



TRANSPORT FOR A GLOBAL ECONOMY

*Challenges and Opportunities
in the Downturn*

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WORKSHOP 1

Intermodal Transport & Supply Chains

Freight Transportation

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FREIGHT TRANSPORTATION

Abstract from a report from the Académie des Technologies, Paris

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1. Introduction

A majority of citizens in France reckon that freight transport will be faced, in the near future, with a growing number of difficulties. Fuel prices for the transportation sector – a major consumer – will continue to rise. The external, “negative” side effects attributed to transport will likewise increase. And concomitantly, the severity of judgement, passed by Society at large, will grow stronger.

If we want to distinguish ‘true’ from ‘not true’ in this somewhat pessimistic opening paragraph, we must start with the principle that “freight transport is *per se* insignificant, it is the entire transport system that matters”. And the transport system is but a link in the chain “Production – Transport – Distribution” that underpins our national economies. This chain now covers the Earth and is inseparable from the ongoing trends in world trade and international commerce.

The National Academy of Technologies of France (NATF) has chosen this standpoint, as the only possible one applicable to manufactured goods (and to a far lesser extent to bulk carriers). Nonetheless, the fraction of world freight represented here is close to 50 % total volume: growing at the rate of 8 % per annum, while the rest of world freight remains approximately constant. The focus must consequently be directed to transport of manufactured goods. And, once we have adopted this point of view, most of the diagnosis (or anticipatory analyses) that we are prone to formulate must be seriously reframed:

- The world transport chain, set end-to-end, is more resilient, more self-adapting to the changes that characterise both environment and Society.
- Its efficiency is to be assessed on a global scale, viz. International, and this alone places the « modal war, viz. between rail, road and water freight transport » in perspective, in contradistinction to our trend to exacerbate the odds and issues.
- It allows for a considerable influence and impact for IT (information technologies) systems and devices, acting – as our full report calls it – like a “second invisible arm” for the benefit of the economy.

The study takes account of both world and European trends, bringing the specific French case into better focus, and, where felt useful, draws comparisons with other EU countries, for the purpose of gaining a better understanding of the French issues.

Transport, logistics, production/distribution chains

The European Commission estimated, in its freight transport impact report, 2007, that logistics represents between 10 and 17 % of the GDP of the various Member States of the EU. This assessment, although admittedly lacking in accuracy (given that no common standard allows us to calculate the right value in a homogeneous way) nonetheless indicates the high level impact of the cost of logistics on the competitiveness of the EU in the world market as well as on the competitiveness level of each Member State, both in the world market or even in the European market as such. This demonstrates the importance the logistics sector, both in terms of employment and creation of wealth. Logistics and freight transport are far removed from being seen as solely polluting activities. They are essential ingredients for any category of manufactured goods, goods that necessarily must be transported from one level of production finish to another and that must be presented locally to the intermediate manufacturers or end-users/consumers, not forgetting that the associate wastes along the line or through use then become new products that end up in other processes and products. In order to analyse them appropriately, logistics and transport must be resituated in the context of the production/distribution chain, inasmuch as they are inseparable and necessary, constituent parts thereof.

Container traffic

Container traffic represents some 35 % of world traffic for yr.2002, but the associate sectorial growth rate in excess of 10 % per annum (thus far higher than world traffic as a whole) means that it will rapidly become the majority factor in international trade. We need only note in this respect the spectacular rise in capacity of container carrier vessels, from 900 TEU¹ in 1968 to 16 000 TEU in 2008. This strong growth trend in container traffic shows how relevant and useful this large scale 'packaging' mode has become, and indeed is one of the factors that has made world trade progress.²

Containers carry 85 % varied goods, that are integrated at some stage in a production/distribution chain, this not being the case for bulk-transported liquids or solids. The fraction of such products in world traffic has risen from 26 % in yr.1970 to 41 % in yr.2002.

Evolution of the production/distribution chain

If container traffic has grown so rapidly, it is because it closely follows the trend of evolution of production/distribution chains themselves, either conducive to this development or developed itself to meet the chain evolution needs.

World production went through and is still enjoying considerable development over half a century: the figures from South-East Asia show a ten-fold increase, Western Europe, five-fold, as also in the USA. Concomitantly, the volume of manufactured goods traded has been multiplied

1. TEU the "twenty-foot equivalent unit" is a measure for container capacity, including the 20' and 40' sizes. This unit simplifies volume and mass calculations for terminal or onboard storage. Thus the combined mass of 1 forty foot and one twenty-foot is 3 TEU (One 40'= two 20') Cf. standard ISO-668:1995.
2. The first four ranked world merchant navy operators are European, and, to better appreciate the new trends in trade, we also note that the first twenty operators are 49 % from SE Asia, 46 % from Europe and only a single operator represents North America.

by a factor 45 round the world, while mining and agriculture have only seen a growth factor of less than 10 times. The explosion of global trade in manufactured goods has led to the fact that the specific organisation needed has become the standard practice of all international trade exchanges and that the associate trading culture has become 'binding' to all partners, at all stages of the transport and logistics processes.

Thus the production/distribution chain has made its regulations more binding, in order to better control the world space in which the 'virtual factory' has developed. This concept, together with the notion "machine to machine" concept, is, in essence, a negation of the distance separating two successive steps in a manufacturing or distribution process. The same rules, such as "zero stock", or "zero faults" are now applicable, not only to the manufacturing process, but include the transport segments that link the steps. Control (and optimisation) of operation that come under the heading "internal handling" of the factory integrated in a single site has shifted to cover logistics control of the disseminated factory, the surface of which is now global.

Consequences in terms of the transport system

The transport system is one of the tools that have made globalisation possible: consequently, it is under constraint to provide a service that complies with the requirements of the global framework. Only those operators in a position to offer this level of quality in service can participate in the expansion of global trade and economy. We can now identify the more important features and requirements:

- Total transport responsibility, from machine-to-machine.
- Guaranteed supply of the various items of the production processes of the virtual factory round the world (the German rail-system Deutsch Bahn sees itself as the global logistics manager for all German industry).
- A continuous capacity to adapt, and thus to be constantly in a position to provide accurate and trustworthy information.

It is obvious that this has a strong impact on corporate structure and organisation and on the associate relevant transport operation. Again in contradistinction to bulk transport, with undifferentiated contents, a container has a specific destination and carries specific products, such as parts that have been manufactured in one country to be later assembled in another country, or finished textile goods that will be distributed on arrival into various distribution chains.

They have in common one characteristic, the need to be time-managed with precision (not necessarily implying the shortest possible time), so that the chains that receive such parts or goods remain efficient and reactive, *i.e.*, that they operate with the lowest possible level of local stocks, hence the stringent time constraint. manpower and management skills: new types of job are created in the change and others will come to be. These considerations justify the fact that the NATF has concentrated its study on transport of manufactured goods. This category represents, according to our current estimation, almost one half of all freight transport, and in excess of 50 % in the case of Germany (according to a document supplied by the Federal

Bureau of Statistics) and probably in excess of 40 % in France. The growth rate is more rapid than that of transport of other categories of product.³

2. Organisation of transport and logistics

In order to comply with the demands of the production/distribution chain and their evolution, the transport and logistics companies have started a process of deep-reaching corporate change, ongoing at the time of going to press. We can safely deduce from this that global logistics, as a function, has a promising future ahead. These companies position themselves on the market place in terms of the following necessary functionalities:

- Logistics.
- Handling (including transit handling).
- Transport.

These functionalities can be subdivided or grouped into other concepts and entities:

- Logistics alone.
- Logistics + handling; handling + transport.

It was the major transit handlers (Schenker, Danzas, Kuehne & Nagel...), as well as the various national postal organisations (Deutsche Post with DHL, KPN-Dutch Postal Service with TPG = TNT Post Group, followed by the French 'Groupe La Poste' with Geoposte...) who first began to integrate and develop the logistics concept to follow their freight "from deposit to delivery", insofar as they could manage all the interfaces with the handlers and carriers through hubs, that enable freight grouping and de-grouping (the role of the handler with respect to the transporter). Some of these companies also integrated part of the transportation function in order to control delivery times and have a leverage on the sub-contracted transporters.

A second group of companies developed around the isolated concept of "transporter", accepting to be a logistics sub-contractor for a major client, ensuring the complete supply chain management. For instance, Exel in Great Britain for Marks and Spencer, Norbert Dantressangle in France for textile shipping for Carrefour, or Thyssen Haniel Logistik in Germany for the Thyssen Group, Gefco in France for Peugeot-Citroën. The recent development of such companies has led to a situation where they cannot assure alone all the transport obligations and therefore are forced to subcontract as they re-orient their business more to the general logistics function. Moreover, container freight transport has developed in a constant manner (+8%/annum) as has the world trade trend; indeed the container is particularly well adapted to world trade conditions and demand. International trade is implemented mainly onboard special container ships and numerous operators have built up extensive container ship fleets (Maersk, MSC, CMA CGM, OOCL,...).

Since the late 80s, these operator groups have made inroads in the logistics sphere of activities to provide "producer to end-user" satisfaction to clients who transit their goods via their containers. In each major market zone, Europe included, they have set up specialised logistics

3. Moreover, a considerable fraction of agricultural foodstuff transport complies with the same constraints.

subsidiaries that carry the goods from the client's warehouse to the port handling facilities and *vice versa*; in general, they sub-contract the land-transport segment. It is for the purpose of managing the load transfer function between land transport and sea transport that these groups are investing and taking an increasing larger management responsibility of the port areas and facilities when the latter become privatised.

Recent history clearly illustrates the trends we have mentioned above. This situation has led to a flurry of acquisitions and mergers. Today, 56 groups have a financial turnover in excess of a billion dollars.⁴ All the above groups (including the two US Groups – UPS and FEDEX) fall into the intermediate category, *i.e.*, the carriers and, very often too, the logistics category:

- The European Groups (30 entities, 10 of which are French) are in the main mail-goods handlers (10 companies) and logisticians (9 companies).
- Those companies concentrated on sea-freight are European and Asian.

Indeed, the concentration-merger phenomenon has been so strong that those companies on the market-place today can offer clients all three functions: logistics, handling and transport, for both express mail or package mail, as well as specialised transport, integrated to the logistics function. Those companies who chose not to integrate the logistics functionality – or who were precluded from doing so because of their initial size – probably will benefit from reorienting their efforts towards transport of other types of goods (bulk, liquid or solid). Two types of company are concerned by this type of evolution:

- Firstly, the smallest companies, the survival of which depends on their capacity to become a sub-contractor of an as yet not completely integrated logistics group. The key factor here is the hire cost of the service proposed, faced with the cost of energy and personnel, on one hand, and by their capacity to connect into the data processing system of the contract partner. This latter item will become increasingly critical for the VSEs given the rapid rate of evolution of IT systems as used by main contractors. How can we encourage them to move into the most recent trends in IT technology and practice? What motivation, what training would be suitable and necessary here?
- Secondly, we have the case of the railroad networks in Europe. Only those trains with a full set of wagon, leaving on a given branch-line in Europe, and headed for another branch-line in Europe, can show transit times comparable to those of road transport. An isolated wagon, under the same conditions, will take from two to four weeks to cover the same distance and this, in essence puts rail transport on a par with canal and barge transport! In other words, it can only be used for bulk transport. In comparison, an isolated wagon in the USA or Canada will cross North America from West to East Coast (or return) in just 8 days. Understandably here, rail freight transport is economically more than viable, it is highly profitable.

Awareness of this context for railroad operators (together with the ongoing freight crisis in France) should allow us to move out of this mismatched situation. Local client serving operators in Germany (approx. 100) allow for regrouping and individual dispatching of isolated wagons,

4. These Groups have been built up through successive mergers: thus, the world's N° 1 group Deutsche Post AG absorbed: DHL, Securicor (UK), Trans-O-Flex (Germany), Ducros (France), Danzas (Switzerland), Nedloyd (Netherlands), ASG (Sweden), Air Express Int (USA), Burlington (USA), Exel (UK), and many other smaller companies.

subsequently integrated into full trains. New wagon sorting management is also needed, as has been implemented in North America. In all cases, the observed evolution demands that there be a real time IT control over transport movements, as is practised in North America, in the Commonwealth of Independent States and in South Africa, but which for the time being does not exist in Europe.

3. Material architecture

Transport of manufactured goods is organised along the chain production site to production site, to distribution or point-of-sale facility.⁵

Production sites are no longer concentrated as they were in the 1970s. Numerous sites – and not only in the heavy industry sector – have either ceased to exist or have been split up: some fraction or even the totality of the previous production has been outplaced. Outplacing takes place when competitiveness calls the odds and often requires high-level investments, that translates into technology transfer, control functions and quality assurance at each stage (the zero fault concept), reorganisation of the overall process, and even new material investments.

If transport is a cost element, more than often it proves marginal compared with the cost reductions obtained through lower manpower costs. As a cost element, it must nonetheless be optimised just like all the cost ingredients in the production/distribution chain, for a given quality level of the service or product: it must necessarily undergo continuous improvement.⁶

South-East Asia has become Europe's factory, and this has led to an enormous growth in sea-transport between the two continents, much higher than for traffic between Europe and North America. The situation is not comparable, however, inasmuch as Europe's virtual factories have moved to sites in South-East Asia and to a very little extent to the West.

Consequently, inter-continental transport is growing very rapidly and, in this sector of activities, sea transport is largely predominant. The exchanges between the EU and the rest of the world are 45 % value and 70 % tonnage transported by sea, 24% par air, but it will be noted that sea-transport is growing at a rate of 14% per annum whereas air transport is growing at only 6 % per annum (source: Eurostat 2005). The figures when available will doubtless be more in favour of sea-transport over the past few years and shall continue to predominate in the near future.

This traffic has led to the launching and commissioning of huge container-ships (400 m long for more than 15000 "boxes" – although they are still able to pass through the Suez Canal: the latter probably setting the physical limit to such ships), that can berth at a few European ports

5. The final kilometres are often in urban areas. Changes here have been managed fairly rapidly by the WP in charge, for two reasons that led to a separation of the two issues "Urban freight" and "General changes in freight transport":

- urban freight and ongoing changes depend entirely on the town itself. Freight is determined in the main by other flows – passengers, town service traffic;
- organisation of freight transport at various levels and the associate changes for the actors involved, is affected only to a very small degree by the final stage – urban freight.

6. The relatively low cost of transport encourages specialisation in production sites and, in this respect, we note that there are, in fact, few factories in the world able to fabricate a given element.

that can receive them and represent not only an attractive transport price but a capacity to enable distribution and exchange patterns that extensively cover Europe's land-mass.

Two French ports, Le Havre and Marseilles, but also Dunkirk are on these super container-ship routes, which can pursue to Antwerp, Rotterdam and Hamburg. If it is verifiable – based on the most recent report on French ports – that their overall traffic progressed 1.5% per annum over the period 1995-2005, it will be noted not only that container traffic over 2001-2005 grew 38% at Le Havre, 22% at Marseilles, but far behind the 51% for Rotterdam, 73% for Hamburg and 107% for Antwerp, but also in absolute volume the latter-mentioned ports were already far ahead of the French ports. These figures serve to illustrate that traffic trends are now avoiding French staging, bearing in mind that sea-transport is both a tool in terms of competitiveness and an indicator of the level of competitiveness for access to and from a country's hinterland and its resident companies.

These North Sea ports designated above benefit from the existing motorway networks and the railroad systems with which they intermesh closely. Moreover, they have developed a flow breakdown process that allows them to pursue sea transport to and from other medium size port facilities.

Le Havre and Marseilles are not interconnected to the railroad networks to any significant degree, whereas Rotterdam has not only developed, but partly financed also, the Betuwe Line which is freight-specialised, this line running from the Port of Rotterdam to the rest of the German territory; the Port also co-finances various other railroads in Germany (thereby responding to the increasing traffic demand and also compensating the gradual Rhine-Meuse river traffic losses (due to increasing climatic disturbances). The Port of Hamburg forwards 35 % of its traffic by rail and targets 45 % by yr. 2015.

Large port to medium port traffic is also very low: France only carries 6 % port traffic by short sea transport along the coast-line, whereas the United Kingdom, Spain and Italy have figures that are 3 times higher and growing rapidly. We can imagine, nonetheless, development of France's two national ports, potentially capable as they are of serving the French hinterland competitively, and thereby extending their zone of influence and goods transport capability throughout Europe, using inshore sea-routes to serve other ports such as Brest, Saint-Nazaire, La Palice on the Atlantic sea-front, Port Vendre and Sète on France's Mediterranean shores, in order to better collect and distribute the containers in transit. Some of these ports are already inter-connected to hub-ports (Le Havre, Rotterdam, Algeiras, Felixstowe) using smaller container ships that collect containers on a regular scheduled basis (once or twice a week). Were this system to become general practice, the growth of container traffic on certain national road transport and transit routes would be impeded.

It is obvious that ports and their facilities are both necessary and unavoidable in the world trade transportation system and also competitiveness depends on the amount and scale of territory that these ports serve⁷. Staging port dockside productivity and associate costs for container-crane movements (with the exception of Port 2000⁸) are far removed from existing European standards, albeit that the latter themselves are less efficient than their equivalents in South-East

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7. Actions ongoing and benefits can only be measured over coming years (port and harbour reform and rehabilitation, responsibility of the actors involved in the fabrication – to end-user chain without a continuity solution, links with railroad networks, use of barge transport at Le Havre and Dunkirk via the North Seine canal to the Ile-de-France basin. ...).
 8. Port 2000 will be the new container handling facility at Le Havre (12 loading-unloading docks).

Asian ports⁹. The other modes, using other transport facilities, also throw light on a French particularity that distinguishes this country from other European countries:

- A low and stagnating railroad sector, whereas all growth of traffic in countries such as Germany, the UK and even Estonia, to mention but three, has taken place precisely in this sector.
- A highly predominant road transport factor, roads accounting for 80 % of France's tonne-kilometre traffic that has absorbed almost all the overall traffic growth.

The planned opening-up of the national railroad network to allow access by private operators (still at a low level in France compared with other European countries that comply with the same regulations) but also the development of close client rail operators (more than 100 in Germany) would serve as steps in the direction of prevailing standards in comparable European countries where one can note more dynamic economic and industrial growth.

Facilities in France, in this area, are under the control of several bodies, ranging from Europe to the local Town-Hall (namely, the EU, the State, the Region, the Department, the Area¹⁰ and the local Town-Hall). The Regions are having more and more influence and say in all three areas – roads, rail and ports, participating actively in investment financing and in maintenance. In contradistinction, we see economic actors who control and manage the production/ distribution chains now exploit the “machine to machine” concept that requires total responsibility and control over the path from end-to-end, in essence being transparent to the intermediate space scale-parameters.

As we drafted this Report, we noted the need for dialogue and concertation between, on one hand, those who specify transport needs (*viz.* The production/distribution operators) and, on the other hand, those who intervene in logistics, handling and transport, including all the civilian and State authorities on the territories involved. Progress will stem from the dialogue, productivity gains will become possible for all, and territorial attractiveness will increase, in particular at the Regional level. The Report recommends (calls for) a real public/private partnership, as is the case at the Port of Rotterdam and the German Railroad infrastructure manager Deutsche Bahn Netz.

4. Virtual architecture

Freight management as we saw above, is an integral part of the production/distribution chain. *It too, must comply with the new requirements of a digital economy that governs the production and distribution functions*, since the goods carried will be fed, in an almost synchronous fashion, into the production and distribution platforms. Integrating the “transport” function into the value chain allows a great number of personnel and operatives to contribute to the satisfaction of the end-user client. The 3 fundamental layers: the facilities and their operation, transport seen as an economic activity and the supply chain (the logistics which, in fact, turns out

9. For example, a container gantry will carry out 46 000 movements per annum at Marseilles, compared with 150 000 at Antwerp, or framed differently 50 movements per hour at Marseilles compared with 150 at Shanghai. Cost per movement (in 2003) was 95€ in Marseilles compared with 50€ in Antwerp (Source: IGF/CGPC)

10. NB – ‘Area’ in English is used here to translate this French notion of several Town halls agreeing on and sharing certain services and facilities (e.g., rubbish disposal); in French, agglomerations de communes.

to be a network) that links the value chain actors together, integrate as if in a perfect jig-saw puzzle.

A second “invisible hand”

In order to throw light on the colossal field of innovation that IT technologies have now opened up for business enterprises, we can evoke a second invisible hand that complements that imagined by Adam Smith¹¹ to illustrate the forces at play in the market-place.

This new invisible hand emerges with its 5 fingers providing: simultaneous information, real-time optimisation, finance, integration and localisation, structuring the economic activities thanks to a dynamic system, a new product/service relationship that continuously improves, capable simultaneously of:

For the first finger (or thumb): providing *instantaneous information* whatever its source and for a nil marginal cost – the expression here is ubiquitous information – and the delivery point can be the office, the home or when travelling.

For the second finger: giving *real-time optimisation*, i.e. with results that are available not only for design and planning stages but also for operational aspects: enhanced handling speeds and associate memory capacities that make this possible. Digitisation allows you to solve the most complex combinatory situations and to handle random phenomena, such as queues, in real-time.

For the third finger: making *real-time tariff setting* possible, viz., Yield management that enables tariff revision on a continuous basis that ensures best use for available resources, facilitates financing and new handling capacity investment.

The Fourth finger: ensuring the integration function, both at intra-corporate level, co-ordinating the various skills for the benefit of the end-user client, and also at inter-corporate level providing for new possible partnerships, and going as far as the world-scale, flexible enterprise, for which the modules are inter-connected in a variable geometry network. The management function for the flow of goods comes under the heading “Supply Chain Management” (in fact, it is not really a chain but rather a network). In this light, inter-modal transport could become a real prospect and quality-assurance could be guaranteed by supporting software skills that automate the processes being controlled (BRMS : Business Rules Management System).

For the fifth finger: offering a global reference bench-mark that makes it possible to track goods by geo-localisation with an accuracy of 1 cm anywhere on the Earth’s surface, with an associate movement function. An invisible facility using satellites and either optical or radio frequency item labels (RFID) is gradually being implemented. The sets of applications are numerous: guidance and navigation, geo-localisation, fleet management, real-time data processing, remote detection, surveillance and tracking.

11. Excerpt from Wikipedia : “Once in *The Wealth of Nations* and other writings, Smith demonstrated that, in a free market, an individual pursuing his own self-interest tends to also promote the good of his community as a whole through a principle that he called “the invisible hand”. He argued that each individual maximising revenue for himself maximises the total revenue of society as a whole, as this is identical with the sum total of individual revenues.”

This invisible hand is **forcing companies to collaborate** and this pre-supposes a complex organisation (which nonetheless we can understand and control) with the proviso that we effectively control the system and distribute the costs and profits equitably. If one uses all five fingers together, i.e., the hand, as levers to undertake a projected action, then we stand in a better position **to understand the system *in toto*** and to move the competitive level of the company up to a level that only strategic IT implementation can provide for. To act efficiently on a complex system, we must necessarily deal with it in a global manner.

If inter-continental sea transport has carried out its integration, so that integration is indeed one of the elements that leads to development of world-scale virtual factories, this observation does not hold for other transport modes in France.

Railroad freight will only survive if there is an awareness of the now inevitable nature of virtual reality. It is, to take an image, no longer possible to write the future story of railroad freight if we only use one finger on the keyboard under the presupposition that we are handling a perfect operational situation (based on the principle of positive fail-safe system where a system failure leads automatically to a higher level of precaution, again with an image even when the fire is extinguished, the convoy must stop. We can no longer ignore that the four other fingers of this second invisible hand provide instant data, dynamic tariff setting, integration and geo-localisation.

Unfortunately, and despite high level investments, progress in this field is slow. The reason for this state of affairs is not technical, and the 5 plagues that beset our railways may provide (part of) the required explanation: we have a rail system that makes no distinction between passengers and freight, with a corporate structure totally devoted to safety without taking into account the competitiveness factor, with a social (personnel) organization that does not meet the requirements of a service industry culture, where the skills and job categories are no longer in phase and thus lead to an unsatisfactory service level. The very nature of freight companies must change and new railroad paradigms must be invented. We did in fact do so, when we innovated by introducing the High Speed Train (TGV) concept and the success of this enterprise was brilliant. The experiments under way to launch “combined transport” should, we feel, be pursued. But there are many other paths that we might explore and if the couple production systems / IT is appropriately intermeshed, then we shall have other successful developments. Railroad freight should be seen (and act) as complementary to other existing modes and involve the full gamut of possibilities, all the fingers of the digital hand, for the purpose of providing a service of a quality that meets the demands of the customers.

A new business model. Freight transport ++: Multimodal transport + logistics (including dedicated activities)¹²

Without IT systems, there cannot be a natural synergy between transport and logistics. Management for fleets of vehicles and management of warehouses are traditionally ensured by

12 We can make an opening remark at this point – corporate Boards, in most instances, will only accept and act on investment proposals for their data processing systems if there is a pre-justified productivity gain. In so doing, the Board members are forgetting on essential point, viz., that the IT systems that can procure such gains (and often it is less than one expected), also and especially allow you to undertake many other tasks and to develop new business models that would have previously been impossible. Return on investment (ROI) is to be found here. Thus, taking aeronautics as a case in point, when seat booking by computer began (CRS – computer reservation system) the initial aim was to improve productivity. However, and very quickly, the system managers moved on to the concept of ‘yield management’ which helps augment corporate revenue, by simply attaining hitherto unequalled aircraft filling rates.

different type of companies: transport being seen as closer to civil engineering and logistics being seen as an industrial sector. IT has changed all this, and it is now possible to work “in real time”, whilst constantly improving the load factors, which initially appears as self-contradictory (with the rewarding result of having optimised – *cf.* the 5 finger concept – distribution circuits). Moreover, the younger generation operators are capable of contributing to end-customer satisfaction by offering dedicated service, that come under the heading “co-manufacturing”. The latter value creating process often makes the difference when choosing the contractor¹³.

Transformation of traditional warehouses, when assigned to diversified and constantly evolving activities, is spectacular. In the traditional warehouse, goods handling is sporadic and the overall storage time is high. The main function, as seen from the visitor’s point of view, is the storage function. In what we now would appropriately call a logistics platform, assigned to functions in a diversified and digitised economy, movement replaces the static scene and the impression the visitor now has is that of a factory (qualified however as a virtual factory inasmuch as the goods leaving are the same as when they entered the ‘factory’).

Companies that will in the future be in charge of transport of goods for manufacturing units working on a global scale will, less and less, be limiting their services to the single “production” transport function. They will also contribute to service rendered on the end-user’s premises, thus combining transportation, logistics, sub-system assembly in synchrony with all the other partners involved¹⁴.

The need to have a main contractor capable of handling major systems does not at all imply that the SMEs specialised in technical value-adding operations will disappear: making available a fleet of trucks with drivers or providing the locomotion for trains. Nevertheless, the associate commercial aspects will call for guaranteed service quality assurance. Quality therefore needs to be checked and this in turn is based on a form of virtual architecture that is entirely dependent on IT and their systems. Often the companies do not wish to be seen only as providers of traction-locomotion (although this is a perfectly worthy activity, but we assume that it is not a well-paid one). However, if you want to do business, you must sell a given level of service (*i.e.* in a quality-price combination) and guarantee the results. This has always been true, but it becomes a more stringent condition to comply with in a digitised economy where synchrony of activities, with the ‘just-in-time’ concept, is systematically being sought.

5. Prospects for evolution – system sensitivity to external costs

Inter-continental transportation

In terms of traffic to and from Europe, we saw that it is essentially (45 % value and 70 % tonnage) carried out by sea. Air traffic (24 % value) is negligible in terms of tonnage and its growth rate has been 4 times lower than that for sea-transport over the years 2003-2005.

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13. In all the examples set out here, the precise specification of corporate stakes at issue were carried out jointly by the external consultant IT company and the in-house IT services – this enabling appropriate choice of the specific software packages to be installed, their integration and the taking into account of the IT process at all stages along the value chain. The company BTL, for example supplies all its contracted trucks, a complete GPS-GSM- onboard CPU, to avoid where possible any breakdown in the transport chain.
 14. These modern companies will have to incorporate a triple culture, so to speak, that combines civil engineering, industrial engineering and management and marketing skills. Contribution of the sole transport sector to the turnover of such companies may no longer be a majority part.

Transportation in general (freight and passenger traffic) accounts for about 20 % of the world's fossil energy consumption, *viz.* 1 900 Mtoe/yr. Sea transport here only contributes 5 % (*viz.* 100 Mtoe/yr., less than 1 % of world consumption). The cost of international sea traffic is low, not to say very low, with respect to the value of the goods transported, the order of magnitude being about 1 to a few per cent, and in this cost, energy represents approx. one third.

Under such conditions, it is likely that – excepting some special cases – the costs borne by the transporters in terms of energy consumption, as well as the associate costs (tariff setting external costs, in particular for emission of CO₂) will not, at least up around yr. 2030, have more than a marginal effect on this segment of the transport and logistics chain and the expected price rises here will not fundamentally call the spatial organisation of the virtual factory into question.

Transport in Europe and in France – The consumption of energy and emissions

80 % of all freight transport in France is carried by road haulage.

We might begin by observing that the fears expressed and relayed by opinion makers and media do not correspond to the real measurements taken in France: CO₂ emission levels for the whole road sector have stabilised since yr. 2001 and represent some 24 % of all national emissions. If we consider all the greenhouse effect gases (GHGs) together, the fraction of global warming that can be attributed to this road sector has likewise been stabilised, at 20 %.

Nonetheless, road transportation in coming years *will have to assume pro rata its part of decreased externalities, whether they be framed in terms of CO₂ or other external costs.* We can therefore admit the corresponding costs will somehow be integrated, either in the total energy cost or in a kilometre based tax. In order to analyse this question and possible evolution, fuel price can usefully be subdivided into three component parts C1, C2 and C3, as follows:

- **C1** represents the fraction of the price that equates with the industrial fuel production-refining process; the price of a barrel of oil and production/distribution, plus associate VAT and naturally the part of the carbon tax applied to the sole production-refining process;
- **C2** represents both the utilisation made of infrastructures and specific external costs induced by transportation (accidents, pollution other than CO₂, noise abatement costs ...to mention the more important): C2 may be compensated by a tax on energy or by a mile-based tax;
- **C3** represents the “cost of emitted carbon” and is related to the general policy applicable to CO₂ emissions when the fuel is being burned, and in this context transportation only represents 24 % of the total national consumption.

For all the types of energy that can be used for freight transport, the above sub-division is applicable and through this process we see that:

- **C1** results from the market place pricing of raw materials and the cost of refining. This cost will undergo the most sizeable increases in the course of the next decades.
- **C2** currently is changed into a tax on energy, that we consider to be proportionate to the distance covered and therefore is representative of the facilities available for transport and for the associate external costs. The recent report “Handbook on estimation of

external cost in the transport sector” requested from the University of Delft (NL) by the European Commission demonstrates that the fraction for the external costs is relatively low¹⁵, less than 3.5 c€/km on average for trucks, *i.e.* about twice that of equivalent railroad transport. This component part of the global cost could very probably be compensated by a road toll levy (using remote sensing systems) that would represent the utilisation made of the road facilities, and this process is proposed by a certain number of actors involved (a start for such a system can be observed in the ‘Eurovignette’¹⁶ project advanced by the European Commission). This would provide local political authorities with a real lever to a transport policy, whether it be local, regional or national.

- **C3** will be established through the European value (or world value) that is decided or is a result of carbon permit markets: the current projections show that a probable value of 30-50€/tCO₂ could be envisaged up to yr. 2030 and following that point in time, if the so-called “factor 4” policy is adopted, the appropriate values could rapidly rise to reach 100-200 €/tCO₂ and this would only represent a limited fraction of the cost of petroleum product fuels, around 8-13 c€ per litre, in the first phase and 20-50 c€/litre in the second phase¹⁷.

Possible and probable impact of the price of energy on transportation

The increase in prices will probably be a serious issue: a doubling up of prices between yr.2005 and yr.2030 is a reasonable working hypothesis. This corresponds to an average per annum increase of 3,5 %. This figure concerns both energy and taxes and is only one of the factors (non-majority, in fact) that make up the cost of transport: labour costs and investments have a much higher impact.

It can then be noted that productivity gains in the “freight transport” function have in the past been higher than 3,5 % per annum and that such gains will very probably be pursued in the future; with constant technological progress, and an organisation with more and more IT driven functions, these gains are possible and likely.

Moreover, the “central motor” of the expansion process will be in the international traffic sector, essentially by sea-routes where the energy cost plays a far less important role than for land-based modes of transport. The conclusion we are led to draw here is that freight transport will continue to accompany the phenomenon of world trade growth. And as we have observed today, this growth could well be accompanied by a stabilised level for CO₂ emissions.

Evolution of the price of fuels and tax levied for external costs by time horizon 2030 can be set out in table-form (below), if one presupposes the evolution of two pilot prices (standard barrel of oil and the tonne of CO₂):

15. Moreover, accidents represent some 30 % of this value and we know that this cost is dropping rapidly in France, and the same downtrend is also observed, fortunately, throughout Europe.

16. Cf. explanations about this EU directive at <http://europa.eu/scadplus/leg/fr/lvb/l24045b.htm>

17. Cost of CO₂ due to transport can be levied as an energy tax. It can also be framed in the form of a carbon quota-permit basis.

2030 (base 100: total price in yr. 2007)	Oil barrel predominates	CO2 predominates	Moderate evolution
Total Price	200	190	160
Price of energy	120	80	80
Kilometric Usage	60	60	60
Price of CO2	20	50	20

Possible and probable impact on modal distribution

This question is somewhat different from the previous one, given that fairly low price differences (10-30 % over the period envisaged) could lead to important transport policy changes, from road to water or to rail. Should we not, however, question the generally held belief that these differences are serious? In this light, we may note that:

- The figures set out in this chapter demonstrate clearly that, whatever the scenario, the price of the barrel of oil plays a predominant role. This price is used to determine the end-user price for other fossil energies (gas, coal) and tends to draw them upwards, as it does for other vectors such as electricity¹⁸. When we think about it, no transport mode escapes an increase in the **C1** component.
- As far as external costs are concerned, they could play a role, notably if they are levied at toll barriers. We must not, however, consider that this role is restricted to road transportation only: the University of Delft (NL) report is extremely clear on this point.

The conclusion here is that the overall picture is not black and white and to pursue our analysis we must come back to the core principle of this NATF report: it is the end-to-end balance that must be considered and which determines policy choices and it is the ratio performance-cost along the chain and not at link level that fixes the decisions. Future development of different modes (road, rail, water) will depend on their **capacity to constitute global paths to the end-user**. It is this capacity that will call the score, far more so than the price of energy or of external costs.

Closing remarks

The answers to our questions tend to show that the future evolution could prove more moderate, more “in line” with current trends than the vision that is commonly advanced. Not that this should lead us to conclude we are seeking to deny that energy-savings policies will be encouraged by increasing energy costs. What this chapter shows is simply that the cost factor is not the main trend variable and that the three transport modes could adapt to the new situation.

6. Prospects for technological and organisational change

The three transport modes have considerable room for improvement. It will lie within their responsibilities (especially for actors who demonstrate a capacity to adapt and be most reactive

18. Given that these prices are highly volatile, the very strong link evoked here often goes unnoticed. Between February 2005 and April 2008, the price of Brent crude oil in euros increased by a factor 1.94, gas by 1.87, coal by 1.90 and electricity by a factor 1.90.

to market-place changes) to transform such potential into real developments, bearing in mind that the market will also have to comply with changes taking place in the production/distribution chain.

Systematic use of IT – necessary if the actors want to integrate the world-scale production/distribution chain – will lead to innovations with strong productivity gains in the sector. Rail transport, which today is the least integrated of the three, should prove to be the main beneficiary.

Future evolution of the logistics-transport function, as yet far from complete, will lead to defining new organizational structures and should allow newcomer actors to ensure perfect coherence and real synchronisation in the overall system. The key actor will no longer be the person who possesses a transport tool and he will no longer be “bound”, so to speak, to using a single tool (or mode). His aim will be to optimise the overall cost of the logistics transport function for each application. Global optimisation of the product/production-distribution chain/ logistics transport equation will be possible: and indeed is already practised by some actors (e.g. IKEA). The choice among each of the possible modes will be based on an objective comparison of costs and services.

As far as land transport is concerned, the main problem is about low costs of use of the infrastructures. Making “best use” of roads, rails and associate facilities, optimising the transport schedules and carrying out maintenance operations will contribute to lowering costs, and to limit the heavy investments needed to ensure proper traffic flow and to follow the growth patterns. Improving productivity in this way has considerable impact. If we look at the specific case of rail-road transport, we note that no account has been taken of productivity progress in the most recent European foresight studies. In France, there is a legal obligation for the RFF¹⁹ to delegate network maintenance to the SNCF (French national rail company) and this makes it impossible to set objectives and benefit from the progress.

We can add that public-private partnerships in the financing of infrastructures and plant facilities should not be limited to financial actions, but should at the same time enable the private sector to make available to the public authorities its specific capacity to innovate and improve productivity: through engineering, building and maintenance and even as far as actually operating the system.

There are numerous, promising new technological openings that could be applied to transport vehicles and rolling stock:

- Cleaner”, more economic vehicles: all modes must progress rapidly here, in particular the road haulage segment, where the pressure is very high and where the vehicles are replaced at a rate 4 to 5 times more rapidly than for rail stock.
- New vehicle designs that increase the volume transported.
- The advent of high speed rail freight trains.

Finally, European harmonisation is under way; the aim of which is to simplify the system, reduce associate costs and route times over the European land-mass, and this is especially important for the railroad networks.

19. RFF- Réseau ferré de France – the public establishment that manages the French rail-roads infrastructures.

These changes should allow the various modal systems to compensate for increasing costs with increased productivity, especially in the areas of energy expenditure and lowered environmental impact. Even though it is difficult to accurately measure the impact for each mode, taken individually, it would appear that the road haulage system and roadworks will prove the most reactive in coming years, but that the railroad sector still has a high improvement potential in the long run.

7. Manpower and vocational profiles

What makes freight transport specific with respect to passenger transport, is that the first mentioned mode couldn't exist without a transport-logistics system, the latter being a sub-system of the production-distribution chain. The client-passenger is an integral actor in the system, capable of reacting and providing real-time information, in contradistinction to a freight package that is entirely dependent on the handling organisation. Dealing with freight implies facing up to a specific system, the main feature of which is a much higher level of integration than for passenger traffic, the latter being a system that requires a specific approach, both in terms of R&D and for training of executive staff.

However, because of the importance and the attractiveness for Society, research related to passenger traffic accounts for 90% of the French R&D. This paradox merits reflection, given that the freight transport and logistics sectors, expanding at a rate of 10% per annum, and representing 15% approx. of our GDP, not forgetting the high level of impact on productivity that spins off to other sectors, should prove naturally attractive.

Crises seen as revelatory

We should endeavour to draw positively from crises or speculative bubbles to identify certain essential phenomena – in particular when they relate to the economy – that could potentially enlarge the circle of those who feel that progress in research is something that is of concern to them and somehow determines their future, and not specifically the circle of research scientists and engineers *per se*. This situation ties in with the image of freight transport in Society, *i.e.* with a capacity to convince younger bright generations that it would be an intelligent decision to invest career-wise in a field that is far more promising than at first sight.

Identifying rapidly evolving economic segments implies new high quality public partners

The NATF report describes the respective roles of urban transport, long distance or regional transport in the system, but also the growing impact of multimodal transport and the necessary and ubiquitous integration of IT, all of which constitute elements that enhance system optimisation and reduce system operation costs. Cost reduction is a trend that leads to a widening of the spectrum of public partners present and enhances their respective ranks in the contracts, as clients of the research efforts and employers for new elite managers of the freight system: an increased role for cities and regions and a major role for Europe in the world and, comparatively speaking, a lesser role for State intervention than in the past, exception for interface infrastructures.

Freight transport R&D, between continuity and break-through phases

Though it is true that some French research teams who have invested in transport and logistics studies, have been pioneers and have accepted part of the challenges set by the issues, it remains nonetheless that a more global dynamics should be set in motion. The main contractors, first and foremost the ANR Agency must devote the necessary levels of investment,

both in intellectual and financial terms. They must assure themselves that the experienced contractors, engineering schools, graduate doctoral schools, schools of management and business studies, with support from the Centre national de la recherche scientifique (CNRS) must be in a position to mobilise all competence and skills needed to gain better knowledge of the global transport system and at the same time enable cross-fertilisation and mutual enrichment of the scientific and technical disciplines involved.

The dialogue between the fields of IT, infrastructures and rolling stock, on the one hand, management logistics and sales teams, specialists of socio-economic parameters on the other hand, must be seen as a priority. They are a prerequisite to attaining international visibility and national attractiveness.

How could we train an elite world-class corps in an area where R&D is largely confidential?

In order to build an 'aura' of renown for this sector, we first need to embrace its complexity and diversity, in terms of the speciality skills needed to properly comprehend the issues. Research should be focused – given the ongoing and expected changes – on the “supply chain”, on the “connecting to compete” concept, that we discussed earlier.

In essence, the National Academy of Technologies of France recommends that we do not wait for a new organization for the academic research sector and the implementation of the university campuses comparable to those of other world-class universities in order to aim at and produce high-level research in the field of the “freight transportation system”. The Academy observes that in parallel to the above scheme for future research campuses, numerous elements plead in favour of a regrouping of Higher Education components on such campuses, open as they will be to students from many different course backgrounds and choices, and could enable the building at Master's level of speciality courses being offered that would attract the best candidates, who would thereby be trained and certified in the various academic levels, as having acquired the skills and set of competencies that will make them captains of industry and leaders of the economy²⁰.

8. Recommendations

Concerning **statistics**: collection and management of information should evolve to remain in phase with deep reaching changes observed in world trade and their impact on every national territory; information deemed relevant should be transmitted to policy-makers.

Concerning **integration of the transport sector into the production-distribution chain**, that makes the integration necessary and serves both pilot and organisation functions, with application, now or later, of associate constraints.

Concerning the specificity of the transport-distribution-logistics sectors, note is taken of its impact on global competitiveness in all other sectors of the national economy. Efficiency is therefore primordial both for the economic at large and for jobs in particular and must be seen as a priority when it come to making national policy decisions.

The exchange platforms, ports and multimodal platforms are necessary for the development of competitiveness of the domestic economy, their rehabilitation must be pursued actively in

20 Ought we not extend the scope of these recommendations to various complex systems whenever a high-level integration of technological, economic and society-oriented components promises to be a key to future solutions?

order to reach the best levels observed in the world and to reposition France as a staging country on the major international exchange routes.

The various taxes or tolls applied and applicable to the transport sector must be made more “legible”, for the purpose of providing the actors involved with “leverage” to attain efficiency policy-making.

Encourage and enhance the changes in French companies towards the new professional activities emerging in this field. Encourage, in particular, the development of fabrication-to-end-user logistics, inasmuch as such specialists will be major actors in terms of the concept of global scale virtual factory.

Develop of French high level research and training in the field, based on the convergence of complementary sectors such as Trade and Industry, with a strong and pervasive contribution of IT processes.

To organise a forum for exchange and dialogue among all actors, whether they be private or public.