Inland freight transport scenarios for Europe in 2020

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Introduction

Forecasting trends and future developments in the transport field has never been an easy task. It is a sector that is sensitive to all those parameters affecting the trip-making "desires" such as economic development, social trends, habits, etc., and where major periodic "jumps" in technological or regulatory regimes may change the "scene" completely. In considering, therefore, the prospects and scenarios in the field of inland freight transport for the 21st century we clearly need to make some assumptions about the broad parameters that are likely to be present at the economic, policy, and technological levels.

Structural changes take place in "cycles," almost in an "epochal" fashion, that is characterized by a prevailing policy, trend, or technology and which influence directly the transport scene, or the political, cultural and economic environment in which transport operates.

There are first, long-term cycles which are due to major "jumps" in technology, or the political or social environment.

Examples of such cycles are the coming of the railways, the emergence of private motorized transport, the take-off in commercial aviation, and the recent dawn of the Information age. These were primarily "technical" revolutions but there are also examples of "revolutions" in the political or socio-economic fields, which started major long-term cycles of change. The creation of the European Economic Community (originally) and later the European Union is certainly one of them, as also is the abolition of Communism and the change of the Eastern European countries to market economies, or (perhaps of a smaller magnitude) the recent wars in South Eastern Europe.

On top of these long-term cycles, there are superimposed identifiable short-term ones. If we just take the past 20 years, for example, one can identify the 1970s as the age of energy and environmental consciousness, the 1980s as the age of "Regulatory Reform," and the 1990s as the "Decade of Infrastructure Issues." The information revolution cycle is only beginning and is likely to proceed with lightning speed all through the 2000s and 2010s. Already, technologies that now seem antiquated are less than 15 years old (e.g. the Fax) while others which have taken hold of the market and seem to be our daily way of handling things are less than 5 years old (e.g. EDI (Electronic Data Interchange), and the Internet).

From a forecasting perspective, the problem is therefore essentially one of predicting *turning points and then identifying the changes that a particular cycle will bring.*

It is not difficult to identify the cycle that we are currently entering. It is the cycle of information technology and telematics. Thus, the main attempt of this paper is to try and see what will be the likely impacts on freight transport in Europe in the face of these new technologies taking hold of the market. In doing so we also look into other elements of change that are not necessarily of a technology nature (e.g. changes in policy). Our "target" horizon of 2020 seems well justified since the "short-term" cycles of change (at all levels), that are now only beginning to show, will by 2020 have matured and taken full effect.

More specifically, within the framework of this paper which discusses the prospects of freight transport in Europe for the coming first two decades of the new century:

- The current situation is first analyzed and presented in the light of current trends and events that are likely to have an impact on the future, noting that
  - structural changes in the past are characterized by a prevailing policy, trend, or technology; and,
  - future changes are likely to be the result of such prevailing trends or technologies, proceeding to consistently see what these could be.

• The quantitative and qualitative outlook of future freight transport is then discussed in terms of expected developments and policy implications in: inter-urban, urban, and rural freight transport, identified as most likely "enabling factors":
- the new Telematics-based systems and applications, and the advances in Logistics and supply management techniques;
- more integration in the field of telecommunications usually referred to by the name of "Convergence," and of course the form and extent to which policy makers will resolve the still outstanding related institutional and legal issues.

• And finally, estimates of the likely timing for the (market) implementation of all these "factors" in the future are also made.

During the last decade the author has been involved in two major attempts at "forecasting" the future in the field of transport.

• The first was the work of the scientific network NECTAR (Network of European Co-ordinated Transport Research) of the European Science Foundation (ESF) under the name ***Europe 2020 group*** co-chaired by this author and published in Giannopoulos and Gillespie (1993). Part of that overall effort was also the work of another group of the ESF for ***Scenarios*** published in Masser et al. (1992).

• The second was the work that ended in December 1999, coordinated by the author, for the development of a 10-year Master Plan of research in the field of transport in Greece, and published in TRUTh et al. (1999).

The current context for transport

Our previous remarks about repeated failures in the past to predict coming cycles of change do not erase the fact that the future – especially the short to medium term future – is never independent of the present, or of the past, and ongoing changes, which are taking place, will inevitably have carry-through effects.

So, as we enter the 21st century, it is appropriate to start with the consideration of the trends and developments of the present and recent past, and use these in order to specify those aspects of the background within which to consider the future.

Major trends and events in terms of demand and policies

• We can start with the main "elements" that generally influence the **demand** for transport (not freight transport in particular). These are:

- The current socio-political environment;
- The prevailing value systems;
- New methods of production organization; and,
- New forms of spatial organization.

• **The current socio-political environment:** The last decade or so has seen an increasing reliance upon market forces as a means of regulating the supply and demand of transport services. In a period of rapid technological change, the market mechanism is clearly recognized to possess many advantages as a means of deciding between competing options. In the long term, the unfettered action of market forces may very well lead to the re-establishment of private monopolies in the transport field, requiring re-regulation. So, competition within markets as one of the principal forms of decision making within the transport field will necessitate a permanent mechanism for monitoring the proper functioning of the market, and corrective policy decisions if needed.

• **The prevailing value systems:** Shifts in societal value systems seem to be occurring which put greater emphasis on the satisfaction of individual rather than collective desires. Such a shift, if continued through, obviously has direct implications for all kinds of transport, in terms of the proliferation of "lifestyle choices" and the growth of new forms of consumption and leisure. At the same time, there is also evidence of growth in environmental or "green" value systems, the generalization of which will also have profound implications for future transport.

• **New methods of production organization:** New forms of flexible, lean, "just-in-time" production are being implemented, to meet changing customer requirements and expectations. These are taking place alongside a clear trend towards "globalization," which in the European context is expressed by the formation of a single European-wide production system. These new forms of production organization impose quantitatively and qualitatively different requirements upon the freight transport system, with general increases in the frequencies of movement, in the distance over which movement takes place, and in the required reliability of transport systems.

• **New forms of spatial organization:** Developments in transport and communications have facilitated the emergence of complex forms of spatial organization, in which much greater integration across space has taken place. Such integration can be seen at a variety of scales, including cities and rural areas, cores, and peripheries within national territories, and between countries at the European scale. More than 80 percent of the European population now live in medium-sized to large-sized urban areas.

• On the **supply** side, the efforts to satisfy demand are focused primarily on two areas:

• **Development of a coherent network of a European-wide Transport infrastructure:** The notion of the Trans European-Transport Networks (TEN-Ts) that incorporates European wide Road, Rail (both high-speed and conventional), maritime, inland water, and Intermodal networks, is the leading effort at the level of the European Union in developing such infrastructure. Other countries are following. The process of development is slow and requires funding far beyond what can be made available by governments alone. So, relatively "new" forms of financing through private, or public-private partnerships are being tested.

• **New technological possibilities:** These affect primarily the "supply" but may also affect the "demand" for transport. The use of **Telematics,** i.e the use of telecommunications and computing, is perhaps the major element of these possibilities. The "informatization" of transport (especially freight) as a result of the application of Telematics, is transforming the scene and has facilitated possibilities for greater integration as witnessed in the development of advanced logistics systems, and "network service" providers, etc. These, as already mentioned, are the focus of this paper.

• Coupled with the above "elements" at work today, and partly because of them, corrective changes are expected to the **Transport Policies** adopted by European governments. These are characterized by the on-going "full and unconditional" *liberalization process* in European transport markets.

• **At the EU level,** the move towards the EMU and an enlarged Single Europe has resulted in a number of concrete steps at liberalizing the transport market, which within the next 2 to 3 years will have eliminated practically all restrictions and transport-related barriers. As new countries become candidates for adhesion, and others are aspiring to do so in the first decade of 2000, the geographical limits of application of these policies will extend beyond the boundaries of the existing membership of the Union.

To mention the most important such liberalization measures that are going to take full effect, within EU countries, and produce wide-ranging impacts all over Europe by the turn of the century, we can list the following:

- Frontier checks for road freight crossing from one member state to another were abolished in 1993;
- All quota restrictions for road freight transport were removed with the exception of the eco-points system which is maintained for environmental reasons;
- Restrictions on cabotage on all modes of transport have gradually been removed from 1998 onwards and are expected to be completely abolished in all modes and countries by 2004;
- Entrance to the profession for road transport has been liberalized;
- Separation of rail infrastructure from railway services operation has been already introduced in the legislation of all EU countries;
- The concept of the Trans European Rail Freight Freeways (TERFFs) is being promoted;
- Price controls on airfares have been lifted;
- Revenue-sharing agreements have been removed in air transport;
- Common licensing and safety standards have been established in air transport;
- National quota restrictions have been removed in maritime transport; and,
- Controls at EU frontiers for inland waterways and cabotage have been removed.

- Together with these significant changes in international – primarily EU – transport policy, are on-going policy reforms **at the national level.** Practically every European government has a pronounced policy towards
– privatization of supply;
– liberalization of markets; and,
– decentralization of decision making.
A central point of concern is always the **environmental costs** of transport. This point has kept for a number of years (perhaps decades) the discussion going for a variety of measures such as **road pricing** and other policies. Some of these measures represent EU or OECD-wide initiatives while others are national or regional in their origin. In any case, the process remains very slow and cautious and it is still doubtful that the many regulations and policy decisions needed for road pricing implementation on a wide scale will be finally introduced.

- **At the organizational level,** significant changes are occurring in the way transport companies are organized and develop at corporate level. Various co-operations, mergers, and acquisitions are increasingly seen as important ways of minimizing the costs of transport supply, and increasing profit margins. As a result, the international transport supply industry is becoming "globalized" and the "mega-carriers," which are large multinationals operating in all modes of transport, in every country of Europe, are emerging in both freight and passenger transport.

Assumptions about the future context of Europe

If the above are some of the most notable current trends and "events," how could one predict the future? This can only be based on some assumptions about the overall context of Europe, i.e. the kind of Europe that is envisaged. This may look a bit farfetched question to ask, in the context of this paper, but after the rapid changes in Eastern Europe over the early 1990s, and the Balkan wars of the last 4 years, no question could be more appropriate but also more difficult to answer. Without being too specific, a few general assumptions are therefore necessary and these are presented here. Their presentation serves mainly as a reminder of the importance and relevance of the wider political and socio-economic context of change without which no discussion as to the shape of the future of transport can be meaningful.

- **Assumption 1**: *By 2020 the "European Union" will be larger than the current EU.* Very likely most or all of the eastern European countries and the countries now forming EFTA will have joined the EU, and the European Union will encompass between 400 and 500 million people – more than twice as many as the USA or the Asia/Pacific countries.

- **Assumption 2:** *By the same year (2020) there will be a stronger European Government with the means to impose and safeguard a European Transport policy.* This means that although each country will have its own legislation, jurisdiction and government, European Institutions will have decisive powers over certain sectors of the economy such as International Trade and Industry, Research and Technology, Environment, Transport, and Telecommunications.

- **Assumption 3:** *In the coming years until 2020 (and hopefully far beyond it) there will be peace in Europe.* The events of 1999 in South Eastern Europe have set some parts of this region back many decades in terms of transport (and other infrastructure) as well as on almost all issues of socio-economic development. So it may seem an obvious assumption to make, but it is very important to remember that all forecasts, by "default," are based on the assumption of peace and co-operation.

- **Assumption 4:** *European or national government policies will continue to be formed by a process of "balancing" the concerns for "growth," "equity," and the "environment."* "Growth" would call for a high-tech and market economy scenario with as little state intervention as possible. "Equity" would place emphasis on policies that primarily try to reduce inequalities in society both in social and spatial terms, while the "environment" would place the emphasis on the quality of life and environmental aspects.

The process of formulating policy is likely to continue in the future to be a stepwise one, that moves by successively focusing on one of these three basic concerns.

Changes to the quantity of freight transport

Overall transport volumes and modal shares

In terms of volumes of transport that are likely to materialize in the coming decades, all indications point to the fact that economic, social, organizational and spatial trends are bringing about a highly mobile society. In such a society, the movement of goods and people (as well as information) has increased in the past, and will continue to do so in the future.

By some EU estimates, characteristically used in support of the TEN-T policies (CEC, 1997), transport demand as a whole is expected to nearly double by 2010 as compared to 1995 (fig. 1). Cross-border traffic is expected to grow by 2-3 percent per year. By 2010 there will be approximately 30 percent more passenger cars and 20 percent more trucks in circulation.

The relative share of transport modes in the total inland transport work is a point of debate. Over the last 20 years or so, policies have failed to halt the "onslaught" of road transport in dominating both freight and passenger transport. Current trends show that in EU countries over the last 20 years road transport has increased its share (in total inland ton-km), from 50 percent to 70 percent in freight, and from 76 percent to 80 percent in passenger transport. These increases have been made to the detriment of rail and inland waterways, the first

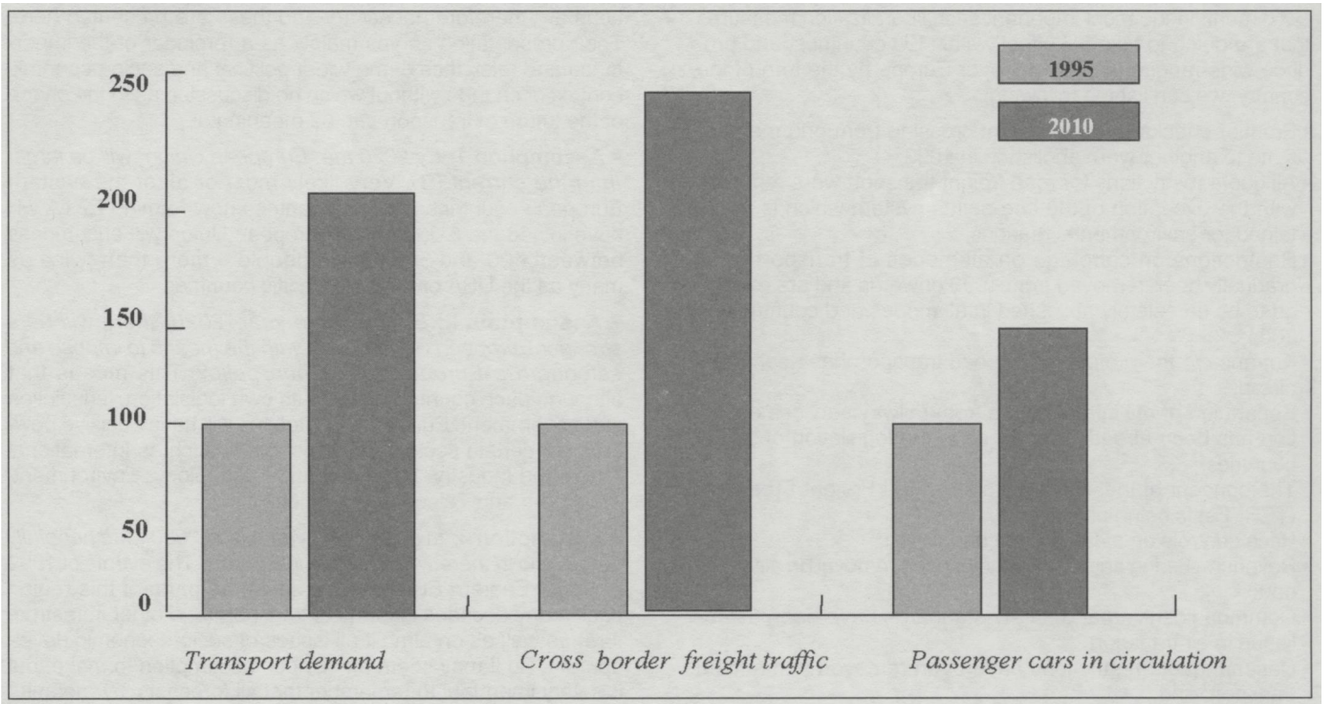

Fig. 1: Estimates of future transport in the 15 EU countries (base year = 1980).

reduced from 28 percent to 15 percent in freight and from 10 percent to 7 percent in passenger volumes, and the second accordingly (figs. 2 and 3). These figures do not include Short Sea Shipping (SSS), which if added will change these percentages somewhat, but not the overall picture.

There is very little indication of the magnitude of intermodal transport in the statistics, a fact that reflects their relative low magnitude in the overall inland transport work today. The actual figures are "impeded" in the above ones, but a safe estimate would be that intermodal (in the true sense of the word, i.e. as defined in the existing EU legislation) accounts for a mere 2-3 percent in freight transport, and even less for passenger.

As we are moving in the future in terms of the alternative policy focuses discussed above – i.e. from "growth," to "equity," and the "environment" – efforts to increase the share of intermodal transport, and at the same time increase the share of rail and inland waterways will be gradually intensified.

It would be reasonable to assume even a partial success of these efforts, which perhaps by 2010, but almost certainly by 2020, will bring a decline in the share of road transport in both passenger and freight to the benefit of intermodal transport. This will be more pronounced over certain major transport corridors that will be properly equipped to offer *a* convincing alternative to road transport.

A different view to the above was expressed in a recent book by Christian Gerondeau (1997). Using well-documented arguments, and adopting clearly a "road-oriented" perspective, Gerondeau challenges all "conventional" arguments against road and in favor of rail and other "green" modes. According to his view, the future is still "road-oriented" in both freight and passengers. The inefficiencies built into rail transport through decades of monopolistic inefficiency are hard to overcome, and produce a credible alternative to road transport. If this line of argument holds true, it may well be that the future modal shares will continue to look more or less as they are today and perhaps even more road-oriented.

Changes in the geographic distribution of (freight) flows

Besides the overall magnitude of (freight) transport flows, their geographic distribution is also subject to change. The main reason will be the different rates of GDP growth across the different regions of Europe. As was shown in Meersman and Van de Voorde (1997), an important factor in generating freight transport demand is GDP and the level of industrial production. These two factors do not always develop concurrently, because in a number of European countries economic growth is stimulated by the service sector and not by the industrial one.

Thus, as the prospects for industrial development of the less developed European regions of today are increasing, the relative growth rate in some Western European countries is likely to be lower than that of the others. As a result, the volume of (freight) transport will also develop at stronger rates along certain axes. The geographic location of these "new" axes of increased movement of freight can be forecasted by referring to the past and (expected in the) future indicators for GDP and Industrial Production across Europe. Towards 2010, and perhaps further beyond, higher growth rates of GDP and Industrial Production are expected in Southern and Eastern European countries as compared to the Western ones. Therefore, the rates of increase of freight transport flows are likely to be much higher in these areas of Europe than elsewhere, thus "moving" the bulk of inland freight, geographically, from western to a central, and south, southeasterly direction.

At the same time, a shift is likely to occur in the logistics chain that brings today most of the raw materials and containers, that support industrial production and consumption, through the large ports of Western Europe (Antwerp, Rotterdam, Hamburg, Havre). More and more of these materials in the future may well reach their final destinations via the Southern-South Eastern ports such as Gioia Tauro, Taranto, Piraeus, Thessaloniki, or the main ports of the Black Sea. This

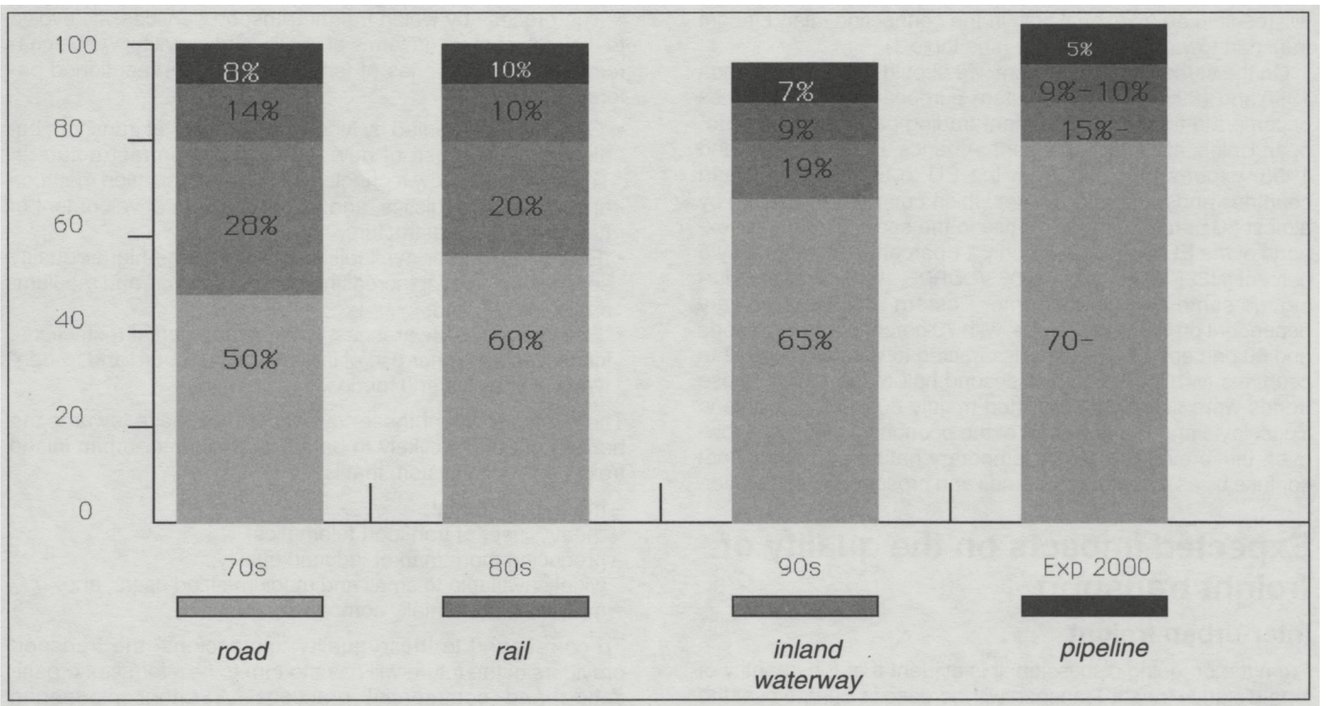

Fig. 2: Relative shares by mode of freight transport in the European Union.

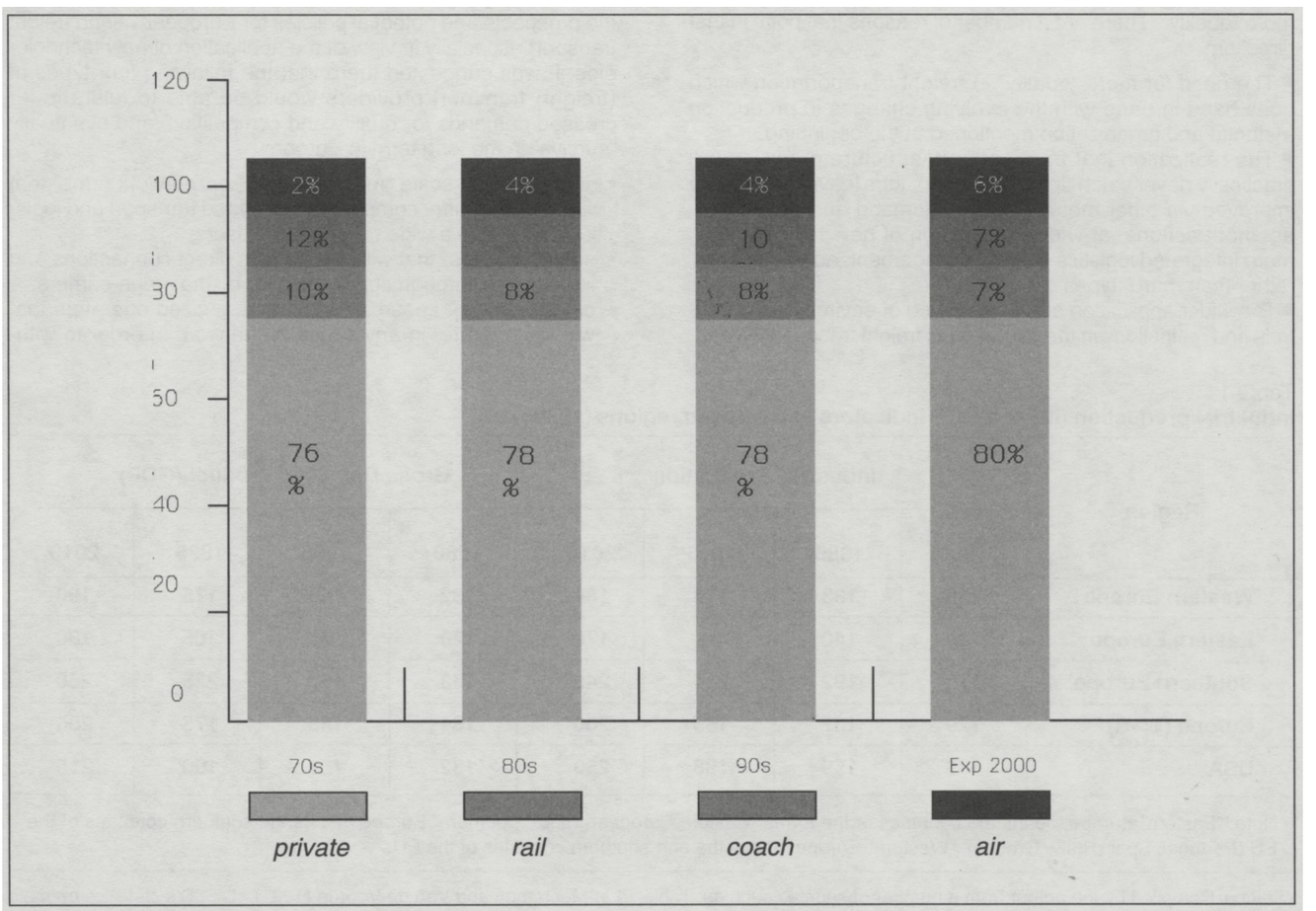

Fig. 3: Relative shares by mode of passenger transport in the European Union.

will result in an additional shift in the connecting inland freight transport towards these areas (see table 1).

On the same line of argument, we should note that between 1990 and 1996 the former Eastern European Bloc of countries became the third most important trading partner of the European Union, after Asia and North America. Between 1991 and 1995, exports of goods from the EU to Eastern European countries and the former Soviet Union countries increased by almost 50 percent in value, while in the same period total exports of the EU increased by only 11 percent and imports by 5 percent (MEERSMAN and VAN DE VOORDE, 1997). Similarly, during the same period, the former Eastern Bloc became very dependent on Western Europe, with 70 percent of all its imports and 60 percent of all its exports directed to Western European countries (WTO, 1995). In the second half of the 1990s, these trends were somewhat distorted mainly due to the events in Yugoslavia and the downturn of the economy in Russia. However, these events are of a temporary nature and should not confuse us as to the overall trends and prospects noted earlier.

Expected impacts on the quality of freight transport

Inter-urban freight

From the on-going discussion, it is evident that the quantity of long-distance freight Transport will increase in Europe over the next two decades, and the bulk of this increase will move geographically towards the developing Southern and Eastern regions of the continent.

As the level of traffic flows goes up, so will the demands for more "quality." There are a number of reasons that point in that direction:

- The need for more "quality" in freight transportation which goes hand-in-hand with the evolving changes in production methods and organization mentioned at the beginning.
- The realization that transport infrastructure provision will practically never catch up with demand, thus leaving a lot to be improved via other means, namely demand and traffic management actions, or wider application of new technologies, more integrated logistics chains management, and other "soft" rather than "hard" types of actions.
- The wider application and observance of environmental controls and restrictions in the operation of freight transport by land.

The process by which freight transport services will evolve to their future state (in terms of quality and quantity) will be characterized by the series of (short-term) cycles mentioned before, i.e.:

- "Growth," represented by increased volumes of transport, but also increased use of new technological infrastructure in Telematics and new technologies, new organization methods and advanced logistics, and to some extent development of new physical infrastructure;
- "Equity," i.e. wider availability and use of the higher quality services by an ever increasing number of small and medium-sized "users"; and,
- "Environmental" awareness, with environmental restrictions, incentives for higher use of intermodal transport, and "green" types of vehicles and modes.

The overall result of these "cycles," as we move towards the horizon of 2020, is likely to be a European inter-urban inland freight transport system that is:

– more multi-modal;
– "heavy" user of transport telematics;
– producing more market-induced quality;
– widely available to small and medium-sized users; and,
– more environmentally compatible.

To correspond to these quality "dimensions" the transport providers of the future will have to turn to new forms of organization and commercial practices. A rather pioneering European research project called EUROFRET (EUROFRET CONSORTIUM, 1993), assigned by the EU Commission's DGXIII (Directorate General for Research) in the framework of the 3rd R&D program at the beginning of the 1990s, examined the prospects and potential policies for European inland freight transport especially in view of the application of new technologies. It was suggested there that the following four types of (freight) transport providers would be able to fulfil the increased demands for quality and competition, and eventually "survive" in the long term in Europe:

- large size and scale "mega-carriers" or "network firms" that will be able to offer competitive integrated transport and logistics services to a wide range of end users;
- "subcontractors" that will survive with direct connections and "life support" through subcontracting by the mega-carriers;
- "co-operatives," i.e. small and medium-sized operators that will "co-operate" in any sense of the word in order to with-

Table 1
Industrial production (IP) and GDP indicators in European regions (1970=100)

Region	Industrial Production				Gross Domestic Product (GDP)			
	1980	1985	1995	2010	1980	1985	1995	2010
Western Europe	126	133	158	180	132	143	175	190
Eastern Europe	130	140	90	170	120	130	105	160
Southern Europe	173	192	215	245	153	167	225	260
Europe (W+S)	129	137	165	200	134	145	175	200
USA	139	159	198	250	132	151	190	215

Note: "Eastern" Europe means the countries of the former Eastern European Bloc. "Southern" Europe means the southern countries of the EU (Portugal, Spain, Italy, Greece), "Western" Europe means the non-southern countries of the EU.

(Source: Compiled by the author from a number of sources such as: Table 11 in Meersman and Van de Voorde (1997), OECD's statistics on main economic indicators (November 1998), and WTO statistics and projections).

stand the competition; and finally,
- "specialists," i.e. firms that specialize in certain types of services that cannot be "mass produced" by the mega-carriers.

Seven years later, the above views still stand valid, having been partially justified by the developments and trends of the past. It is expected that competition in the service provision will be the driving force behind the above developments in the organization of service provision. Since competition and other market factors are likely to press tariffs down, the main thrust for competitive advantage will be given by all four of the above types of operators in the domain of increasing the quality of service provision.

This is likely to happen via two major developments in the freight transport business environment of the coming decades:

- Higher integration of the transport provider into the whole supply Logistics chain. Supply chain management will be the higher order level of management into which Transport will be integrated as one of a series of other supply chain management functions such as order management, inventory control, warehouse control, etc.
- Closer co-operation and "integration" with the customer. This will necessitate more intensive use of information and telecommunications technologies in order to support the large amounts of information flows movement that will be needed between firms and spatially diffused customers. It is clear that with the relocation of service and manufacturing activities in space that is expected in the new and enlarged Europe of the future (as per our previous discussion and assumptions), freight transport firms will need a constant flow of information, both horizontally (i.e. between firms and customers) and vertically (i.e. within the company).

So, the most compelling forms of policy action that would follow from the above would be:

- Support on the development of advanced **international** transport infrastructure and data communications networks, to support the operation of the future freight (as well as other) transport system. The importance of national territorial transport infrastructure systems will gradually dissolve in the future.
- Adoption of competition rules and guidelines, both within one mode and between modes of transport, so as to avoid distortions to competition and monopolistic situations. The foreseen types of operator companies discussed above, that would in any case be compatible with market mechanisms, should be "protected" and "accepted" within the overall transport policy.
- Facilitation of the development of integrated Logistics services that take account of all modes of transport and thus give multimodal transport a fair chance of being selected.
- Greater concern and "promotion" of the interests of the final, end user in freight transport service provision.

Later in this paper we examine in more detail the new applications that are to be expected in the future in the fields of Telematics, and Logistics.

Urban freight transport and distribution

The increase of long distance, intercity, freight movement will be accompanied by an increase in short-distance final product movement, mainly in urban areas. As goods from production sites are moved more frequently and in greater quantities to storage centers, and from there to the final market, more need will arise for short-distance, more accurate and more "just in time" physical movement of freight vehicles. Globalization of markets will strengthen this phenomenon, augmenting the spatial distribution of final products and thus their physical movements in urban areas. As funds and space for more urban transport infrastructure become scarcer, urban freight transport in the Europe of the future will have to rely more and more on three areas of improvement:
- the development of electronic aids to help improve the operation and exploitation of the freight transport and distribution networks:
- urban traffic management systems to help optimize urban traffic flow: and,
- the development of new means and modes of urban freight transport (e.g. new electrical vehicles and pipelines).

- The first of the above areas of improvement corresponds to the **new Telematics and advanced logistics concepts** outlined above for inter-urban transport, since it will form the end parts of the integrated logistics chains mentioned there. As such, our discussion in the previous section, and the presentation of the expected advances in Logistics and Telematics fields that follows, covers also urban freight.

- Technologies for dynamic, on-line **Urban Traffic Management (UTM)** are likely to see widespread application in urban areas across Europe as early as the middle of the next decade. Urban freight transport will benefit from the creation of a whole new "environment" in which the urban traffic system is expected to operate in the future. It will aim to ensure the most efficient and productive use of the available space for the movement of people and goods. This new UTM system will be central to the concept of *Integrated Urban Road Transport Environment (IRTE),* i.e. a series of interlinked and co-operating Telematics systems and data bases that will allow on-line optimization of traffic flows, dynamic information to urban travellers, route choice and guidance options, and other functions.

Application of some sort of *demand management* actions, within UTM, to help reduce the load of private trip making in the congested urban space is also expected by the 2010 year horizon. *Interactive route guidance (IRG)* and *automatic debiting,* which have until now developed separately, will soon see unified application and this will open up new possibilities for efficient integrated demand management that will greatly shape the future of urban freight and distribution. The related issue of *road pricing,* i.e. paying for the use of road space in congested urban areas, is one that will also be of influence on the future shape of urban freight transport. Its principles have been discussed for several years now but agreement on a common attitude is far from being reached. In this author's view, some form of road pricing seems inevitable so that it will be at least partially in operation in Europe by the turn of the next decade (2010). This will be helped by the current development of integrated electronic toll payment systems that are now going through a period of intense technological and regulatory development.

Other aspects of urban freight management such as *Automatic Vehicle Location (AVL)* for Tracking and Tracing, as well as optimization of the distribution process, are examined under the section on Telematics.

- As regards the possibility of **new modes of urban freight transport** one can see two major developments:

• The first has really to do with alternative forms of vehicle propulsion and is not, strictly speaking, a new mode: for example new *electrically driven vehicles* with battery autonomy of more than 150 km. These new forms of propulsion are likely to be in considerable use in European urban areas by the next 8 to 10 years, but their full and widespread use is likely to take place in the second decade and towards 2020. The main incentive for this turn to new, cleaner types of fuels will be environmental concerns and the visible (by then) future depletion of fossil fuels. Current encouraging technological developments in the field of electrical storage (batteries) and alternative fuels are the basis for these assumptions.

• The second expected development is the increased use of *pipelines for* the movement of freight especially in urban areas. Plans already exist and in some cases projects are being implemented to develop underground channels for the movement of freight via pipelines. A well-known example, which is in an advanced stage of materialization, is the pipeline planned to be constructed for movement of freight to and from Schiphol airport in the Netherlands. Projects like this will be more and more politically and economically feasible as the urban areas become more and more congested. Our estimate is that pipelines will form a small but sizable part of the urban freight transport market by the year 2020 and beyond.

Freight "mobility" in rural areas

On the whole, the socio-economic and spatial development of rural regions in Western Europe will be to a diminishing extent based on the economic activities of these areas, and increasingly so on the role of the countryside as a "compensation" area for urbanized society. It will be the provider of "milieux" for housing, leisure and tourism and will be utilized as a reserve of both natural and cultural landscape. Consequently, rural areas will increasingly become destinations of more and more freight transport movements, and will increasingly acquire the needs of urbanized areas as far as the distribution of goods and freight transport services is concerned.

The potential for improving freight transport services to rural areas, in the future, will be posed much more strongly than today. Any improvements there will be materialized alongside with improvements to freight transport services for urban and inter-urban areas.

There are two distinctive differences between rural and other areas, as regards their potential for improving freight transport:

• The quality of rural telecommunications networks is generally far behind that of urban areas or of the networks that connect them (inter-urban). Improvement therefore of the rural telecommunication networks is a necessary precondition for the utilization of the rural areas' potential in development.

• In rural areas, "upgrading" demand is an essential element in the successful implementation of comprehensive freight transport services. In rural areas, the end users are even more "critical" of the operation of the whole system. Thus improving social infrastructure, especially in "education" to help individual end users become more and more acquainted with the modern technologies that are (to be) employed by freight transport, is an important factor.

Considering the wider socio-economic importance of keeping rural areas "alive" and "attractive" for people to live there, away from the big urban areas, the above points take on special importance. Thus, improving the service to these areas by high quality freight transport, alongside with the urban and inter-urban areas, should well be the primary goal of policies to be followed in the next two decades.

Enabling technologies and systems

The most critical "enabling" factors for the development of the freight transport services of the future are:

- first, the new computer and telecommunication technologies (Internet-based or other) and their related applications – referred to by the single name of *"Telematics";*
- second, the group of organizational and management applications that form the new field of *Logistics* and *supply chain or distribution management;* and,
- third, the *convergence* between the technologies and systems in telecommunications, information technology, the Internet and consumer electronics.

Freight Transport Telematics applications

Over the last 10 years we have witnessed a "revolution" that is still unfolding. It concerns the application, in the various forms of transport activity, of the new telecommunications technologies and computing known as Transport *Telematics.* Prominent among these technologies are the Internet, and the satellite or cellular telecommunications (GSM) based methods of transmitting data, as well as other technologies like smart cards, electronic payment systems, Tracking and Tracing, and so on. There is an on-going "revolution" at the moment as far as use of these technologies and systems is concerned that will change the form and content of freight transport within the coming two decades. In the following, we refer to these new systems in a structured way so that we obtain a common point of reference.

● **Systems and technologies:** The various Transport Telematics technologies and systems that affect freight transport operation can be presented in terms of the three main areas of their application, i.e. *systems for*
- *the vehicles* (on board the vehicle),
- *the network and infrastructure,* and
- *the office* (management of operations).

This distinction is primarily used for the purposes of presentation and discussion in this paper. Obviously all systems interact and co-operate to produce integrated applications. Also the distinction between applications for freight or for other types of transport is not always clear or meaningful and there are a lot of systems, especially the infrastructure used, that are in common.

❍ ***Systems for the vehicle:*** These are principally based on board the vehicle and monitor the condition of the driver (also assisting him in his driving), of the vehicle, and of the freight. There are numerous technologies and systems that support the availability and use of distributed intelligence on board the vehicle. They can be distinguished into systems for:

- monitoring the functioning of the vehicle itself or its equipment (i.e. monitoring of vital functions such as brakes, tyre pressure, steering, etc), as well as remote diagnostics and maintenance;
- the "intelligent" load (i.e. monitoring temperature, pressure, disturbances from bumpy road or driving, etc);
- aiding the driver in his(her) driving tasks; here are systems that range from relatively simple driver aids such as emergency warning, navigation and traffic information provision, and vision enhancement, to more comprehensive and far-reaching ones such as automated vehicle guidance, cruising, intersection negotiation, lane change, lane keeping, stop & go functions, etc.; finally,
- automatic electronic coupling of freight vehicles (especially for railways).

These will operate under the various high frequency communication high speed image processing technologies, and their interconnection with available open wide area networks of communication. These technologies connect the vehicle with a control center, at company headquarters.

❍ ***Systems for intelligent network infrastructure and management:*** In this area, there are various applications that deal with the provision and functioning of intelligent transport infrastructure and its management. They generally concern all types of traffic, but there are some exclusively for freight (e.g. weight in motion). Let us see in more detail the principal individual systems, most relevant to freight transport.

Intelligent, integrated urban (and inter-urban) traffic man-

agement systems have been mentioned before. Considerable work is still to be carried out to test in practice the new systems and for setting pan-European standards for integrated traffic management especially for inter-urban traffic. The possibility of using systems such as *Interactive Route Guidance (IRG), User Fee-Financed Infrastructure (UFFI),* as well as other services within an intelligent traffic management environment will open the door to a series of major applications. Agreement on standards for the USC (Unified short-range channel link) that will enable such advances has been in the past perhaps the most difficult task. As there are already systems available, a unification will come eventually, but it may be for the next generation of systems, i.e. in the 2010 horizon.

Of direct relation to the intelligent traffic management systems (or perhaps an eventual part of them) will be the potential application of ***systems to improve environmental performance*** at specific, sensitive, parts of the European road network. Such systems are of direct relevance to freight transport operation. In an *environmentally-led automated access control,* or "gating" system, specific actions and measures can be activated at pollution alert thresholds. In the ultimate stage of its development such an environmentally oriented system of traffic management and control will be precisely measuring the emissions and noise for all means of (road) transport and will provide reliable data for environmental condition monitoring and public air quality information. This will mean that weather conditions monitoring, coupled with a GIS-based forecasting of atmospheric pollution levels (perhaps linked with the monitoring of environmental vehicle parameters by on-board systems), will provide the basis of the fully *integrated environmental and traffic management* systems of the future. Such systems are likely to materialize beyond 2010 towards the 2020 horizon.

The establishment of a comprehensive and global ***system for positioning, communication, and guidance/navigation*** of vehicles will be another very important development that will influence a series of major advances in freight transport and distribution. These advances include universal and affordable systems of positioning and guidance that can be used by all types of transport vehicles and provide alternatives for a free and competitive market-oriented system operation. The ***Global Navigation Satellite System (GNSS 1 & 2)*** is one such example that is under development. The 2010 time horizon seems a reasonable time horizon for the full implementation of such systems.

On the contrary, ***Real time, interactive travel and traffic information*** **services,** to help drivers (and passengers) make the best choices concerning their travel, are expected to be in widespread use within the next five years. The communications networks, together with the equipment needed for user interaction, will develop in the near future along an independent path, derived from existing technologies such as ISDN, wireless GSM, and similar. End-user facilities for trip planning can be provided without difficulty by a series of different service providers. Widespread realization of such services is foreseen before 2010. What is needed is choice of a communication medium that is widely available, and standards as well as a reliable and well-established network of databases. As regards the communication medium and standards, the selection of the Groupe Spéciale Mobile *(GSM)* system for pan-European application has not so far acted as a catalyst, as originally expected. However, once the basic communication needs covered by GSM are fully met, improvements to the GSM technology and infrastructure are expected to open the way for comprehensive traveller information systems. Market forces are already strong enough to generate products with attractive cost/benefit characteristics in this domain. For freight transport, additional effort is needed to make the best use of the options available in the GSM specification for data transfer and manipulation.

For driver assistance and co-operative driving systems and their major functions of:

– *Intelligent Cruise Control (ICC),*
– *Co-operative Detection and Ranging (CODAR), and*
– *Interactive Route Guidance (IRG),*

the following can be observed:

• *Intelligent Cruise Control* offers such great improvements in safety, efficiency, environment and comfort in driving that already many of the automobile companies or their suppliers are engaged in developing it for commercial use. For Commercial Vehicle Operations, its major field of application will be on inter-urban travel. The early implementation of *ICC* will require choice of the method and technology for detection and range-finding. The "co-operative" nature of today's feasible solutions leads to the conclusion that an early agreement, on a European scale, between all the interested actors is less feasible in the near to medium-term future.

• On the other hand, *Interactive Route Guidance (IRG)* can be envisaged in the near future especially for dense and congested urban road networks.

• As regards *Co-operative Detection and Ranging (CODAR),* a common European approach to a suitable implementation path is still to be established. Arrangements at European level for a common frequency band (e.g. the 80 GHz) may take several years, making it likely to happen by the year 2010 horizon with wider commercial applications well after it.

Finally, integrated end-to-end applications of new technologies and systems such as the above are on the drawing board or in advanced stages of planning and pilot implementation in Europe or the USA. Examples of such applications are given in the section "European end-to-end applications."

❍ ***Systems for the Office:*** These systems include the so-called office "front-end" telematics applications. They are applications that deal with the "soft" side of the business. They aim at sorting out tasks such as freight handling and management, connection with the various telematics applications outside the office, connections to clients' systems and applications, integration with the so-called "back office" applications (internal organizational and managerial tasks), etc.

There is a variety of such systems currently in full development that are at present gaining acceptance and commercial success. The most important among them are the following:

• EDI applications to interconnect the office with the clients and end users (shippers) for freight order processing and monitoring as well as other tasks;
• Enterprise Resource Planning (ERP) software for financial-economic planning tasks;
• Internet applications for on-line load status information to the clients, and other customer interactive applications;
• Freight Resource Management applications, i.e. decision support systems that help intermodal transport operators to allocate freight to different transport modes under constraints of time, capacity, and cost;
• Systems that connect the central office with the monitoring of the position and status of vehicles and loads, and inform the clients (mobile EDI or Internet-based applications);
• Various applications for (pre)clearance with authorities at customs, border crossings, ports, and other similar points;
• Applications for finding and booking of freight capacity, such as (electronic) "Freight Stock Market," or communicating with other modes of transport for booking space (e.g. ferries); and,
• Special applications for hazardous goods management, e.g. handling, clearance with authorities, monitoring, etc.

Most of these systems are still in the development stage and are applied only in pilot applications. However, some applications, such as EDI for freight handling and interaction with clients, are now reaching their "critical mass" that will allow them to operate under full market conditions (stage 4 in the diagram of figure 4). Others, such as the various Freight Resource Management tools, are still in an experimental and pilot stage.

It is generally thought that the various "freight office" applications will develop fully within the first five years of the new decade maturing fully by 2010. The speed that characterizes the development and market acceptance of certain technologies such as the Internet (see next section) will also characterize the development and market acceptance of their related "soft" systems for the "front office."

● **European end-to-end applications:** By end-to-end applications are usually meant complete systems that incorporate a number of technologies, and offer end users, at both ends, a full and reliable service. Such applications are only now beginning to be discussed, planned, or under prototype or pilot implementation. It will take perhaps the best part of the first decade before we see any actual commercial implementations, but these applications are certainly along the lines of the integrated systems that we will see more and more in the future and that will characterize the 2020s.

Let us see in more detail two examples of European end-to-end applications.

● ***European International Commercial Vehicle Administration and Monitoring System*** (indicative name suggested by the author). This application envisions an integrated system that will achieve a seamless movement of freight vehicles in Europe through monitoring, management, controlling, and disseminating information about international road freight on the national and international road network. The functions impeded in such a system would comprise:

• *Public administration functions:*
- vehicle registration data
- driver registration data
- other vehicles and drivers information (e.g. driving penalties, point system, etc.)
- commercial vehicle safety data (for dangerous goods)
- fees and taxation data (e.g. in connection with transit fees where applicable, road pricing, etc.)
- border crossing information (where applicable).

• *Roadside function:*
- roadside weigh-in-motion
- citation and accident electronic recording
- roadside or border crossing electronic screening for vehicle and goods identification and other data exchange
- safety inspections as regards mechanical functions of vehicles.

• *In-Vehicle systems:*
- on-board cargo monitoring
- on-board vehicle mechanical functions monitoring
- cargo and vehicle identification data
- trip monitoring system (mobile EDI, Tracking and Tracing).

• *Company headquarters functions:*
- freight administration and management
- fleet management
- hazardous goods management
- vehicle maintenance management
- fleet taxation and credentials records.

Between the above four subsystems there will be telecommunication and data transfer links based on various appropriate technologies such as EDI and/or wireless or dedicated short range communications (DSRC). For example, between:

• Public Administration – Roadside systems: wireless or wire connection and EDI
• Roadside – In Vehicle: DSRC, or wireless
• Public Administration – Company: EDI
• Company- In Vehicle: Wireless (mobile EDI), DSRC.

Application of such a system on a European-wide scale is perfectly within the possibilities of current technology, and mainly needs political initiatives and acceptance. It would enable the seamless, non-stop movement of commercial vehicles on the European road network, with minimum (or zero) delays at border crossings or other control points. At the same time all data concerning the cargo, the vehicle, and the trip would be available to the administration, the company, and the end user. A system like this could be in application in the countries of the EU by 2005 at the earliest but given the fact that no initiative exists so far and the necessary political agreements between the member countries take time, a more likely date would be 2010. For the rest of the countries of Europe to join, it would take a few more years, probably by 2015.

On the contrary, in the USA a system that comprises almost all of the above elements is already being tested on a pilot basis. It is the Commercial Vehicle Information Systems and Networks (CVISN) program of the US DoT and the Federal Highway Administration. A number of research institutes and consulting companies provide the architectural and technical input to the program. More than 30 states are participating in the prototype and pilot application of CVISN, and many motor carrier companies. Full deployment is foreseen for 2005.

● ***Multimodal Mobility Centers.*** The idea here is to provide comprehensive information and services for multimodal transportation chains, i.e. the combined use of more than one mode for providing attractive and competitive end-to-end transport services to users.

The first stage of development would comprise the creation of telematics-based *"modal mobility centers,"* i.e. for each mode of transport. These would interconnect various sources of information concerning the particular mode, in order to provide "one stop" information to users. The types of information that would be available would include: schedule and tariff information, traffic management conditions and information, capacity availability, freight search functions (freight exchange), other travel information. These modal mobility centers would be based on ports, airports, highways, railway terminals, etc. and would be linked via the Internet to offices and information provision centers, or via mobile EDI to the vehicles themselves.

At a second stage, the modal mobility centers will be interlinked to support the interoperability of the various modes and to create the future *integrated multimodal mobility centers.* The promotion of intermodality and the Logistics applications mentioned in later sections will be greatly helped by these developments whose time scale, however, must be realistically put in the period 2005 to 2010.

● **The timing and process of innovation application:** The time scale for a wider, commercial application of these new technologies and systems will depend on a number of obstacles that have to be overcome. Already some estimates based on the author's experience and judgement have been given. The deciding factor for market acceptance will primarily be the user's perception of costs and benefits, or more precisely "value for money" for the particular technology or its various applications into systems.

For the past decade, the attitude of users was characterized by considerable distrust and hesitation towards investing in new technologies and systems. For the great majority of freight

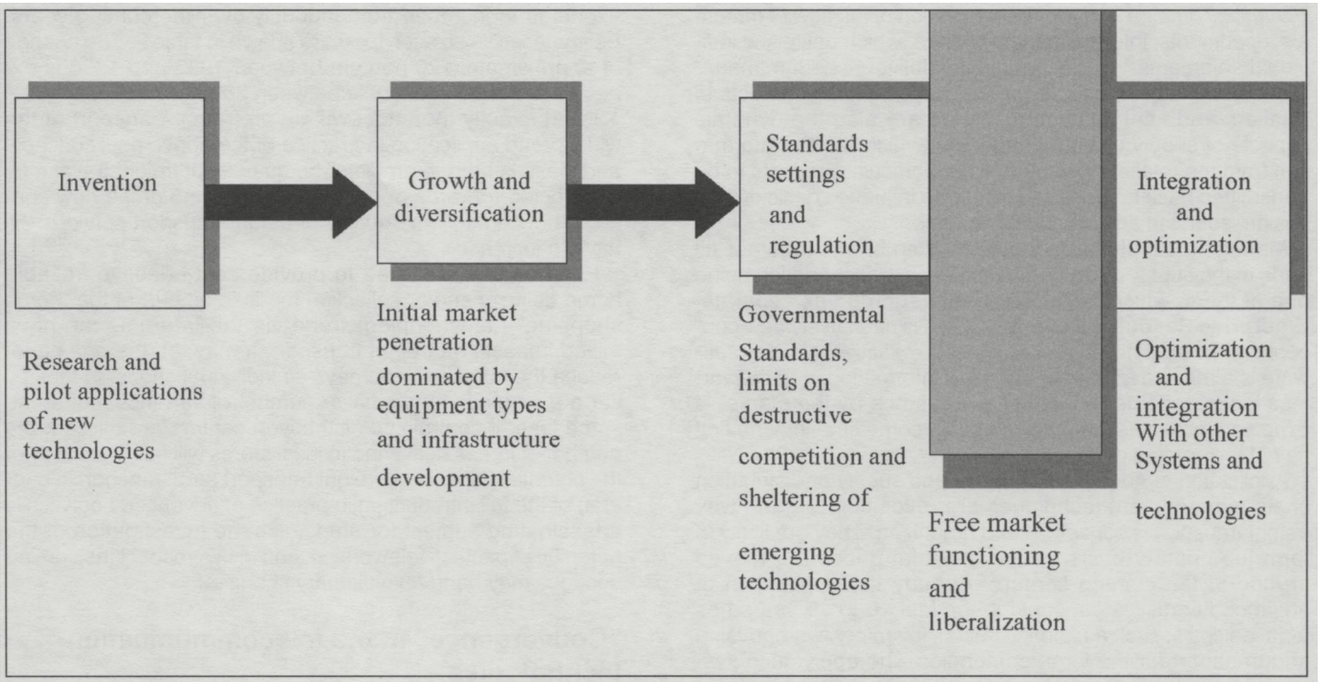

Fig. 4: The process for the development and market penetration of new technologies and systems (adapted from ENO, 1998).

transport operators, the attitude has so far been to look at these new systems as little more than fancy gadgets for scientists to play with, and not for the "real world." This attitude is rapidly changing, and it is certain that once a "critical mass" of users chooses to install and use one system then its wider application is substantially enhanced.

The process through which a novel system or technology catches on and becomes a marketable product is depicted in figure 4.

At the beginning there is (pre-competitive) research and development characteristically mentioned as "Invention" in figure 4. This is typically supported by government or private (industry) sponsored research. The EU's Advanced Transport Telematics (ATT) programme in the 4th and 5th FP is a typical example. This phase is followed by a stage of initial commercial growth and diversification in which market systems are developed and promoted in commercial applications. Concurrently with this phase but as a distinct process, and as a "critical mass" of users is achieved, the setting of rules and regulations for the orderly function of the market takes place. Then as the number of users increases, full market functioning and "liberalization" is achieved.

The final stage is the full optimization and integration of systems and services to achieve highest user satisfaction and acceptance. The whole cycle, from "invention" to full market integration and optimization, may take anything from 5 to 20 years or more, depending on the type of technology, its cost, market appeal, and other factors.

It is perhaps realistic to say that the coming two decades will be the time when most of the various Transport Telematics systems will mature and achieve wider market acceptance and integration till the right end of figure 4. As a general observation one can note that applications at the office, i.e. the ones that have to do with the management of the (freight transport) functions, will be the ones to proceed faster achieving integrated commercial applications within the first half of the decade.

The same can be said about the applications that are based primarily on Telecommunications and the Internet (e.g. Tracking and Tracing, booking, EDI – mobile or not, etc.). Others, that require more substantial (intelligent) infrastructure development, such as automatic vehicle guidance, cruising, intersection negotiation, etc., will take longer periods to mature, perhaps further than 2020.

One last observation regarding timing estimates. In the decade of the 1990s we have witnessed implementations and market penetrations of new technologies and systems at tremendous speeds. In a recent *Financial Times* survey *(Financial Times,* 1998), A. Waller of the Cranfield Centre for Logistics was quoted as saying that "Technology is driving change 20 times faster than 100 years ago." It took the telephone 35 years to reach 100 million subscribers but it took the Internet only 2 years to reach the same number. Similar speeds were experienced by the earlier technological novelties of the Fax (in the second half of the 1980s), or the e-mail of the early 1990s.

So if anything, the time scales mentioned in this and the previous section as possible implementation dates and horizons could materialize earlier if the reaction of the market to products based on the new technologies is similar to the one experienced so far.

The outlook in Logistics – Supply and distribution chain management

Of equal importance and significance as the new telematics applications for the future shape of freight transport in Europe will be the advance of Logistics as the ultimate "tool" for managing the whole supply or distribution chain. Freight transport will eventually be fully integrated into this "chain" management concept, and its control and management functions will be greatly influenced by the whole "science" of Logistics.

Supply chain management was defined in a recent overview by investment bankers Morgan Stanley Dean Witter

(Financial Times, 1998) as "the integration of the flow of materials, documents, information and finance, which optimises individual shipments." Correspondingly, delivery chain management is a similar procedure but for delivering final products to retailers and final customers. There are also the dynamic aspects of supply chain management which require information from the retailer on daily sales of particular products to be transmitted back to the manufacturer to influence decisions on design, sourcing and production volumes.

Managing supply or distribution chain brings together all parts of the supply or distribution process, transportation being one of them, which were previously regarded as separate. **Enterprise Resource Planning** (ERP) is a relatively new concept that was defined in order to help do exactly that. ERP software is already available to pull such information, and the various tasks, together but its full acceptance by the market is expected to take its time until maturity, some time into the first half of the coming decade.

Application of advanced Logistics and supply or distribution chain management techniques are revolutionizing the way freight transport is conceived and organized. They are likely to form the primary basis for the way that goods are moved around in the coming century. Already the application of advanced Logistics concepts in the last 10 to 15 years has reduced costs, such as administration, inventory, warehousing and transport for the large companies who apply such systems, to 7.5 percent of revenues in 1998, from 14.3 percent in 1987. Something of the order of 6 percent would be the absolute minimum to be expected by 2005. Also cycle time reductions were down from 27 days in 1987 to 12 days in 1998, and these are also levelling out with only three more days expected to be taken out of delivery lead times by 2003 *(Financial Times,* 1998).

New concepts are being developed which are expected to be the new "catchwords" of Logistics in the coming decade and consequently have an important impact on freight transport and the way it is executed and organized. For example:

- "Agility" and "leanness" are the concepts that will characterize the next stage in supply chain logistics;
- Customized packaging, labelling and pricing, and increasing exchanges of personnel with customers is also a novel idea expected to catch on in the first decade of the new century;
- On the technology front, increased use of barcodes or electronic tags (if they become, as expected, cheap enough) to track products through the system and increased sales through the Internet are to be expected;
- "Postponement" is a key concept with products customized at the end of the delivery chain for particular markets and individual customers to minimize the need for stock-holding. The boundaries of manufacturing and distribution are becoming blurred. Delaying the finishing process reduces inventory.
- The need to tailor products for the individual customer is spreading from high value fields, such as cars, to more mundane, lower value articles. This process, known as *"mass customization,"* puts further pressure on the supply chain. Mass customization attempts to deliver a tailored product for the same price as a mass produced one.
- Home shopping, primarily via the Internet, is being introduced gradually and is expected to become a major form of shopping by the year 2010 and beyond.

The implications of these developments that will penetrate the market gradually over the greater part of the 2010s, maturing towards 2015, are far-reaching not only for the way we view today's freight transport, but also for the manufacturers and retailers as well as for the third party logistics suppliers themselves.

The global market for Logistics and related services is expected to increase tremendously over the coming years. Estimates of its size for 1996 are shown in table 2. The change of approximately 20 percent between 1992 and 1996 is expected to more than double between 2000 and 2005.

What exactly the effect will be on freight transport of the widespread application in practice of the above new concepts and ideas is hard to predict. The quantity of freight travel may be affected upwards or downwards by some of the new concepts but certainly the quality of freight transport services will have to increase.

For example the need to provide cost-effective, reliable home delivery and/or collection facilities as part of the "home shopping" (teleshopping) trend via the Internet, can have mixed impacts on freight transport. It may, on the one hand, reduce the number of journeys as individual shopping trips by car are replaced by a smaller number of van trips, but at the same time, if centralized distribution centers are utilized, the number of lorries delivering to local stores will fall. The study of the potential impacts on freight transport (and transport in general) of the full introduction in practice of advanced Logistics is a fascinating subject for study, like the investigation of the potential impacts of teleworking, and in this respect the coming decades may bring revolutionary changes.

"Convergence" in the telecommunication technologies

Perhaps the most powerful enabling technology, for freight transport, is becoming the Internet and its related telecommunications technologies. In just over two years Internet-based applications for freight transport have moved from 1st generation applications of simple presentations of the transport providing companies and their services to the 2nd and 3rd generation of dynamic, interactive applications in which the end user can plan, book, and follow the progress of his (her) transport. These applications are penetrating a surprisingly large number of users very fast (in fact as fast as the Internet penetrates the market). They can be seen to become widespread within the next three years or so.

Here too, the trend is towards the integration and interoperability of the various telecommunications technologies that are promoted now all over Europe. The term that has come to encompass this trend in the telecommunication technologies is **Convergence.** This is defined as the union of telecommunications, information technology, the Internet and consumer electronics. Its influence will be manifested by an entirely new generation of products and services generated from the cross-pollination of these disparate industries. If the speed by which the Internet sized up the business world is an indication, *Convergence* is expected to take root and generate a whole number of new applications no later than the middle of the new decade. This development will facilitate the materialization of the freight transport systems and services that were anticipated earlier and which are in close relation to users' needs.

When we think of *Convergence,* we should think of the convergence of today's personal computer and the Internet to the point that the Internet will be "the computer." In the not-too-distant future, the information stored on each of the individual computers will instead reside on the Internet. Thus, the Internet becomes a storage medium for both data and applications as well as a communications medium, distributing virtually unlimited computing power to anyone, with low-cost, high-performance Internet access devices. Two or three years from now, the new technological breakthroughs of *Convergence* will be possible because the pipes used to transmit digital information are already evolving into "broadband."

The impacts of these developments on the way that freight transport will operate in the coming decade will be very sub-

Table 2
The global market for Logistics

Geographic Area	GDP ($m)	Logistics ($m)	Logistics GDP%
North America			
Canada	585,105	70,191	12.00
Mexico	334,726	49,753	14.86
US	7,576,100	795,265	10.50
Sub-total	8,495,931	915,209	10.77
Europe			
Belgium/Luxembourg	286,383	32,573	11.37
Denmark	174,237	22,440	12.86
France	1,537,582	171,230	11.14
Germany	2,352,472	306,264	13.02
Greece	122,870	15,269	12.43
Ireland	67,392	9,611	14.26
Netherlands	392,550	44,495	11.33
Portugal	101,182	12,871	12.72
Spain.	581,565	67,022	11.52
UK	1,151,348	122,344	10.63
Sub-total	7,961,853	941,141	11.79
Asia/Pacific			
Hong Kong	153,068	20,332	13.71
Japan	4,599,706	522,982	11.37
Korea	484,777	59,764	12.33
Singapore	94,063	13,074	13.90
Taiwan	273,440	35,686	13.05
Sub-total	5,605,054	652,498	11.64
Remaining other countries	7,080,122	916,168	12.94
1996 global size	29,162,960	3,425,021	11.74
Estimated 1992 global size	23,743,432	2,894,092	12.19
% change 1992-1996 ($m)	23	18	3.6

(*Source: Financial Times* survey on supply chain Logistics, 1998).

stantial. Applications such as full electronic transfer of documents, on-line connection to the various government agencies for customs and border crossing clearance and other services, on-line tracing of the goods by the customer, booking services, electronic "freight exchange," intelligent freight planners, etc., will become possible at a mass scale reaching inexpensively even the small and medium-sized users.

Key horizontal and policy issues

Policies to facilitate innovation and to resolve some of the contradictions and sustainability questions that arise in the evolution from the "Invention" to the "Integration-Optimization" phase of figure 4 will always be necessary. In this technology-led (r)evolution of a market-driven freight transport operation in Europe, national and international governmental policies should focus primarily on a number of horizontal issues that will form the necessary guiding paths of development, and will make sure that the interests of the final users are secured. These are presented in the following.

The continuous push for integration

As we have already indicated, technology trends are such that within the first decade of the new century, advanced information systems will expand from networks within individual companies to open networks, and the quality of the information processed in such a network will improve tremendously. It is also expected that such systems will expand from within a particular industry to large community systems and to international information systems. Many companies have already created worldwide information networks that facilitate the flow of information necessary to control the new logistics applications. There is an obvious need, therefore, to push for truly integrated freight transport services that will take advantage of the tremendous possibilities offered by *Convergence* and the new information transfer networks.

Integration has to take place at the geographical, the technological, and the modal level.

- At a geographical level, we refer primarily to services that are truly international.
- Technological integration calls for all standard problems to be overcome, both in the telecommunications and transport arenas, in order for genuinely border-less infrastructures to be developed.
- At the modal level, integration of modes means truly multimodal systems, i.e. offering the user the optimal combination of modes according to commonly accepted socio-economic criteria.

The continuous push for more integrated systems and services that will benefit the end user (shipper) should therefore continue to be a very important policy objective to pursue in the short to medium term future until the market itself makes the provision of such systems self-supporting and evident. It can even be said that the strength and success of the development of transport and related telecommunications infrastructure in Europe in the future will be related to the degree of implementation of the above three levels of integration *in both* the transportation and telecommunication systems.

The continuous push for pan-European and world standards

Many of the developments in telecommunications and information technology and their applications in freight transport and logistics will emerge in different ways, at different times and at different speeds. Trying to control these developments in a top-down approach will cause inflexibility and inefficiency and it is not advisable. However, the proliferation of all kinds of systems may also be harmful, and some kind of assistance in the required standardization, or help in achieving horizontal and vertical co-operation among the various systems and technologies, is valuable. This is an important policy task for governmental organizations.

The need for continuous monitoring and some control

All over the world, deregulation and privatization are emerging as the current basis for policy formulation in almost all aspects of economic activity including of course freight transport. It is assumed that these basic economic policies will create possibilities for increased efficiency through competition amongst companies and countries. There is no doubt of the necessity for continuation of these policies and trends. Indeed, it is only within a competitive and carefully deregulated environment that all the changes anticipated in this paper can take place. There is an important need however for policy makers and governments to organize basic monitoring mechanisms to ensure that safety and environmental protection rules are followed and that monopolistic tendencies will not occur, while the true interests of the end users are met. Thus governments should organize permanent market observation mechanisms in order to systematically gather statistics and monitor what is happening in order to take appropriate action if necessary.

Solving the institutional and legal issues

From the preceding analysis it becomes clear that the new technology-driven systems and infrastructure cannot simply develop from the modernization of existing physical infrastructure through repair, replacement and optimization of existing systems. They will also require the technological modernization of entire systems, including their institutional and social components. Even if we therefore assume that the technical and infrastructure aspects will primarily be materialized as a result of market forces initiatives, or their co-operation with public bodies, governments should primarily address the institutional and legal aspects.

Examples of such institutional and legal aspects are questions of liability and authentication in EDI, questions of securing privacy and accuracy in electronic booking and payment systems, protecting the commercial interests of companies dealing through the Internet as regards access to confidential information, various fair competition issues, the issues related to the internalization of the external costs, etc. These issues are not of course static and therefore governments should establish permanent procedures to address them and take appropriate action.

Considering the social and behavioral issues

Freight transport is part of society's overall "mobility package." As such, there are serious questions about the future operation of the freight system that relate to social justice, equity, and public acceptance. These questions, or rather their disregard, are usually part and parcel of processes that result in uneven development and consolidation of asymmetrical power relationships between the various regions or geographical areas.

Raising questions of social justice and exclusion may perhaps, at this current phase of policy framework in Europe, be considered to belong to an outmoded frame of mind. However, absence of these considerations cannot remove the problems of those who are caught in the doldrums of persistent deprivation and perpetual restructuring, and will not prevent these questions from being restated more strongly in the future. As we therefore look forward to technological breakthroughs that will radically change the way freight transport is performed in the coming 21st century, we should not stop including the social aspects and impacts in our debate and praxis of future mobility systems (freight or other).

Consideration of the externalities

This item is well known and follows most transport policy considerations. In order to achieve optimal usage of scarce resources, all of the costs that society has to pay for (e.g. for the adverse environmental effects), in order to facilitate transport activities, have to be taken into account, and ideally be paid for by the users of these facilities. Freight transport is no exception. On the contrary, it has been in the past at the center of debates concerning compensation for external costs, primarily those caused to the environment.

In the coming decade, or just beyond, the same technological breakthroughs that will make the foretold "revolution" in freight transport operation possible will also make it possible to measure and account for these external effects. The issue will then be primarily a political one. Of course, the internalization of external costs – also relevant in areas other than transportation and communications – could lead to significant changes in decision making, and therefore will continue to be of the utmost importance in the future.

Conclusions

As we enter the first decade of the 21st century, and look towards 2020, freight transport in Europe stands at a crossroads of technological development opportunities that will radically change its face, but also of yet unresolved institutional and other policy issues that will determine the range and extent of these changes. As the remaining few restrictions are removed and the liberalization of freight transport in the European Union countries becomes complete (soon after 2000), freight transport operation at European level will seem to be proceeding at two speeds:

- one, characterized by high organizational efficiency and free from administrative and other restrictions, led by technological solutions that are now already at various stages of development; and,
- one in the remaining countries of Europe, mainly in the East, continuing to enforce restrictions, and lagging behind in technological efficiency.

As the EU is enlarged, these disparities will tend to disappear.

The first realization, concerning future European freight

transport, is that its volume is likely to further increase, both overall and within certain modes. By some forecasts cross-border traffic is expected to grow by 2-3 percent per year while by 2010 some 20 percent more trucks are expected on the EU roads. It is an open issue whether the current predominance of road transport will continue to exist in the coming decades. This issue is likely to remain open until credible alternatives are presented to the users either in the form of rail or multi-modal transport. At the same time, a shift of the freight transport volumes can be foreseen from Western European corridors to Eastern and South-Eastern ones as development moves at higher rates in these parts of Europe.

As regards the quality of freight transport services, the overall result of a series of expected "cycles" in the focus and priorities of future developments will be a European inter-urban inland freight transport system with more market-induced quality, and which is:

- more multi-modal;
- a "heavy" user of transport telematics;
- widely available to small and medium-sized users; and,
- more environmentally compatible.

Consequently the structure of the freight transport market as regards the types of companies offering services is expected to be defined by:

- large size and scale "mega-carriers" or "network firms" that will be able to offer competitive integrated transport and logistics services to a wide range of end users;
- "subcontractors" that will survive with direct connections and "life support" through subcontracting by the mega-carriers;
- "co-operatives," i.e. small and medium-sized operators that will "co-operate" in any sense of the word in order to withstand the competition; and finally,
- "specialists," i.e. firms that specialize in certain types of services that cannot be "mass produced" by the mega-carriers.

The **inter-urban freight** transport business environment of the coming decades will be characterized by:

- Higher integration of the transport provider into the whole supply Logistics chain. Supply chain management will be the higher order level of management into which Transport will be integrated as one of a series of other supply chain management functions.
- Closer co-operation and "integration" with the customer. This will be achieved through more intensive use of information and telecommunications technologies in order to support the large amounts of information flows and data that will be needed between firms and spatially diffused customers.

Urban freight transport will be dominated by developments in

- Urban Traffic Management systems, and
- New fuels or modes of urban freight transport.

The first will be the result of the combined implementation and operation of a whole new series of technologies and systems of urban telematics that will form the Integrated Urban Telematics Environment of the future. The second will result from the advent and wide use of new fuels and electrical vehicles, as well as of underground pipelines for the transport of urban freight.

At the same time, **rural areas** will increasingly become destinations of more and more freight transport movements, and will acquire more and more the needs of urbanized areas as far as the distribution of goods and freight transport services is concerned. The need for improving freight transport services in rural areas in the future will be posed much more strongly than today. Any improvements there will be materialized alongside with improvements to freight transport services for urban and inter-urban areas.

The "enabling" factors for the expected changes in the future freight transport services will be three main developments:

- the full application of the new *Transport Telematics* technologies and systems;
- advances in *Logistics and supply chain management* techniques; and,
- possibilities that will emerge from *Convergence,* i.e. the union of telecommunications, information technology, the Internet and consumer electronics that will give limitless new telecommunications and computing capabilities.

The presentation and discussion of all three of these factors in the previous sections of this paper, and of the most prominent of the new systems and applications, revealed a number of possible implications for European freight transport for the coming two decades. It also indicated a possible timing for their full market implementation

According to this analysis, the period between 2005 and 2010 is likely to be the period that will mark the changeover from the current period of prototyping and pilot application for most of the various new systems to their full market operation and wide user acceptance. Then the years beyond 2010, towards 2020, will see the further optimization and integration of systems and services and the full implementation of complete end-to-end systems covering geographically the whole of Europe.

The time scales indicated above are not so much the result of the anticipated speed of implementation of the new technologies and systems (which are likely to mature at very high speeds anyway) but also of the time needed for administrative and legal issues that will have to be resolved. In this respect and even with the assumptions that were made at the beginning of this paper (about the enlargement of the EU, the strengthening of the European Institutions, the establishment of peace, etc.), Europe has an added difficulty as compared to the USA. It is the diversity of national interests and policies that are followed by the various countries, as opposed to the independence but much more uniform approach and policies followed by the states of the USA. Therefore it is perhaps of equal importance, with the advent of the new technological possibilities, to take into account the crucial horizontal and other policy issues that will go hand in hand with any new developments.

A number of these issues were addressed:

- Horizontal and vertical integration of systems and applications. Two characteristic examples were given of such integration in the previous sections. One was the establishment of a *European International Commercial Vehicle Administration and Monitoring System* that would enable seamless movement of freight vehicles in Europe while all monitoring, management, controlling, and information dissemination functions would be made electronically. The other was the establishment of *Intermodal Mobility Centers* that would provide users and operators alike with on-line information and data about freight (or passenger) travel by all modes.
- Establishment of new European and international standards to cover the functioning of the new systems.
- Establishment of mechanisms for continuous monitoring of the function of the market and if necessary controlling it, in order to safeguard the interests of the end user.
- Solving some outstanding institutional and legal issues that stand in the way of a wider market implementation of new technological systems. Examples of such issues are questions of liability and authentication in EDI, questions of securing privacy and accuracy in electronic booking and payment systems, protecting the commercial interests of companies dealing through the Internet as regards access to confidential information, various fair competition issues, the issues related to

the internalization of the external costs, etc.
• Making sure that the implications to society and social justice are addressed and dealt with. And finally,
• Finding ways to bring into the picture the much discussed, in the past, external costs such as the environmental costs associated with freight transport operation of all modes.

The importance of these policy issues cannot be underestimated. Past experience teaches us that achieving consensus and political agreement is perhaps the most difficult and time-consuming part of implementing technological innovation. Basic economic and social history also teaches us that all human behavior, preferences, and trends are periodical in nature and, as was stated in the Introduction, real life progresses in cycles. So the current period of intense deregulation and privatization is likely to be followed by some kind of return to regulation and more government involvement. The overriding issues could be the need to preserve the environment or secure some minimum level of safety and social equity and public service. It is difficult to predict when this turn in current policies will occur. But it is quite likely to be within the period up to 2020 that we examine in this paper.

As we therefore look forward into the opening 21st century, we can see the market application of a number of technological breakthroughs that will radically change the way freight transport is performed today. At the same time we hope that the delicate social and political issues associated with these new applications will also be solved soon, and that European policy makers will be able to proceed at the same speed and efficiency as new technology.

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