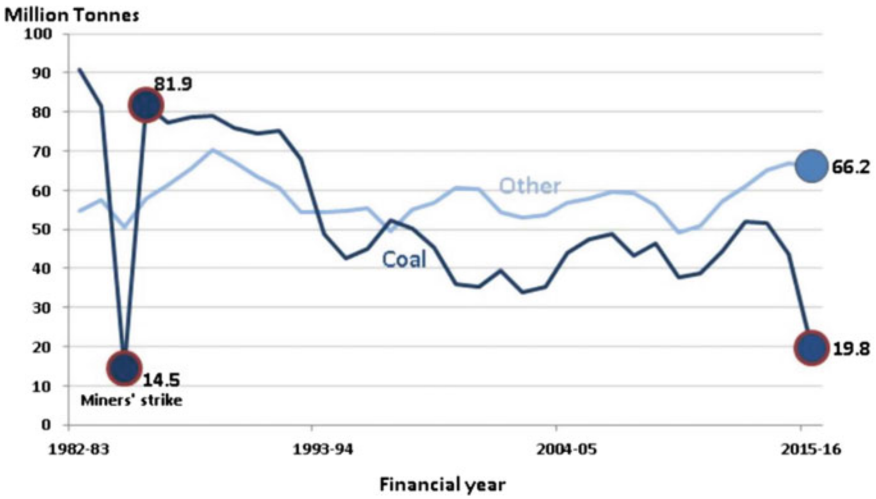


Fig. 10.5 The decline of coal transport in UK (ORR 2016)

coal (54.6%) in comparison with the previous years. Figure 10.5 illustrates the decline of coal.

Several transport forecasts (NetworkRail 2010; ORR 2010; DfT 2016; Kent Council 2005; NetworkRail 2007) indicate a decline in coal tonnage per annum as a result of the reducing demand of coal and the changes in freight charges for coal access. The Intermodal flows are now critical to ensure the future growth of rail freight. Considering the trends clearly showing the decline of coal by rail then the network could potentially be used to transport general cargo where this is commercially attractive to shippers. The existing coal terminals land-related large facilities could be redesigned as a Hub for the concentration of intermodal flows.

Figure 10.6 shows the economic power of the London region suggesting that the Kingsbury (London) and Peterborough coal terminals for example could be reshaped to receive a high number of incoming freight services. Redundant coal sites could be identified to assume a similar role as well (Fig. 10.7).

The 2007 Freight Route Utilisation Strategy (NetworkRail 2007) estimated the transport demand for 2014–15 and the impacts of the new London Gateway port analysing the effect on traffic from the Felixstowe and Harwich Bath side Bay. According to the rail usage of the lines, the number of trains moved daily suggests that there is an operational viability of an increased number of trains without affecting the current efficiency of the service. The container terminal using state of the art on terminal operations include automatic transhipment and high-efficiency cranes within transit scanning devices. The Noel Megahub terminal (Fig. 10.8), for instance, operates by using six parallel rail tracks and a large number of adjacent cranes, each covering terminal function (Terminet 2000). This technology is substitute for conventional shunting yards and intermodal transport as it reduces trans-shipment costs.

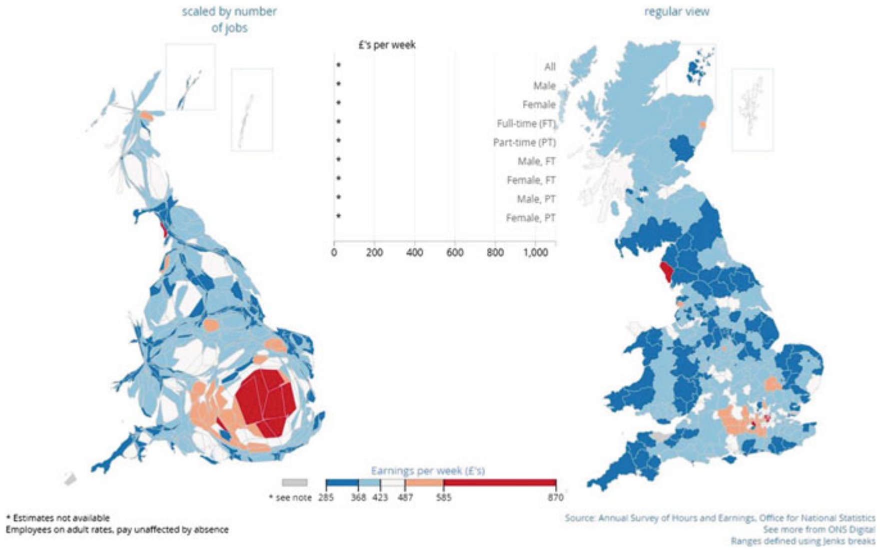


Fig. 10.6 Economic power of the regions based on the employment survey

A design for a fast transhipment small terminal is suggested for intermediate points in order to improve the capacity and minimise investments. David and Marinov (2016) introduce a low-cost road–rail interchange design in order to meet the shippers' requirements. The paper examines the potential of merging container flows to improve efficiency according to the physical internet concept (Montreuil et al. 2012.) The low-cost trans-shipment equipments are positioned over two lines and the semi-trailers and containers are positioned alongside the wagons. Figure 10.9 illustrates a small interchange yard concept. The key advantages of the design proposed are the fast trans-shipment and non-intensive area usage enabling efficient and cost-effective service to shippers backed up by security and good disruption response.

Considering the costs of new infrastructure previous studies confirmed the effectiveness of upgrade the existing system. Abbott and Marinov (2015) discuss the challenges and strategies for rail interchanges creation by redesigning the current railway infrastructure to enable the interchange of rolling stock between a conventional line and high-speed line. The study found that there is a cost saving from delaying the purchase of high-speed trains and the increased functionality of the rail network, despite the high capital cost of the rail yards.

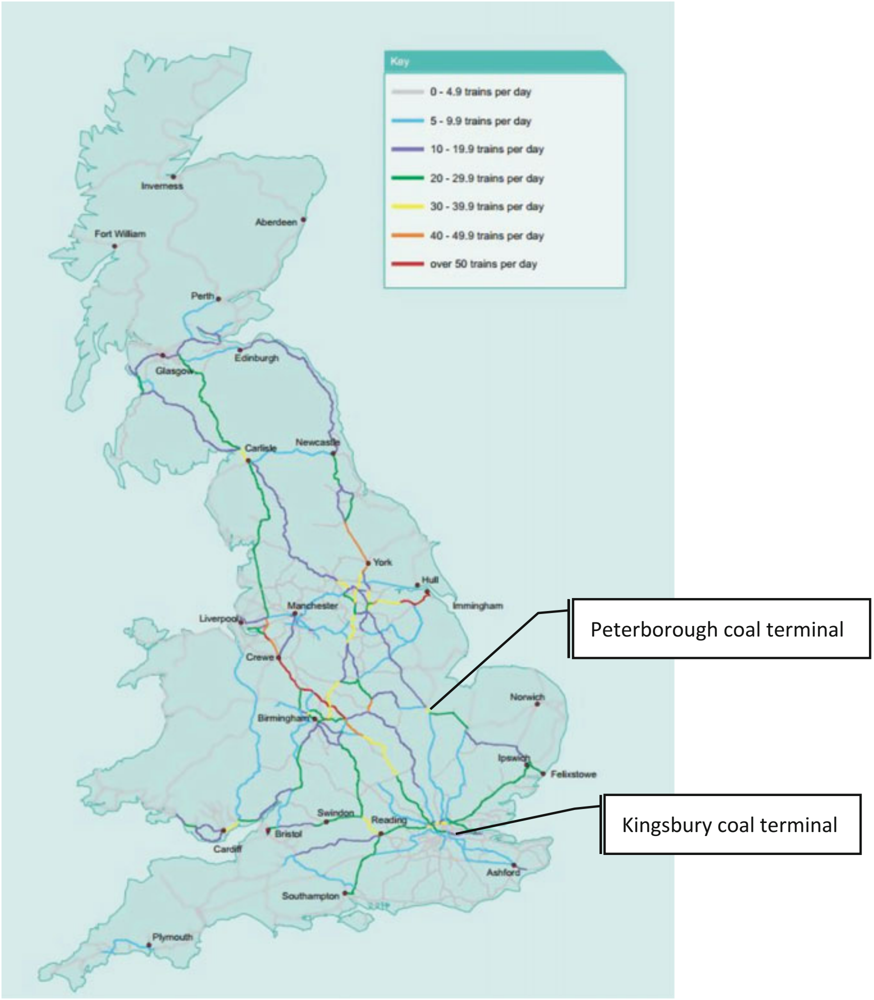
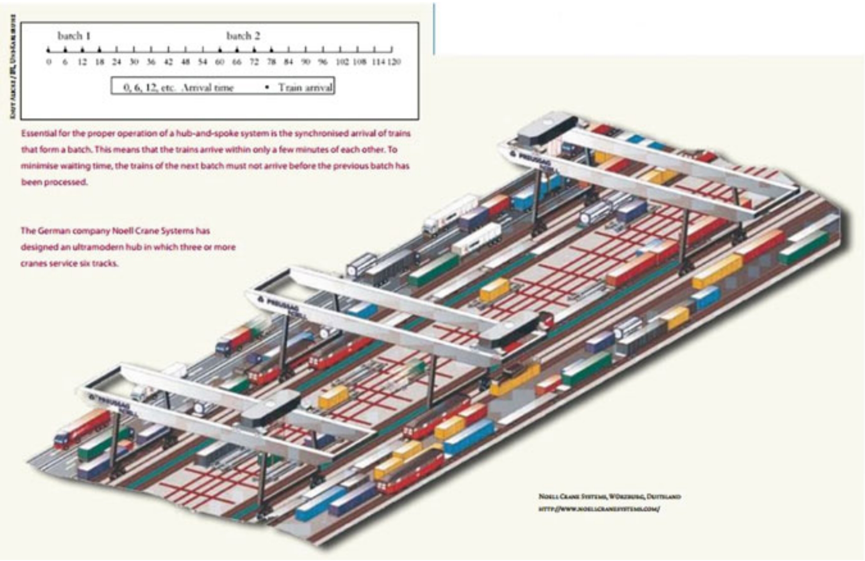


Fig. 10.7 Network rail freight route utilisation strategy (2007)

10.6 Potential Impact Analysis

For analysing the potential impacts of progressive growth of the container flows into the network, it is important to consider the infrastructure capacity and containers characteristics. Containers have standardised sizes 2500 mm (2600 mm refrigerated containers). Although the heights vary considerably, the most common are 9′ or 9′6″, which require the usage of lower deck wagons due restriction imposed by British tunnels and platforms. Typically, 9′6″ × 2500 mm loads are referred to as gauge W10 and 9′6″ × 2600 mm as gauge W12 (RSSB 2013).


Essential for the proper operation of a hub-and-spoke system is the synchronised arrival of trains that form a batch. This means that the trains arrive within only a few minutes of each other. To minimise waiting time, the trains of the next batch must not arrive before the previous batch has been processed.

The German company Noell Crane Systems has designed an ultramodern hub in which three or more cranes service six tracks.

Noell Crane Systems, Würzburg, Deutschland
http://www.noellcranesystems.com/

Fig. 10.8 The Noel Megahub (Terminet 2000)

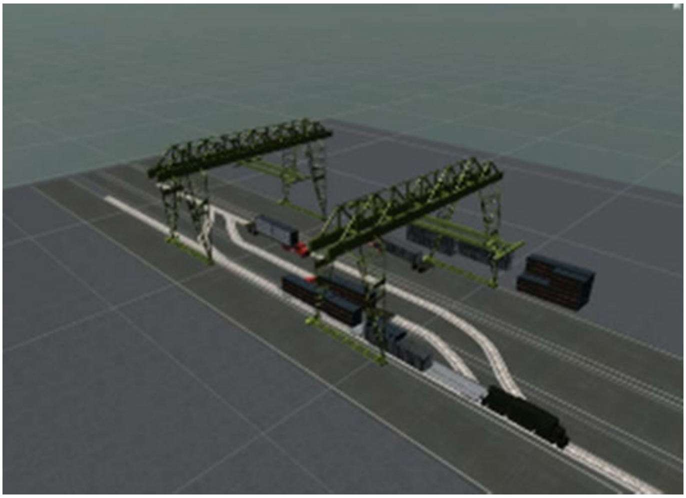


Fig. 10.9 Fast interchange proposed for physical internet operation

Despite the gauge constrain in terms of connectivity the British rail infrastructure is well connected covering the most important cities. The train utilisation in Great Britain, however, is still 20–25% lower than the median performers amongst four European comparators (McNulty 2011) suggesting that improvements are required in order to archive a significant economic benefit with the modal shift.

Table 10.3 Potential benefit impacts of intermodal flow growth

Growth projections 2030	Tonnes lifted —low constrained forecast	Tonnes lifted—medium constrained forecast	Tonnes lifted —high constrained forecast	Tonnes lifted —FMS forecast unconstrained
Ports intermodal (deep-sea containers arriving in the UK via ports)	22	31.81	45.69	41.76
Productivity benefits (billion pounds/year)	£ 0.48	£ 0.69	£ 0.99	£ 0.91
Road externalities (billion pounds/year)	£ 1.05	£ 1.52	£ 2.19	£ 2.00
Total gains (billion pounds/year)	**£ 1.53**	**£ 2.21**	**£ 3.18**	**£ 2.91**

In comparison with the rail transport, the Eddington Report (2006) estimated that road congestion reduces the British GDP by between £7bn and £8bn per annum. According to Rail Delivery Group (2015) KPMG estimated in 2013 that rail freight delivers gains £1.6 billion per year (£1.1 in productivity benefits and 0.5 in road externalities reduction). Table 10.3 indicates the potential gains of Port intermodal flow forecasted for 2030 (ARUP 2016).

Considering the need for new interchanges, four strategic rail freight interchange projects have been proposed to the Planning Inspectorate and Executive Agency England and Wales.

10.6.1 East Midlands Gateway Rail Freight Interchange

The Strategic Rail Freight Interchange environmental statement scoping report (Roxhill 2012) proposed to comply with The Infrastructure Planning Regulations 2009 (Environmental Impact Assessment 2009 Regulations) presents an intermodal freight infrastructure connecting the terminal to the Nottingham to Birmingham with focus on freight. With Up to 557,414 the East Midlands Gateway Rail Freight Interchange is designed to accommodating 12 to 16 trains up to 775 m long per day. A new rail line and new road infrastructure are widespread in three zones:

Zone A development area of 516,968 m^2 and between 7 and 17 warehousing units;

Zone B development area of 38,508 m^2 and between 1 and 2 warehousing units;

Zone C rail interchange area of 1,938 m^2 and between 2 and 4 warehousing units.

The contribution of the SRFI includes economic (subregional and regional) and social potential impact on the local labour with direct and indirect employment generation, commuting with road improvements, housing and public services;

The development has been granted beside controversy opinion of Castle Donington Parish Council (CDPC) that the DIRFT Stage III proposals for Daventry present 40% larger area potentially delivering the SRFI for the Midlands, more economically and quickly solution (Planning Inspectorate 2012).

10.6.2 Northampton Gateway Rail Freight Interchange

The Interchange for Northampton Gateway proposal submitted by Roxhill consists of an intermodal freight terminal with 468,000 m^2 of warehousing plus 155,000 m^2 additional floorspace in a mezzanine.

A new road infrastructure includes a bypass to the village of Roade and improvements to Junction 15 of the M1 (Northampton and South Northamptonshire district). The project is expected to be submitted to the Planning Inspectorate Q3/Q4 2017 due the conclusion of The Secretary of State that "the proposal has not indicated whether the proposed development is likely to have significant impacts on another European Economic Area (EEA) State" (The Planning Inspectorate 2016a).

10.6.3 Rail Central Interchange

Rail Central Interchange submitted by Ashfield Land Management is located in Northamptonshire (approximately 20 km northwest of Milton Keynes). With up to 8,000,000 sq ft (743,200 m^2) of storage and distribution buildings, the SRFI includes a range of different buildings (service depot, HGV facilities, lorry park facility, hotel and restaurants). The scoping opinion (Planning Inspectorate 2016b) concludes that potential cumulative impacts need to be identified; therefore, the proposal is expected to be submitted to the Planning Inspectorate Summer 2017.

10.6.4 West Midlands Interchange

Four Ashes Ltd proposal (Ramboll Environ 2016) for the West Midlands Interchange includes the rail freight terminal with container storage, connections to the West Coast Main Line (WCML), and Heavy Goods Vehicle parking. The 800,000 m^2 of warehousing, ancillary service buildings and Parking will be rail

Fig. 10.10 West Midlands interchange (East terminal option)

served to receive up to 10 trains per day within 795 m reception sidings handling up to 775 m train length maximising train efficiency.

Two layout options were presented for interchange in W10 gauge (West Terminal Option and the East Terminal Option illustrated in Fig. 10.10) with access to the main line from both directions.

Geographically, the West Midlands interchange is located at Staffordshire, approximately 10 km to the north of Wolverhampton, immediately to the west of Junction 12 of the M6. Due to further clarifications required by The Planning Inspectorate (2016c) the project is expected to be submitted to the Planning Inspectorate Q3 2017.

10.7 Conclusion

Significant social and economic impact can be achieved by significantly increasing the performance of the railway. Improvements on the links and terminals such as East Midlands Gateway Rail Freight Interchange, estimated in over £300 million, are economically viable considering the return of the investment contributing to logistics cost reductions. The existing network and actual terminals also present an opportunity for redesign of the rail infrastructure, increasing rail freight volumes and by helping the Government to achieve a significant reduction in road congestion and carbon emissions.

The introduction of innovative rail technologies in terminal services has a positive impact on the modal shift from road to rail, attracting more demand and potentially reducing operational costs and carbon emissions. Innovation has to be an integral component of rail systems' management and be commercially focused. It cannot be treated as an option extra/nice to have component.

The rail freight sector has strong endowments in terms of energy efficiency, speed, operation with a controlled environment, security and safety. It needs to exploit these in new ways to regain access to markets currently dominated by road transport. If it is to do this, it cannot maintain the existing technical, operational and commercial models in the vague hope or aspiration that these will be attractive. More of the same is not a tenable option.

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