Abstract

The environmental benefits of transporting freight by rail are well known and realized by authorities such as the European Commission. The rail freight sector cannot, however, afford to sit on its environmental laurels and expect traffic which has not used rail to fall automatically to it as a consequence of these items. Instead, prompt actions to increase efficiency based on logistics principles are needed. In this paper we provide an open discussion on rail freight services, policy and practice, constraints, opportunities and solutions with a special emphasis on the current situation in Europe and the UK. Specifically we elaborate on imminent questions such as whether intermodal freight services could be a good solution and in what cases; if a new rail freight system is about to be designed, what should be the orthodox wisdom to follow; could Single Wagons Load be commercially effective and competitive and the like.

Key Words: rail freight, CO2 emissions, environment, rail services, policy, practice

I. Introduction

This paper aims to provide a discussion on rail freight services, policy and practice, constraints, opportunities and solutions with a special emphasis on the current situation in Europe and the UK. As part of an open discussion we elaborate on environmental and business benefits of shifting freight from road to rail, accompanied and unaccompanied transport, block trains and container trains followed by the business segment Single Wagon Load Traffic. Inspired by Marinov and White (2009) here we continue the discussion.

II. Shifting Freight from Road to Rail

The environmental and business benefits of shifting freight from road to rail are indisputable, putting them into practice, however, is complex and covers technical, operational, commercial and managerial issues. One of the main environmental benefits of switching from road to rail is simply that articulated lorries create nearly three times as many CO2 emissions per tonne kilometre as does rail transport as a whole.

Figure 1 shows development of specific CO2 emissions, defined as emissions of CO2 per transport unit (tonne-km), by freight transport mode (road, rail, maritime, inland shipping) over the period 1995 to 2009. As it is observed, rail freight sector may use its energy and fuel inputs in a more efficient way but it is our contention that it has not yet been able to exploit this for commercial gain. It is also able to use a wider range of fuel and energy inputs than competing truck services which are
wholly dependent on liquid hydrocarbon fuels which are likely to become more expensive as an input cost.

Apart from environmental benefits, shifting from road to rail, when properly done, could lead to other benefits, as reported by DfT (2010), such as:

- Building resilience into the whole supply chain by increasing available options;
- Improving delivery and collection reliability with less delays caused by road congestion;
- An overall reduction in road traffic and hence improving overall road safety by reducing the number of vehicles on roads;
- Minimising exposure to drivers’ hours and working time directive issues;
- Mitigating the impact of fuel price uncertainty and availability;
- Reducing the number of vehicles required to fulfil the same amount of work;
- Producing commercially attractive alternatives to road transport able to yield benefits and profits for users, owners and operators.

The rail freight sector cannot afford to sit on its environmental laurels and expect traffic which has not used rail to fall automatically to it as a consequence of these items. Instead, prompt actions to increase efficiency based on logistics principles are needed.

It has been argued that rail freight systems encounter difficulties to provide “door to door” services. This is mainly because of physical barriers and lack of infrastructure, meaning many of the existing rail freight systems do not provide the necessary level of access to terminals and client premises, so they cannot be easily served by rail and imply a road sector at the beginning and end of a transit. Ensuring access to facilities in a network is very capital intensive, requires strategic planning and involves politics that can be problematic and excessively time consuming.
Intermodal freight services could be a good solution for many practical cases in which rail freight networks can be extended employing “road legs” as long as the overall transit is efficient and cost effective when compared to the all-road option. This is how a better utilization of the existing resources could be achieved, if it is done properly but needs much better integration of the physical supply chain and the information systems governing the planning and implementation of the transit. Rail needs to be much more fully integrated into the supply chains of users and move away from a “wholesaler” position to one involving much more attention to the detailed and continuously evolving requirements of shippers/receivers and to fully match the sort of services routinely offered by road freight operators.

Rail has largely elected to operate large single commodity trains as the preferred product and service option. This has become self limiting in terms of market application and volume thresholds able to be retained onto such services.

Crucial for the freight operation is the transhipment in terminals/yards/hubs/interchanges for intermodal, pallet and bulk commodities. There is a strong diversity of freight facilities according to size, capacity, design, technology and equipment, operating policies as well as management focus. The measurable performance (operational/technical and commercial) is not transparent or readily measurable from available industry sources and this limitation needs to be overcome. Differing models of terminal location and technology need to be investigated.

The availability of well connected sites that do not require major infrastructure investment in signals and points/switches can be a major point in any site selection and development criteria. In terms of regions, for instance, is it economically viable and preferable to have one big freight hub or are shippers/receivers better served with a number of small interchanges forming a loose network? Other models could include regions in which we could have one big intermodal terminal and a number of small satellite terminals. Much of the endowment of railway yards, sidings and terminals has, regrettably, been sold off for development and this has led to major cities and conurbations without any real or effective local rail freight terminals for container or logistics traffic and they are as a consequence wholly dependent on road based freight services. It needs to be recognised also that new technologies are already available that effectively displace the need for a major sophisticated terminal site and that cheaper, simpler and more cost effective options are potentially more attractive to specific locations and applications. These could potentially be much closer to the origin and destination of the cargo and allow rail to participate in traffic and commodity flows from which it is precluded at present because of terminal limitations.

### III. Accompanied and Unaccompanied Transport

The rail freight operators fulfil two basic types of intermodal service, namely:

- Accompanied transport;
- Unaccompanied transport.

3
Accompanied transport is when trucks (tractors and trailers as a combination) are transported by train. Unaccompanied transport is when semi-trailers are transported by train without any driver or tractor unit attached for the duration of the transit. The transhipment operations use roll-on/roll-off systems allowing trucks to embark on well-floor freight wagons. Some Roll-on/roll-off systems make it possible to loading/unloading the whole freight train simultaneously, meaning the unloading and loading times are significantly reduced and hence creating more operating capacity. Terminals, which are not equipped with roll-on/roll-off systems, fulfil the transhipment operation on a lift-on/lift-off basis using cranes, forklifts and the like. Lift-on/lift-off systems can require more time and more resources to fulfil transhipment operations but are also capable of loading containers as well as road trailers and there is value in this flexibility. The use of the “circus” style loading of piggyback trains in Canada and elsewhere in the US demonstrates another simple method of making the inter-modal transfer. Bi-modal trailers are able to be moved between modes of transport without any external lifting. (e.g NS Triple Crown Services) Suggest a picture insert here.

The Cargo Speed System (see Figure 2) was developed as a means of bringing Roll-On-Roll-Off concepts from the shipping sector into inter-modal freight terminals.

![Figure 2 Cargo Speed System](http://cargospeed.net/), accessed on 5 September 2011

According to CargoSpeed the benefits of roll-on/roll-off systems for terminal operators, in particular, are as follows:

- **System CargoSpeed gives terminal operators a choice.** They can choose to either transfer the same volume of road to rail freight at 20% of the operating cost of a typical Lift-On/Lift-Off terminal or transfer 7 times the volume for the same cost as a typical Lift-On / Lift-Off terminal. This makes the business potentially more efficient and profitable.
- **System CargoSpeed is scalable.** The system has been designed to allow terminals to grow as demand increases. From mini-terminals with 2 Pop-Up mechanisms, right up to maxi terminals with 40 Pop-Up units and the ability to handle over 750,000 movements per year.
- **System CargoSpeed is interoperable—CargoSpeed rail wagons are unique.** They can support either Roll-On / Roll-Off operation or Lift-On / Lift-Off operation. This allows the system to be used in existing terminals and provides a clear migration path to a more efficient Roll-On / Roll-Off future.
- **System CargoSpeed is efficient.** In a Maxi terminal an entire train of 40 rail wagons can be unloaded and re-loaded in only 8 minutes (20 minutes including time for the train to enter, and exit, the terminal). This compares with over 4 hours for existing Lift-On Lift-Off terminals. Time is money and System CargoSpeed saves time.
• System CargoSpeed is flexible. Terminals are multi-directional—trains can arrive and depart the terminal from either direction. This significantly increases the operational flexibility of the terminal and reduces the construction costs.

• System CargoSpeed allows the use of electric traction in the terminal. As the system is primarily a Roll-On / Roll-Off system, no lifting is necessary in terminals. This means that electric traction can be used in the terminal and the time wastage and environmental impact of switching to diesel when a train arrives is not necessary.

However, what is observed is that there is a serious reluctance among the terminal operators and other agencies to undertake investments and implement innovative roll-on/roll-off systems or other new technologies including terminal equipment and specialist stand alone rolling stock which may have limited alternative service applications.

### IV. Container Train

Container trains (see Figure 3) are perhaps rail’s most successful recent foray into high value time sensitive traffic flows. The use of modular cargo units and a focus on traffic driven by the demands of shipping lines and other logistics operations has required rail to raise its capabilities to adequately service this type of traffic. This has resulted in a variety of responses from the rail sector including complete trains of specialist container carrying wagons including specialists designs for high cube units and double stacking in railway domains outside Europe.

![Figure 3 Container Train, Grangemouth – Aberdeen, the UK](http://www.scot-rail.co.uk/page/DRS), accessed on 5 September 2011

Various models of operation including port to inland terminals and network operations have been used and methods and patterns continue to evolve (See FS book/RG). The use of blocks of container wagons within other scheduled train formations has largely been replaced with trains wholly composed of inter-modal units in some railway domains notably the UK. The operation of mixed container wagon formations and other traffic has recently re-emerged as a means of raising load factors on trains but with the obvious corollary that differing traffic types necessitates the use of different terminals. Key to the success of the container activity within the rail sector has been the
different type of management approach that places much higher emphasis on asset management (locomotives, wagons and containers) to ensure the equipment is much more productive. That said there remain concerns that this is still not adequate in the face of aggressive road based competition.

Container trains have found greatest favour in the movement of international shipping traffic between ports and inland terminals for both import and export business flows. The common model is for a loco hauled 20+ wagon formation to shuttle between the ports and the terminals. Capacity may be entirely contracted to individual lines or shippers or may be wholly open for individual users to secure space. Other models of part open/part contract trains also operate. The trains primarily operate on a shuttle basis with very limited commercial and operational changes to the train formation. This can act as a constraint on the number of terminals served by individual train operators and is a product of the model of privatization within the UK. The lack of willingness and the absence of a mechanism to ensure the routine and reliable transfer of containers between “competing” but collaborating train operators should not be discounted as a constraint.

Rail has a better market share representation in this sector than overall freight but has elected to largely position itself as a wholesaler effectively treating the containers in the same way as bulk commodities with minimal added value or associated logistics features. This has effectively limited market share together with the constraints associated with the cost of the train technology and operating model deployed into service. For routine high levels of traffic the use of the large trains works well but for lower and intermittent traffic this makes the orthodox service offer less attractive and less competitive. There has been limited use of shorter trains because of the “lumpiness” of the cost profile largely attached to the locomotive.

Rail terminals for containers and piggyback activities are specialist facilities and are costly in terms of construction requirements, space for train related and truck related activities together with storage of containers in active stacks. Most container yards are now paved and seriously reinforced to accommodate the high point loading pressures exerted by terminal loading equipment. The cost of extensive paved and supported areas is significant and restricts the choice of locations where these can be sited together with considerations of links and signalling to main lines. The use of long train formations can also be a problem in terms of the scale of the loading pads and associated roadways for trucks to deliver to or collect containers from trains. Equally more compressed sites have limitations if trains have to be split and marshalled at entry and exit.

The major container terminals normally employ large gantry cranes able to span rail tracks and roadways for the movement of containers to or from trains either direct to a truck or for intermediate movement by straddle carriers or front lifters. The cycle time for a complete lift can vary wildly due to vagaries of weather, wind etc but is usually about 15-20 per hour per crane. The layout of the terminal and the location of container stacks is very much down to individual operators and the nature of the areas they service. Some medium sized terminals have elected to move from the gantry cranes to operational patterns based wholly on front loaders. This demands the entire yard areas are reinforced to support this equipment at full load but does endow a high degree of operational flexibility.
Piggyback trailers (Figure 4) were originally loaded ‘circus style’ with trailers being backed onto wagons before being secured. Whilst relatively inexpensive it demanded driver skills to back trailers over long train formations and then move the tractor away to allow the following trailer to be loaded. This method has been largely replaced by using gantry cranes or front loading equipment and treating piggyback trailers in a similar fashion to containers.

Other methods of loading including side loading and swinging booms have been trialled but have not found favour. Piggyback is a relatively simple concept and was originally conceived as a means of securing truck load freight onto rail for long haul sectors. It developed rapidly and remains in use but has been displaced on some flows by the use of containers (non-ISO) which are aerodynamically more efficient and able to be twin stacked thereby yielding a much larger cargo volume per unit length of train by dispensing with the trailer.

Container trains can and do operate as block trains (see Section V below) solely made up of intermodal wagon sets of varying design, volume, weight and speed capability. The advent of hi-cube containers has been a problem in the UK as the vertical dimension of these units is a limit on their ability to be used over parts of the rail network unless cleared to the more generous loading gauge. Containers have found greatest application in deep sea maritime trades. Their use in the UK and Europe for domestic traffic has been less successful given the volumetric constraints of the ISO dimensioned units when compared to modern tri-axle road trailers. Specialised containers are deployed on inter-plant moves for the transport of specialised commodities (foodstuffs, chemicals) where the weight capability of rail is used to advantage. The real constraint on the use of rail for more containerised traffic is the model of technology and commercial operations presented by the train operators which seem disinclined to innovate or seek means of lowering the cost base of their services.

V. Block Train

In most of the cases a block train is ordered when the client has enough freight to fill in a full train according to network constraints. The freight is normally of one type, for instance, agricultural products, fuel, steel, automobiles or containers. The origin and destination points are fixed. The block train is normally operated on a fixed schedule. Intermediate stops are not needed other than for operational reasons such as crew changes or servicing. Shunting is not required, meaning the block trains do not reassemble once formed up and loaded. The number of freight wagons in the
train is fixed by a combination of route constraints (gradients, curvature, axle loads and loading gauge). The freight wagons are not interchangeable and are normally designed to transport a specific type of freight. Therefore in many cases block trains experience a 50% efficiency, meaning the freight wagons run loaded from origin to destination and they return empty to be loaded again. This applies particularly to bulk flows such as coal, aggregates, minerals, agricultural products such as wheat and liquid fuels. The very nature of some of the products in the containers or rail vehicles makes them incompatible with other commodities and the empty return leg for reloading is an integral part of the product supply chain. It is apparent that this production scheme is less complex and faster than Single Wagon Load (Section VI below) simply because the block trains do not fulfil intermediate stops for reassembly procedures. They are the rail freight sector’s primary product and service offer but there are limits to the applicability of block train techniques and technologies.

The business risk of the scheme relays upon the client because the client needs to have a sufficient amount of freight to fill a full train. This in itself can be and is a problem. To commercially employ a locomotive and a rake of wagons may set a threshold of cargo volume and revenue that can be produced on a routine basis to offset the costs of the locomotive, wagons, train crew, fuel/energy, and maintenance and access charges. A failure to achieve this may take rail out of contention for flows that cannot generate enough traffic to be profitable. Within the UK this means a loco and train set has to move ~825 teu per week to be attractive to train operators before they consider allocating resources to service flows. Below this aggressive supply side dominated threshold rail does not seem to be interested and the traffic largely defaults to road transport. From a rail freight operator perspective the business model is that the client purchases the full train even if the client does not have enough freight to fill the full train all the time. Rail is acting as a wholesale provider with no interest in flows that do not support its supply side model. There is a need to take costs out of the existing technical, operational and commercial model and lower the threshold at which rail can participate in terms of breakeven threshold on distance and volumes.

VI. Single Wagon Load (SWL)

Single Wagonload traffic represents the largest share of the European rail freight market, still transporting significant quantities of chemicals, cereals, paper, pulp, automotive and the like. SWL transports are a crucial supply chain element for Europe’s predominantly midsized and geographically dispersed industry and agriculture. Single Wagon Load traffic is still a big revenue earner in many countries around the world, for instance the US, Canada, Australia, China, Russia. But what is observed is that many European Railway Undertakings are losing money with their SWL activities. Closing down this business segment does not appear to be a valid option, since SWL can be connected physically and commercially with block (full) trains, other load business and intermodal traffic meaning it provides feeder and repositioning services for the latter (Rail freight portal provided by UIC http://www.railfreightportal.com/ consulted on 7 September, 2010).

It is a common opinion that single wagon load is too costly and unreliable because requires yard operations and services with multi-stopping freight trains. The rail freight yards hinder the fluidity of the rail freight operation and therefore these facilities are major source of delay. Rail freight yards
such as shunting yard, marshalling yards (see Figure 5) and gravity yards are thought of as the bottlenecks in the rail freight networks. Furthermore, rail freight yards are thought of as a none-revenue component of the rail freight service (Kumar 2004). These facilities incorporate a significant amount of resources (both static and dynamic) which are difficult and potentially costly to maintain (Marinov and Viegas 2011). There have been arguments that the customers have changed their needs and in the cases where the demands are not sufficient to form a full train, then such demand origins better be served by trucks. This begs the question as to what constitutes a commercially effective and competitive train. The retention of a large locomotive hauled model may be entirely adequate and acceptable for high volume regular services and volumes. For lower level and intermittent flows the need for a more cost effective technical and operational solution with a commercial profile more akin to road freight may be required.

We support the opinion that a properly constructed and managed wagon load production scheme possesses significant merit in terms of “hub and spoke” operational structure, where yards act as reassembling hubs and redistribute traffic over network spokes. The down grading and abandonment of rail freight yards and sidings particularly those serving or able to serve new logistics applications might be a strategic and irreversible mistake. It should be noted that a lot of EU freight traffic is diverse and cannot be simply served by block-trains only, operating on a “point to point” basis. It is critical to make the best use of the existing resources; not to abandon them to competing modes on the basis of short term rationalization.

![Figure 5 Classification Bowl of Maschen Marshalling Yard south of Hamburg](http://www.voithturbo.com/media/vt_news_2008_02_gb_screen.pdf), accessed on 5 September 2011

Political interventions might be further needed underpinned with convincing measures to optimize the allocation and utilization of the available resources and promote the merits of SWL. New production schemes based on logistics principles (such as consolidation, pull and push production systems) that incorporate scheduled and spot/traffic dependent type trains could all lead to optimized solutions of practical value. Market studies to identify the sort of services and technologies shippers want and are prepared to pay for would be useful in giving some objective basis for any service development and enhancement.

What needs to be avoided is the rail freight operators falling back to a supply side position and not recognizing what the shippers want in terms of availability, reliability, consistency, through transit security and condition monitoring. This is where the truckers win because they have addressed
these problems and consequently won the greater share of the market. Rail freight has to take these lessons on board as a matter of urgency.

References

