Strategic Rail Research Agenda 2020

European Rail Research Advisory Council




ERRAC

May 2007

ERRAC

Chairman

Åke Wennberg Bombardier Transportation

Vice-Chairmen

Philippe Renard SNCF

Manuel Pereira Technical University of Lisbon

Members

ARNAUD Claude, Veolia (Connex)

CAMURRI Ferdinando, Ansaldo Signal

DE JESÚS, Pedro M., Portugal

DELBEKE Jos, EC

DIJKSTRA Gert, Netherlands

DUCHEZEAU Françoise, RATP

EDSTRÖM Nils, Banverkert

ELLIS Jonathan, Network Rail (UK)

FERNANDEZ Emilio, European Freight and Logistics Leaders Forum

GONZÁLEZ Francisco Javier, Metro de Madrid

GOODALL Roger, University of Loughborough

GRASSEGGER Evelinde, Austria

GRIGOROPOULOS Gregory, Greece

GRILLO PASQUARELLI Enrico, EC / DG TREN

HAUSMANN Karl, Switzerland

HEIJNEN Frans, Invensys

HELLINGER Rolf, Siemens

IRWIN Christopher Conran, European Passengers' Federation

JAEGER François, Luxemburg

KLEEMANN Ulrich, Knorr-Bremse

LACÔTE François, Alstom

LEMMER Karsten, Germany

LUNDGREN Malcolm, Sweden

MAESTRINI Emilio, FS

McNAUGHTON Andrew, Network Rail

METTHEY Jack, EC / DG RTD

MIGNEREY Pascal, France

MOSOCZI Laszlo, MAV

OSWALD Rainer, Voestalpine

PAWLIK Marek, Poland

PEREZ SANZ Javier, Spain

PESONEN Markku, VR

PRISTA Luisa, EC / DG RTD

REDECKER Ralf-Peter, Balfour-Beatty

SCHÜTTE Jörg, TU-Dresden

SCIALLIS Guiseppe, Italy

CASTELLETTI Maurizio, EC / DG TREN

WEISSENBERG Paul, EC / DG ENTR

ZEUG André, DB

Contents

Foreword 4

Executive summary 5

Chapter 1 A vision for the future of rail 6
What can we expect in 2020? 6
Behind the scenes... 6
Impact of climatic change 7

Chapter 2 Europe 2020 - the business environment 8
Target setting 8
Market demands (long term society needs & short term customer needs) 9
Railway system research needs 11
Integration of networks for different markets 12
Value for money 14
The strategic vision of research in the railway sector 14

Chapter 3 Research priority areas 16
Intelligent mobility research priority areas 16
Energy and environment research priority areas 17
Personal security research priority areas 19
Safety and homologation research priority areas 20
Competitiveness and enabling technologies research priority areas 23
Strategy and economics research new priorities 26
Infrastructure research new priorities 28

Chapter 4 Achieving the vision 31
Intelligent mobility 31
Energy and environment 31
Personal security 32
Test, homologation and security 32
Competitiveness and enabling technologies 32
Strategy and economics 33
Infrastructure 33
Benchmarking 33
Training and education 34
Conclusions – the vital role of innovation and cooperation 34

Foreword

The aim of rail research in Europe is to improve the railways in all respects for the benefit of its citizens and wider society. Based on technological advances, we, the stakeholders, shall develop integrated, "greener", "smarter" and safer pan-European rail transport systems that respect the environment and natural resources; and secure and further develop the competitiveness and the leading role attained by the European railway system in the global transport market. Railways will also reinforce the competitive position of Europe's major cities and the quality of life for their inhabitants by providing fast efficient transport into the central business and cultural districts.

There are two basic areas of research: those that look at innovative solutions through scientific and technological developments and other more specific research ones tailored to achieve specific outcomes.

While the first edition of the Strategic Rail Research Agenda focused on the need to realise interoperability on a continental scale, this second edition addresses the need to improve the customer experience through better performance, and to improve the cost effectiveness of rail in the freight and passenger transport areas as well as to assist the deployment of interoperability.

Åke Wennberg
Chairman

Executive summary

The **European Rail Research Advisory Council** (**ERRAC**) is an advisory body to the EU Commission representing Member States and all stakeholders in the sector ranging from operators and infrastructure managers to manufacturers, freight customers, passengers and academics. Its mission is to develop a 'Strategic Rail Research Agenda' to inform the planning of research programmes across the EU. The **Strategic Rail Research Agenda 2020** (**SRRA**) identifies key research objectives to ensure that rail remains at the heart of Europe's transport system over the next decade and a half.

The **Vision for the future of rail in 2020** aims to increase the railways' role in the European transport system by providing seamless and integrated high speed passenger services and door-to-door freight services as well as efficient metropolitan and urban mass transport. Technical solutions should always be seen in the light of their contribution to the commercial attractiveness of rail transportation. ERRAC has set out **Railway Business Scenarios** based on rail doubling its share of both the freight and passenger markets as well as tripling the freight and passenger market volume compared with 2000. The SRRA identifies the priority research areas and the key technologies that have to be developed to turn this vision into reality.

The long-term framework for the SRRA sets out seven research priority areas for the next decade:

1. Intelligent mobility

A European-wide intelligent infrastructure is needed to support customer information systems to provide compatible technology between Member States and across transport modes.

2. Energy and environment

New standards and regulations must not only increase the level of environmental protection but also safeguard the commercial competitiveness of the mode while reducing dependence on fossil fuels, reducing exhaust emissions, improving design and offering a systematic approach to noise and vibration.

3. Personal security

Identify new methods of improving security for customers and staff in relation to both terrorism and the more common problem of vandalism.

4. Test, homologation and security

The spread of European homologation and acceptance procedures requires the speeding up of product approvals while squeezing out risk through improved safety management.

5. Competitiveness and enabling technologies

Increasing the competitiveness of the rail sector can be achieved by improving product attractiveness for customers and reducing life cycle costs through modern technology on all aspects of railway operation including rolling stock, maintenance procedures, ticketing systems and infrastructure.

6. Strategy and economics

New accounting and planning models will provide a better understanding of the costs of operating and maintaining rail infrastructure and how these costs vary according to changes in the frequency and types of train service.

7. Infrastructure

Cost efficient maintenance, and maintenance-free interoperable infrastructure systems will be developed that yield increases in traffic capacity, loading and track stability.

CHAPTER 1

A vision for the future of rail

What can we expect in 2020?

A Europe in which the high-speed train has become the standard transport mode for connecting cities since our continent has the optimal dimensions for train travel. For European citizens the use of rail is a natural choice for journeys with distances up to and over 1000 km or with a door-to-door duration of 5 hours, passenger services are frequent and reliable, trains are comfortable and safe, access is easy and high quality information is available. Travelling is seamless, flowing from guaranteed intermodality at stations and airports, providing an array of on-board services based on the same advanced technologies available at home or in the workplace to provide passengers with a seamless connection to the world outside.

A Europe, able to breathe again, that has succeeded in avoiding a complete standstill on its road network and has prevented irreparable damage to the environment through the broad recovery of modal equilibrium for freight traffic. Freight shuttles, on a Trans-European Freight Network, predominantly dedicated to freight traffic, are serving the economy with longer and heavier trains running on time as an integral part of the loaders' logistical chain. They link industrial platforms, supply combined road/rail or intermodal services for maritime units and provide transport for finished products to the distribution platforms. The use of high-grade technology for sensors, information techniques and telecommunications means that goods are monitored and controlled continuously and the condition of payloads are checked over the entire length of the transport section. The railway mode plays a vital role in determining the quality of city life.

A Europe, in which local travel within and around large cities takes place mainly by environmental-friendly modes using rail transport, as metros and light rail, often integrated with heavy rail. Its characteristic features provide space and comfort and a real alternative to car use. Its limited impact on the environment and other external effects, together with a considerable degree of user flexibility as a result of an effectively controlled transport chain and services (intermodality, ticketing, information, etc.) make it an essential element of daily life for Europeans. Thus rail is contributing significantly to the quality of life in our towns and cities.

Behind the scenes...

A Europe, where an integrated European railway system has been achieved and individual railway companies run cross border train operations under their own responsibility from origin to destination. They have also forged alliances with partners, both from within the sector

and from other transport modes. Repair and maintenance can be carried out everywhere in Europe with uniform assessment procedures, standardisation and modularity.

A Europe exists where no administrative, technical, operational or physical barriers will hinder rail transportation movements across a Union with more than 27 Member States. Massive investment in infrastructure has been supported by new funding schemes. Simplified and harmonised legislation is applicable in all European Union (EU) Member States. External effects are also encompassed within transport pricing enabling a noticeable shift in modal use.

A Europe, where commitment in the railway research community, involving the manufacturing and supply industry, railway undertakings and infrastructure managers, users, academia, environmental and urban planning organisations, Member States and the EU, has produced commercial improvements with innovative technology.

Impact of climatic change

It is becoming generally accepted that the world's climate is changing due to mankind's actions, and that the main effects over the next few decades will be a gradual warming of the global environment, with increased extremes of climatic events such as rainfall and snowfall, wind storms, droughts etc.

The railways, together with all other transport modes will be significantly affected by such changes, with increases in overall temperatures leading to more severe operating conditions across the continent. However, the environmental benefits of rail in a European transport environment driven by carbon trading will raise political expectations that rail shall take a much increased share of passenger and freight transportation than at present.

The European railways have preparedthemselves for eventualities such as global warming and the need to assume a greater role in the transportation of people and goods, and have developed strategies for dealing with these issues on a continental scale.

CHAPTER 2

Europe 2020 - the business environment

Target setting

The first ERRAC Strategic Rail Research Agenda published in 2002 set ambitious targets for the growth of European railways. These are still relevant, but since 2002 some updating has been necessary in order to take into account the latest developments, as shown in the table below based on the European Transport Statistics 2006 edition.

Projected transport demand in 2020

7600 *10^9 Passenger kms (43 per cent more than 2000)

6000 *10^9 Tonne x km (70 per cent more than 2000)

Projected Modal Split 2020 (per cent, EU 25)

Freight	Road	Rail	Inland Waterway	Short Sea Shipping	Pipeline
Total	42	14	3	39	2

Passenger	Road	Rail(including Metro/Light Rail)	Air	Bus
Total	72.5	11	9	7,5

Projected Volume 2020 (pkm/tkm*10^9)

Freight	Road	Rail	Inland Waterway	Short Sea Shipping	Pipeline
Total	2520	840	180	2340	120

Passenger	Road	Rail(including Metro/Light Rail)	Air	Bus
Total	5510	836	684	570

The 2002 SRRA predicted that the overall transport demand would grow by 40 per cent for passengers and 70 per cent for freight by 2020 compared with 2000. The starting point of the railway business model for 2020 was that the railways would capture a market share of 15 per cent for freight and 12 per cent for passengers (including urban rail transit) in Western Europe.

A number of factors has affected progress towards these targets and will provide challenges in the future, a 1% reduction in both market share projections is considered prudent to accommodate the greater than forecast growth in air transportation and road freight that has tended to overshadow some of the real progress made in rail passenger volumes.

Market demands (long term society needs & short term customer needs)

Personal security

The increased awareness and importance of personal security poses a challenge to the railways. By its nature of it being a form of mass transport with high volumes and complex networks, it is more difficult to reassure passengers of a high level of personal security than it is for most other transport modes, despite the fact that rail is safer. Research is needed to reassure the personal security of the railway customers and staff, including anti-terrorism measures, in a cost-effective way, while maintaining easy access to trains.

Energy efficiency

Energy resources are getting scarce and legislation on emissions is getting stricter. Even though the railway is the most energy-efficient and green transport mode, research is needed on energy efficiency and eco-design to further improve the performance of rail and secure a sustainable transport future for Europe.

Freight market

The freight market is changing with the changing focus of the European economy. Since 2002 the role of China as a major exporter has transformed global freight movements as globalisation increasingly forces manufacturing out of Europe.

There will be less bulk/low value freight transport and more high value transport. As the size of container ships increases it becomes less and less feasible to use road transport alone to move the containers to their final destination. Instead rail will have to take an increased share in order to allow the EU's major ports to continue to operate. Research is needed to find solutions that enable rail freight transportation to meet these changing demands. North-South and East-West freight forridors will help to tie the continent together by facilitating port exchanges and binding Russia and the Far East into the European network. Cooperation with Russia and Ukraine on heavy-haul-freight research and development could be beneficial to all partners.

Complementarities between modes

The period from 2002 has been one of rail working with all other transport modes to give Europe the mobility it needs to drive economic success and provide high quality employment and living for its citizens. With the advent of restrictions on the usage of cars in cities, fast and efficient rail transport is increasingly working with the car to provide access into city centres. The advent of "budget" airlines has created a mobile society in Europe that was undreamt of a decade ago. With the reliance on regional airports, rail is again providing the means of accessing these. In urban areas, metro and light rail are very often the backbone of multimodal integrated public transport systems, able to provide an alternative to the use of private motorised modes.

Attractiveness

The increased expectations concerning attractiveness also pose a challenge for the railways. Rolling stock currently has a lifespan of 30-40 years, but technologies are changing much faster, creating a need for interchangeable components in order that existing rolling stock can be kept up to date with the latest features that passengers value. This also applies for rail infrastructure and equipment, which often needs to preserve a historical architecture while still providing modern levels of service and comfort. Research is needed to enable quick and cost-effective retrofitting technologies for rolling stock, or to allow for updated technologies to replace sub-systems and components.

Demographics - aging population

Europeans are living longer and choosing to have children later in life. Simultaneously, better health for the retired will mean that the retired generation will have far greater mobility than ever before. For rail, this means that there will be greater demand for leisure-based travel from an affluent group of older people who are likely to be increasingly demanding of the quality of service provided. Issues of accessibility comfort and perceived security can be anticipated to be of great importance to this group of discretionary travellers. Railways with much historic architecture and buildings have traditionally been difficult to adapt to changing situations. This is particularly relevant where improved access for 'Persons of Reduced Mobility' is rightly demanded. The Railway Undertakings must respond in an enthusiastic and cost-effective manner as improved access for senior citizens and other mobility impaired groups is improved access for all. On the other hand, railways, particularly rural lines can also profit from the increase in leisure travel. Research is needed to be able to adapt to the possibilities that this demographic change brings.

Demographics - labour force

The other significance of the demographic shift will be the availability of manual labour to undertake many of the difficult and demanding jobs that ensure the continued running of the railway. Research is needed into the use of technology to increase the productivity of staff and remove some of the physical difficulties in order to both attract qualified staff to the railway and ensure that they are used to their full potential. Considerable investment is needed in education and continual training and development.

Regionalisation

The 2002 SRRA railway business scenario was developed mainly in regard to a set of expanding Member States in Europe and the running of services between them. However, in much of Europe there is also a growing tendency towards regionalisation. The responsibility for regional and urban transport is decentralised, which brings many challenging opportunities for revitalising existing or developing new regional and urban rail lines and services. A growing number of success stories exist in Europe and the expertise in this field should be increased so that the railway sector can further the development of complementary multi modal transport solutions at a regional level.

Railway system research needs

Interoperability

The 2002 SRRA regarded the implementation and progress of interoperability throughout Europe as being of utmost significance in the progress towards the 2020 targets. Since then progress has been steady.

The existing suite of European regulations (the Technical Specifications for Interoperability) for the high-speed network has been revised, but those for the conventional rail network are to a large extent still a work in progress. In particular the specifications for ERTMS level 3 have not been produced. Without this the capacity targets of the future network will be difficult to achieve. Progress has been made on a directive aimed at standardising Light Rail and metro systems, but again it is not yet in force and the standards upon which it relies are not written. Where TSIs do exist their adoption has been slow. The overall transition of the European railways towards full interoperability with each other will be slow, taking many decades, unless faster migration routes can be found. This is an area in which research is needed today in order for interoperability to be achieved in time for 2020.

It is necessary to see the system as an integrated whole while achieving the optimisation of the individual sub-systems. Therefore priority should be given to research projects aimed at generating draft European standards, with emphasis given to those consolidating the TSIs. The objective is therefore the establishment of a longer-term interoperability and safety perspective that can only emerge from a step by step integration of the EU and its ultimate extension to the adjoining CIS, Balkan and Turkish networks.

Research needs to evolve interoperability and safety requirements from new business, operational and technical needs. In this it must embrace such issues as supply chain management; third party logistics; real time management of customer information along the supply chain and the emergence of new technologies. Developments could also be driven by the widening context of integration to embrace the regulatory needs of COTIF (Convention Concerning International Carriage by Rail) & the Russian organisation OSJD. All such work must be driven by whole-life-cycle and cost-benefit considerations from conception to deployment and this will demand close monitoring and feedback assessment of each proposed new application. But it should never be overlooked that faster migration depends primarily on the political will and a willingness to provide operators and infrastructure managers with adequate investment funding on a consistent long term basis. Research into how such funding can be justified, and its expenditure made truly cost-effective is of paramount importance.

Liberalisation

Market liberalisation has now been instigated throughout much of Europe and access to the railway infrastructure is opening up. This leads to an increasing number of different operators with different rolling stock tailored to attracting particular customer segments using the network.

This has had two consequences. Firstly by allowing some operators to gain easier access to new rolling stock has boosted growth in the use of railway services, secondly it has removed the intrinsic link between infrastructure manager and train operator that has traditionally existed in integrated railways. In the absence of a fully TSI compliant infrastructure and rolling stock, research is needed to determine how to optimise the operation of trains and infrastructure such that risk and cost are not unduly exported between the infrastructure manager and the train operator; this is especially the case in fully liberalised markets in which there is the potential for many different vehicle types to use the infrastructure.

Growing networks

Since 2002 the investment in high-speed lines has continued. The European high speed rail network has expanded in Spain, UK, France, Germany and Italy and where it has done so has become the mode of choice, taking market share from air and road. The rail link between Sweden and Denmark has created entirely new cross border flows and the economic regeneration of Southern Sweden. Across Europe cross border travel by rail is becoming the norm.

As expected in the 2002 SRRA the European Union has expanded to 27 Member States. This has added a considerable amount of railway infrastructure and expanded the European railway eastward. In doing so it has brought new challenges. In the western part of Europe, the rail network is growing, particularly, where it concerns urban rail and high-speed rail. New lines are continuously constructed in many different countries and cities. This growth of networks has its effect on demography, e.g.: cities are able to build/redevelop new areas thanks to new rail connections, people will commute by high speed trains over far longer distances, etc. Socio-economic research is needed to determine how the railways can become an important partner for governments in managing these effects.

Shrinking networks

In central and eastern Europe, on the other hand, the rail network is shrinking due to a decline in patronage, even though the modal share of the railways is higher than in Western Europe. There is and will be an urgent need for greater investment in the maintenance and modernisation of extensive heavy rail and tramway systems. Given the current lack of funding, research is needed to develop cost-effective infrastructure and rolling stock with a low life-cycle cost, to make them more attractive for passengers and freight customers in order to stop the further closure of lines.

Integration of networks for different markets

While the rail network is Europe is a single asset, when the use of that asset is considered it becomes apparent that it is used to serve a variety of different market segments. These are shown below. The precise engineering specification of each type of network and the research needs associated with them are different as is the type of client who uses them. These research needs are summarised in the subsequent chapters of the SRRA.

Long distance

For passengers travelling several hundred kilometres between major European cities, the continuous increase of the high-speed rail network and the excellence in operations will lead to significant improvements in the relative journey time (compared to air transport). For overnight connections, the (ticket) integration with high speed and/or air services for the return leg of the journey will be of main importance. In combination with an excellent track record in security, comfort and customer service, these developments will turn rail into the natural choice for journeys with distances up to and over 1000 km or a door to door duration of 5 hours (and potentially more for overnight services).

Inter-regional and suburban

The railway networks in the densely populated regions and/or around the larger cities will be constantly extended and improved in terms of frequency, user-friendliness, reliability and ticketing. Co-modality with other transport modes – and especially urban public transport - will be better co-ordinated. Moreover, technology will enable the railways to guarantee a high level of perceived personal security in these 'open' systems. This will go hand in hand with the trend of decreasing quality of road transport in and around cities, resulting in a modal shift from road to rail on these very large markets.

Rural

Low-density rail lines in rural areas will increasingly serve as a backbone for local public transport and will be integrated with this in terms of ticketing and assured connections. The driver will act as more than just a driver, dealing directly with the customer, providing reassurance against personal security issues and doing some small elements of routine maintenance to the vehicle. The demanding standards for mainline railways (e.g. axle loads, signalling, etc.) will gradually be replaced by far simpler ones. In essence rural railways will be simple, low-cost, yet customer focused railways frequently under local ownership or control.

Urban

As more and more large and medium-sized European cities introduce or extend their urban rail systems, it represents a very large –and growing– market. The systems are generally operated under contracts including public service requirements. In this, integration between modes will be the key for success, whereas cost-effectiveness and increased attractiveness will be the most important challenges, thanks to improved accessibility, comfort and security. Innovation and improvement in these fields will be brought through technical harmonisation of interfaces and major characteristics, following different rules from conventional rail.

Freight

In addition to the heavy freight shuttles mentioned in Section 3.1, that will predominately run on a dedicated Trans-European Freight Network serving the economy with longer and heavier trains running on time as an integral part of the shippers' logistical chain, there will be other developments on the Integrated European Network. As a result of the globalisation of manufacture, general freight transport will increasingly be undertaken by relatively light, containerised trains that resemble a passenger trainset in terms of loads exerted on the infrastructure, average speed, reliability and performance. This results in lower maintenance costs and higher capacity of the conventional rail network and better service for freight customers. Together with the construction of dedicated lines, this will enable the railway to deliver faster and more reliable freight services, making rail the preferred mode for long distance (international) and medium distance freight in Europe.

In addition to smart traffic control, there are two other ways to increase the capacity of freight lines across Europe. One is by increasing the length of freight trains on dedicated lines. The other is by increasing the maximum speed of freight trains so that they can interlace better with passenger services without the loss of valuable slots.

The logistical chain will be extended by the development of a container transhipment network including a large number of low-cost container hubs and internet portals for container routing. The development of refrigerated containers that can be used equally by the maritime, road and rail modes will considerably improve flexibility for the logistics operator and enhance the appeal of rail movements.

Value for money

When looking at the above market categories, one transversal characteristic remains for all railway businesses: the European railways need to provide continuously increasing value for money. In some cases this will be necessary to be able to reinvest in improving the system, in other cases it is a mere condition for survival in the short term. A significant increase in the value for money improved management and integrated long provided by the railways, is therefore the single most important characteristic of tomorrow's railway that should be considered in all research that is done today.

Changes are necessary to meet future expectations by passengers of the quality of their journey from origin to destination, door-to-door. Various factors including affluence and ageing will change passenger expectations of journeys, and by 2020 it is anticipated that many aspects of today's journey will no longer be considered attractive to the user in the decade commencing 2020. Factors such as ease of access at origin, interchanges and destination, importance of protection from climate and also assurance of personal security at points of interchange will have to be considered. Information and ticketing processes including access to information on journey possibilities and timetable for the integrated system, journey purchase and reservation should be taken into account. The evaluation of user-friendly way-finding, both traditional, such as signage and audio/visual announcements, and potential new technical opportunities such as personal GPS/Galileo applications is needed as well.

One of the most significant areas of expenditure for a railway, and one that has no direct impact on the passenger, is that of infrastructure maintenance. This represents – apart from metro and Light Rail systems - approximately half the cost of operating a train service, but does little to encourage modal shift other than by assuring safety. Reducing the cost of infrastructure maintenance would not only improve the value for money of European railways but potentially release substantial capital for further investment in those aspects of railways that do attract modal shift. Areas like new, improved rolling stock and customer information systems, increasing the availability of track networks by target-oriented renewal and new build programmes, or revised station layouts could all benefit.

Generally speaking, the reduction of infrastructure maintenance cost is a comprehensive task which must be addressed from the point of view of the whole system life-cycle. Accordingly, life-cycle cost (LCC)-reduction is the key to achieving a sustainable economic benefit. For example, this means that optimising track quality at the time of installation can drive down life cycle costs when combined with an optimal maintenance strategy.

The strategic vision of research in the railway sector

The strategic vision of research in the railway sector focus on clearly identified needs for RTD activities reflecting the challenges for 2020 – the competitiveness, attractiveness, and performance of the entire rail transport mode. The research and innovation efforts embrace rolling stock, infrastructures, operations and services.

To strengthen the competitiveness of the European rail sector effective results are to be achieved on:

- Enhanced environmental advantages of the rail mode: Reducing emissions, including electromagnetic emissions. Adapting noise attenuation techniques to differing networks ahead of emerging standards. Recycling of materials used in the construction and refurbishment of rail vehicles and infrastructure. Exploring Energy-efficient technologies and alternative energy sources
- Improved performance of rolling stock: Developing new and advanced vehicles concepts using innovative materials and production processes and benefiting from economies

of scale and adaptability to change and reduction of complexity and diversification of currently available products

- Improved performance of infrastructure: Developing innovative solutions to significantly reduce the life cycle costs of high value infrastructure assets. Targeting new interoperability requirements around improvements in safety and security, reliability, maintainability and interoperability
- Enhanced competitiveness: Increasing the performance of products, improving production processes and reducing life cycle costs with the aim to improve the economic attractiveness of the rail transport mode. Exploring IT technologies to develop sufficiently high-quality services and implementing overall intelligent mobility concepts involving customer information for freight and passenger services, improved accessibility and availability
- Long term strategic direction for rail: Anticipating economic, institutional and social changes that might affect the future of the rail sector in Europe so as to enable decision makers to establish long term sustainable guidance and policies.

CHAPTER 3

Research priority areas

Intelligent mobility research priority areas

This research should concentrate on providing the customer focus and improved levels of service flexibility demanded by increasingly sophisticated 21st century travellers. Improved communication networks will speed the introduction of integrated passenger services and remove barriers caused by lack of real-time data on journeys. The achievement of many of the RBS 2020 targets on seamless journeys will depend heavily on successful research in this field. The aim is to achieve seamless cross border, network to network and intermodal transport through improved passenger ticketing and freight customer information. Research will focus on developing information flows which allow seamless door-to-door travel for passenger and goods traffic, better yield management and effective marketing.

A key area of research will be on creating compatible ticketing systems across borders, including urban transit legs through the development of e-tickets and contact-less electronic purses using common interface protocols. The continued growth of urban transit will depend on its ability to respond to individual travellers needs through the spread of e-ticketing, interoperability and journey planning information. Through cooperative European research, technical harmonisation will be introduced for urban, suburban and regional rail, in coordination with other public transport services. For passengers, expected deliverables will include improving the attractiveness of public transport to offer all passengers a service that is easy to book, pay for and use (including people with disabilities and those with luggage) and provide up to date information before and during the journey. In the freight sector, all necessary information should be made available in real time covering possible delays, charging systems, train numbering and terminal management.

New management techniques are needed to enable more efficient use of infrastructure through, for example, improved management and integrated long, medium and short distance clock face rail services following the Swiss example. Research will continue on fleet, staff and maintenance management, staff training and dynamic path allocation with a strong emphasis on ensuring the speedy implementation of the scheduling and journey planning aspects of the forthcoming TSIs. Fleet management and train deployment information should also become available across Europe, as long as the necessary security and commercial issues can be resolved. The competitiveness of rail services will be enhanced by more sophisticated load management based ticketing. The overall objective is to achieve improvements in the quality of service and the efficiency of operations by introducing cost-effective innovation throughout the railway.

Another area of research is the need to harmonise information exchange on matters such as customs and security, real time data and traffic between rail operators across borders and to harness the availability of GPS technology. Both passenger and freight sectors require the definition of tools for developing harmonised information exchange between stakeholders; harmonised regulations, standards and tools for improved security and safety; development of new methods and tools for train configuration management and for train/infrastructure interaction management. For passengers, the implementation of recent passenger rights brought into Community law by the third Railway Package will require secure transfer of passenger information across borders. Research will be required to ascertain how to balance the conflicting demands of passenger security and the civil liberty to travel in privacy. In addition, the development of the Galileo satellite positioning system will lead to numerous new services for passengers taking advantage of the very precise location of vehicles, fixed objects and customers. For example, IFOPT Standards to identify fixed objects in Public Transport have already been developed by CEN TC 278 WG3. Expected deliverables for freight logistics include harmonised interfaces for container and load tracing and tracking. There will be an emphasis on implementing the data exchange required for cross border train planning and the operational aspects of the Telematics for Freight and upcoming Telematics for Passenger TSIs.

Energy and environment research priority areas

Future energy and environmental research will place increased emphasis on energy efficiency, environmental impact, design and the need to prepare for changes reduced availability of fossil fuels. This topic provides scope to explore more radical, environmentally friendly and innovative technologies that can prepare for the step change required for the second half of this century and meanwhile can stimulate radical technology changes and foster creative thinking.

There is a symbiotic relationship between European Commission funded research and the legislative and regulatory process, a link that is particularly strong for environmental issues. Collaborative research is essential to set realistic targets for the legislators and ensure that common validation methods are agreed between stakeholders. Research will focus on the need to resolve issues generated by new EU regulations. Research into noise and vibration must take into account the contribution of the European Commission's 6th Framework Research Programme FP6 and the NOEMIE project (which assessed the relative contribution of the train and track components to noise levels generated by the high speed network) to the delivery of the CR NOISE TSI (2006). Research on new materials offers possibilities of progress in this regard. The introduction of new standards relating to noise reduction and environmental protection must take into consideration the cost and benefits of their deployment. Further work is required on a series of projects covering noise generated by train operation, other rail activity, rolling stock and track testing. Simulation tools for noise assessment, the effectiveness of noise reduction measures and the targeting of maintenance interventions are all areas for further study especially in the field high speed train noise which remains a sensitive issue. Deliverables include reduction in noise, the development of methods of system assessment and decision-making and a reduction of general annoyance from railways and urban transit, in addition to what will have been achieved through the FP6 projects SILENCE and QCITY.

Another key area of research is to examine potential for reducing dependence on fossil fuels which will review fuel sources and their substitution with new eco-diesels and hydrogen. Much work is required into the feasibility, economics and logistics involved in changing energy sources. A general acceptance of the environmental benefits of 'eco-fuels' needs to be supported by research into deployment options and optimum conversion strategies.

In addition, for both metro and light rail, a technical harmonisation of the interfaces between the vehicles and the heating, ventilation and air conditioning equipment could lead to significant reduction in the cost of such equipment.

Reducing the temperature on metro systems is another priority requiring research to evaluate alternative ways of cooling vehicles and stations. It is a complex issue since the extra energy required for ventilation and air conditioning appears incompatible with the aim of reducing overall energy consumption.

Other research with a specific focus on urban rail includes: reducing weight and noise emissions of rolling stock and infrastructure; rail traction and energy supply; energy regeneration braking systems; new methods for measuring the toxicity of fumes in fires; design of vehicle constituents using recycling materials and research on their operational effects; how clean quiet technologies could help encourage modal shift; and research on new funding rules for environmental-friendly applications

The elimination of the use of materials with a negative environmental impact will be a priority. Specific benefits will include meeting anticipated legislative requirements by 2020; identification of external costs; raising the attractiveness of rail to environmentally-conscious clients; and reducing air pollution and emissions.

Reductions in general LCC elements relating to energy consumption of between 2 and 8 per cent are anticipated. This will be achieved through the development of lighter rolling stock and the adoption of a system approach which will include not only the promotion of new structures and materials, but also include the development of more Energy-efficient train control systems. Standardised methodologies for measuring the energy efficiency of vehicles will be enhanced and a database of construction and operational options will be developed.

Research must also investigate alternatives for all the hazardous materials still used in new and refurbished trains and develop a model for a high level of recycling. Reduction of the LCC for fire safety measures can be achieved by using environmentally friendly materials in manufacturing and refurbishing trains, using new materials with the same physical properties. Models may allow almost all of a vehicle to be recycled. Fully modular construction could be adopted to enable easier upgrades and up to 20 per cent of the weight of coaches could be sourced from renewables.

The number of metro and light rail cars is growing rapidly. While they represent one of the most attractive, sustainable and environmentally friendly transport, there is still the potential to improve their environmental impact by the design of key modules such as heating, ventilation and air conditioning technologies, energy recovery on braking and low track impact running equipment. The attractiveness of rail as the most environmentally friendly mode must be retained by the speedy adoption of new technologies for clean and efficient energy.

The world's climate is changing and a number of models have been used to prepare scenarios that quantify these temperature changes for different levels of greenhouse gas emissions. The railways will be affected by increases in temperatures resulting in more extreme climate resulting in, for example, increased incidents of rail buckling and higher air conditioning costs. The industry needs to prepare for global warming by: evaluating global climate change models and their predicted effects on the railway system; evaluating the degree to which weather induced problems are a threat over the next 50 years and identify specific vulnerable areas; assessing the likely rise in weather induced problems by examining data for temperatures, wind speeds, rain and snowfall data; and developing long term strategies for dealing including recommendations for future infrastructure and vehicle development.

New research topics will also include:

- Weight reduction methods to reduce deadweight per passenger
- Streamlining the infrastructure for more efficient land use such as removing bottlenecks, building high speed flyovers and reducing the number of level crossings
- Improve standards for noise, emissions and diesel engines
- Develop new lightweight and low noise freight wagons
- Hot versus cold braking benefits
- Low frequency sub-station noise based on research in other sectors
- Research into the optimisation of the GSM-R network to remove capacity constraints
- Noise abatement systems such as low level barriers
- Land use.

Personal security research priority areas

The original SRRA identified the topics of safety philosophy, safety culture, human safety factors and modelling and simulation. Achievement of the RBS 2020 targets on personal security will depend on research into safety and security and future safety critical traffic management systems and will link in closely with test, homologation and safety.

Specific tasks where a joint approach might be envisaged include:

1. Definition of the safety and security targets and management system for the railways in 2020
2. Reduction of the impact of human errors on the railway system
3. Protection of IT systems
4. The use of satellite navigation for safety critical applications.

Competitiveness of the European railway network depends on high security standards since attacks such as those in Madrid and London show that this is a matter of concern for rail as well as aviation. The integration of security across Europe requires knowledge of the various technologies and security strategies in different regions which reflect the national characteristics and local awareness of security issues. The great challenge is to make the open rail system secure in the face of the new threat of terrorism. New studies will provide a survey on security strategies, operations and technologies applied in different Member States. Based on the survey, various scenarios should be devised with the aim of improving counter measures against potential threats, while maintaining the important features of the rail system such as open access and performance as well as avoiding over-prescription and excessive additional costs for operators. These scenarios must cover both technological and organisational measures, including the training of staff and threat analysis, risk prevention, assessments of cost and crisis management.

Currently in Europe, measures to improve personal security are being deployed such as CCTV, ticket barriers and additional staff on stations and trains. Additional measures have been introduced in other parts of the world, notably the United States from which lessons may be learnt and new technologies adapted. However, the investment required is considerable. The cost benefit analysis in relation to the likely threat should also cover the consequences for the competitiveness of the railways. These measures and their potential effects can be integrated into a toolbox for better-perceived personal security. A specific research action is the design of infrastructure, stations and rolling stock. Increased visibility of staff, for example, is a very important development in this field, where several benchmarks inside and outside of Europe are already available.

Unobtrusive new technologies offer the potential to provide welcoming passenger environments on metro and mainline stations without introducing feelings of insecurity sometimes posed by public spaces. Barriers against the use of public transport could be reduced as nanotechnology, innovative technologies and advanced communications use passengers' mobile phones, satellite based location and contact-less cards, to look after passengers throughout their journey. Subtle monitoring and instant communications with security and train staff will optimise passenger safety.

The research objective is to optimise personal security for customers and operating staff in terms of acts of aggression, terrorist attack and vandalism and will involve:

- Better integration of personal security concerns with the design of infrastructure, stations and rolling stock
- Assessment of the impact of personal security against value of time and its potential impact on modal choice
- Providing better personal security
- Threat analysis, risk assessment and prevention, effective emergency and crisis management
- Development of initiatives for public transport security legislation, standardisation, certification and staff training
- Development of safety systems which make intelligent decisions and take preventive actions under dangerous conditions
- Revenue protection and ensuring only ticket holders only access the system.

Safety and homologation research priority areas

The safety of the European railways is of prime importance not just in terms of the loss of life when a major rail accident causes, but also in terms of the operational cost of degraded mode after accidents and incidents even when no one is injured which undermines the business case for railways. This subject area also covers the cost of accepting interoperable trains in Europe.

The main target areas are:

- To reduce the risk of fatality and the number of fatalities to passengers, employees and passers-by
- To reduce the impact on operational performance of degraded mode operation for the railway
- To reduce the cost of safety acceptance for railway materials by eliminating the need for national requirements.

The targeted reduction in fatalities from the implementation of the enhanced safety measures is estimated below:

In numbers based upon the ETIF 2006 data:

	EU25 2000 Reported	EU25 2010 Projection	EU25 2020 Projection
Number of passenger fatalities per year	149	102	70

The key areas for reducing fatalities are:

1. **Degraded operation**

   Risk is generated when systems on the railway fail. While this rarely results in loss of life, it leads to degraded operation and consequently delays and cancellations, causing inconvenience to passengers and freight customers. Research can fulfil two functions. First, it can investigate ways of making degraded mode operation as close as possible to full operation, minimising customer inconvenience; secondly, research can support EU work to enhance the reliability, availability, maintainability and safety (RAMS) of the railway through the use of new products to prevent the importation of safety and performance risk from operating cross border or across different infrastructure managers networks. Another aspect of degraded operations that could be investigated is the integration of such functions in a European standard driver's desk using modern technology to help overcome degraded operations in the different and national networks.

2. **Interface management**

   A crucial aspect of rail safety is the management of interfaces. In many Member States the new organisational structure will increase the number of interfaces and hence introduce potentially new types of risk. An understanding of how these issues are handled and how best to manage the stakeholders' requirements needs to be developed.

3. **Infrastructure safety**

   Railway maintenance is carried out in difficult conditions and often at night. Research is needed to reduce the risk. Possible areas include the use of remote condition monitoring to create intelligent infrastructure that can monitor and inspect itself. New operational and possession management techniques can make maintenance activity more efficient and safer. The single biggest risk on most networks is at level crossings and junctions. Research to provide grade separation at affordable costs, perhaps by providing standardised flat pack bridges can reduce this risk. Alternatively the use of obstacle detectors mitigates this risk.

4. **Human factors**

   The interaction of drivers, signallers and other railway staff with each other and the assets is an important consideration in the efficient, reliable and safe operation of the railway. Research into this area must be undertaken as a part of any major research project concerning the safe railway of 2020.

5. **Homologation and acceptance**

   The cost of achieving cross border services is escalated by the need to comply with national requirements in each member state through which they pass. Interoperability and the progressive development of a common safety philosophy will reduce the cost. The report of the Commission's task force for cross acceptance in 2006 categorised three types of standards:

a) those suitable for cross acceptance by member state safety authorities

b) those unsuitable at present, but which could be adopted under harmonised European standards

c) those which will always require separate national approval in each member state.

The category C areas require immediate research attention to understand the origin of the national differences and create a road map for harmonisation for equipment such as pantographs and for EMC environments. At present a cross accepted product would have to be constructed to an expensive worst case scenario in order to be suitable across the EU. Research should examine means of easing the nature of this worst case scenario. There is also a need to fully convert category B items to category A. It is envisaged that this will be primarily be via the development of common European specifications. Whilst existing mechanisms such as CEN have a valuable role, research into the fundamental nature of these areas will be needed in order to facilitate this process. Finally a mutually agreeable cross acceptance process will be necessary. Again research is needed for this. Estimates of the cost to Europe of a lack of cross acceptance vary, but in 2006 UNIFE estimated it at 3 billion Euros a year, which suggests there are huge potential savings in this field.

In the longer term the development and implementation of TSIs will speed up the process of cross acceptance as the interaction of standard vehicles on standard infrastructure should be the same throughout the EU. However, in the short to medium term a solution to mutual cross acceptance will be needed as the TSIs are developed and as vehicles and infrastructure are renewed or enhanced to comply with them. Consideration should also be given to how this mutual acceptance process can be combined with the Interoperability and Safety Directives so that all aspects of verification and authorization are covered in a single process.

Achievement of the RBS 2020 targets on traffic growth and the resolution of capacity problems will depend in part on successful research into safety and security, homologation and network security and will require:

- Definition of the requirements for the safety targets and management system of the railways in 2020 to support the activities of the European Rail Agency
- Impact of human factors
- Improving the performance of the network and minimizing disruption due to system failure
- Specifying requirements for the future European railway on reliability, availability, maintainability and safety of the railway (RAMS) to reduce system failure
- Improved arrangements for working on the railway
- The production of a cross acceptance regime in Europe in areas that are appropriate resulting in reduced costs.

Expected deliverables include:

- A reduction in risk to passengers, employees and neighbours

- The incorporation of human factors in safety research and policy making
- Research in appropriate common safety targets, indicators and methods to improve the risk management process, interfacing with the work of the European Rail Agency
- Specification of a RAMS case for European railways to support the common safety targets as the basis for future design standards
- The development of a European acceptance regime with work programmes on those areas which cannot currently be included in this programme due to a lack of knowledge or unique national characteristics
- Methods of degraded operation that minimise disruption to passengers and freight customers and maintain the risk at acceptable levels
- Improved station design to reduce both perceptions of risk and actual risk
- Automated methods of inspection, maintenance and construction of infrastructure to reduce the need to work on the live railway.

Competitiveness and enabling technologies research priority areas

The European rail supply industry has a leading position in the accessible world market, valued at 72 billion Euros in 2005 (with an expected annual growth of 1.5 to 2 per cent per annum in real terms over the next decade), of which it captures around 70 per cent and directly employs 130,000 people in Europe. The railway operators employ 912,000 people. This cluster is aimed at strengthening the global competitiveness of the European railways based on the overall economic competitiveness of the products and services they provide.

This can be reinforced by expanding the application of modularity and standardised interfaces to rolling stock and infrastructure maintenance and the extension of intelligent transport systems. Maximising capacity while reducing costs is another key factor which can be often be achieved by increasing axle loads, speed, traffic volume and the loading gauge without expensive investment. Urban public transport efficiency can be improved through harmonisation of installations, improved operational quality management, innovative design of systems and customer oriented information, communication and fare and ticketing policies.

European manufacturers are at the forefront of new technologies. Europe continues to be the most important market for the rail supply industry, ahead of the North American and Asian-Pacific markets. The outlook for rail transport in Europe is very positive given the rising demand for passenger and freight travel, the highly congested situation on the roads, as well as the increasing awareness in Europe of the need for sustainable development.

However, despite this long-term potential for rail products, the European rail supply industry is currently facing a number of structural problems: a declining rail market share where long term investment has been deferred and a reduction in orders in parts of the industry. In some respects, European levels of rail investment have been counter-cyclical when compared with the high levels of investment in the emerging Asian powers. Many cash-strapped EU governments have been reducing investment in rail infrastructure and rolling stock over the past decade as a result of fiscal restraint.

Moreover, the European rail supply industry has been facing additional challenges such as:

- Prices for rail products remain under competitive pressure while simultaneously the complexity of these products has increased significantly

- An inability to exploit economies of scale because the diversity of national requirements adds considerable cost and delay to the acceptance and approval process
- Increasing competitive pressure from low-cost Asian manufacturers, some of whom benefit from state assistance
- Irregular public sector funding for products creates uncertainty about utilisation of manufacturing capacity
- Some sectors of the rail supply industry need to be further consolidated to achieve a more rational and efficient industry structure.

Despite this, the European railway supply industry has retained its competitive edge and can usually offer the best available solutions to both European and world markets.

Achievement of the 2020 targets in these areas will depend on research into new vehicles and enabling technologies, operational improvements and greater network integration enhancing the competitive position of the European Industry. Technology and innovative train concepts for both passengers and freight transport will be developed with interoperability designed in. Solutions will be based on advanced mechatronic systems, on-board electronics, and information and communication systems.

The expected deliverables will include:

Improved commercial models

A priority is the creation of a system approach based on a thorough knowledge of cost drivers, customer needs and non-fare box revenue obtained through the development of models covering infrastructure, finance, maintenance, and capacity. It should then be possible to undertake an analysis of theoretical capacity available for increased passenger and freight traffic.

Enabling technologies

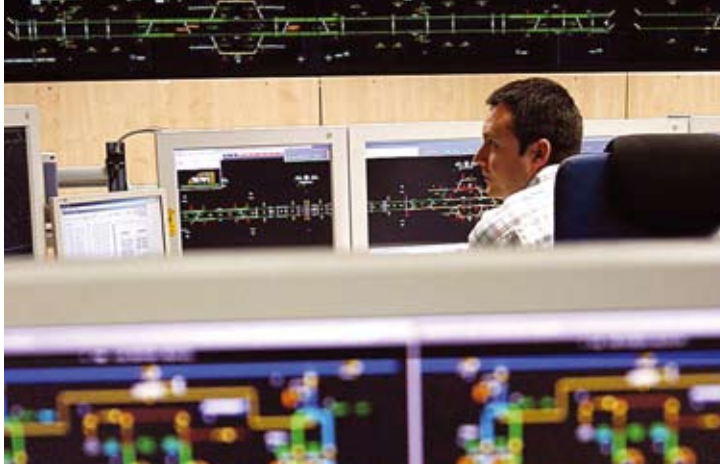
The introduction of new lightweight materials and more efficient construction methods will encourage the development of a better track-train interface resulting in further cost reductions. New technologies will be developed for vehicle structures and components and new performance standards will have to be defined for structural materials and research will be needed on new types of interiors to achieve weight reductions and adapt to new functions. Investigations into coating and surface treatments, production technologies and support logistics will also be needed. The automation of existing rail systems and the development of operating systems with new technology will deliver innovative design of systems and constituents.

Removal of barriers to interoperability and intermodality

Better coordination between urban and mainline transport will allow the creation of integrated services in conurbations and the construction of hybrids metro-train networks like RER and hybrid tram-train networks as in Karlsruhe. The need for cost-effective infrastructure and rolling stock design based on LCC and RAMS requirements will encourage the rapid adoption of interoperable standards.

Improved certification

Much work is required to reduce the cost of approval for new vehicles and infrastructure products with the introduction of virtual testing. The certification of large scale modules through notified bodies and vehicle acceptance bodies could form part of a second modular train initiative. The solution may lie in the creation of a European test centre.



Greater emphasis on human factors

Special attention needs to be paid to improving the quality and diversity of the rail engineering base and creating new opportunities and training for engineers and business managers who would have the benefit of a knowledge management system developed in conjunction with the European rail business schools. In addition, resources could be usefully dedicated to the improvement of driver training on simulators for the upcoming European driver licence and preparing signallers for the requirements of the new ETCS installations.

Interface harmonisation

Although the mechanical integration of the European rail system may take decades, there is much potential for the development of compatible on-board data communications networks. An obvious example is the extension of the modular train (MODTRAIN) concept to cover interfaces and – as far as metro and Light Rail is concerned - work building on the results of modular urban rail (MODURBAN). Another is the evolution of European standards for a new generation of on-board and communications networks as initiated in INTEGRAIL. Integrated information systems will keep users informed of progress in real time. European standards for on-board and trackside networks will need further elaboration based on tasks initiated in the INTEGRAIL project. Functional and technical harmonisation will be enhanced by the development of modular constituents for both new and upgraded urban rail installations.

Innovative maintenance technologies

High levels of maintenance cost act as a brake to the improved financial performance of rail operations. Efficiency can be improved through optimising the split between the cost of initial investment and maintenance on infrastructure and rolling stock. The increasing scarcity of maintenance skills will result in the development of innovative low labour technologies such as remote monitoring of the integrity of bridges and tunnels; track-train interaction models to aid predictive maintenance; degradation modelling of infrastructure to support predictive maintenance; and the use of embedded devices to check tolerances and displacements. Innovative predictive maintenance methodologies for fleet management will also be developed using automated remote workshop technologies. Meanwhile the increasing demand for cross border operation requires the development of technologies able to support the concept of major open workshops for dispersed fleets.

Capacity optimisation

The capacity and reliability of urban rail networks will be enhanced by the introduction of innovative high-capacity urban rail vehicles and the development of high-performance urban rail infrastructure supported by new signalling concepts. Analysis of international passenger and freight flows will aid Europe-wide path allocation leading to better capacity utilisation. This could free up capacity to improve services. The problem of how to remove the dis-incentive of the last kilometre between the train station and the passenger's door also needs to be addressed by providing high quality train movement data via the internet and GSM. This will ensure intermodality for both passenger and freight and remove one of the key barriers to the wider use of rail.

Improved investment models

Can the demands of increased service speeds, loads and traffic volumes be addressed without expensive investment? There is a need for better understanding of upgrading needs and possible solutions for modernising railway infrastructure. The benefits of a common loading gauge to ensure profitability of investments in freight corridors will also be evaluated. It may be possible to redefine standards for infrastructure and its components to reduce investment costs and deliver increased capacity.

Improved operations

Greater efficiency will require the development of new technologies for staff training and traffic management such as virtual reality and simulation tools. Automated monitoring of the infrastructure and associated data processing will aid the development of predictive methods of maintenance for the infrastructure and better scheduling of track possessions.

Ticketing systems

New concepts in ticket selling, validation and control will be developed in order to maintain the protection of revenue and easy access to public transport while reducing costs. Automatic fare collection will be based on innovative fare tariffs using flexible costing and pricing models. Public acceptance of contact-less passes will require investigation into customer acceptance and cross border interchange-ability. Personalised and advanced booking reservation services will be developed for a wide range of customers through the web, mobile phone and voice recognition systems and will be accompanied by the introduction of innovative devices for improving passenger information, comfort and personal security in on trains and at stations

Overall, there will be an accelerating movement towards rolling stock and infrastructure whose design is based on LCC and RAMS principles, seamless passenger transport, increased service speeds. All of which will lead ultimately to greater competitiveness of European rail products, operations, networks and urban public transport.

Strategy and economics research new priorities

The objective of the strategy and economics cluster is to establish how economic, institutional and social changes might affect the future of the railways in order to enable decision makers establish a long term direction for rail. This cluster addresses both options for accommodating the expected increases in demand and for ensuring that the professional management of infrastructure and train operations encourages efficient outcomes.

The main targets are to provide:

- Analysis for long term projections of passenger travel and freight traffic by rail
- Options for managing increases in demand, which include increases in the capacity of both trains and infrastructure; improved train operations, scheduling and signalling; the use of fares and pricing to reduce overcrowding; and scarcity charges to train operators
- Analysis of the contribution of rail to local, regional and national economic development and a method of identifying, quantifying and valuing these benefits
- Identification of the best way to implement interoperability standards
- An assessment of options to optimise full life operating and infrastructure costs, and the effectiveness of incentives to deliver the right outcome.

Many Western European countries are enjoying significant growth in passenger demand on high speed routes and several are experiencing increases on commuting and inter regional

routes. The picture for freight is mixed, with road competition generally reducing rail's market share. If present trends continue, rail freight for the EU25 is unlikely to grow more than 8 per cent by 2020. However, this pessimistic projection masks the strong growth in Germany, the Netherlands, the UK and the Baltic states over the past five years. The use of benchmarking can identify the factors in the success of these networks and apply them more widely across the EU.

A consequence of this growth has been overcrowding during peak hours making rail an unattractive mode for those able to choose an alternative. The industry has various opportunities for balancing demand and supply, managing overcrowding and delivering high quality rail services. Constraints on funds and the competing demands of other modes have intensified the need to identify the economic benefits that result from better rail services in order to justify investment. There are differing views on the contribution of rail investment to economic development. Several major rail schemes have been the subject of economic impact studies but to date there is no overview or framework to inform the analysis of future projects.

Cost benefit methods are well established for assessing the overall impact of implementing new regulations. However, there continues to be a lack of guidance or of examples on best practice in the application of cost benefit analysis to establishing the optimal process for implementing a new standard.

Because of the problems in optimising line capacity, incentives aimed at influencing the behaviour of train operators and infrastructure providers are often ineffective or non-existent. Work is in hand in some countries to provide a better assessment of the costs arising on account of the use of infrastructure of each train and service group and of the effectiveness of different charging regimes in optimising full life costs and encouraging innovation.

Achievement of the RBS 2020 targets on value for money will depend on successful research into new accounting and planning models that strengthen competitiveness and increase capacity. A better understanding of rail's contribution to economic development will provide a sounder economic case for investment in rail in a world in which funding is always in short supply.

The revision of existing TSIs, and the implementation of new ones, is expected to be a continuing process and hence there remains a need for clear guidance on best practice in implementation of standards.

A better understanding of the costs of operating and maintaining rail infrastructure and how these costs vary with changes to the frequency and types of train service provides a first step to optimising the joint provision of infrastructure and services. Combined with an understanding of how train operators respond to track access charges which link the cost of damage caused and capacity utilised by train operation to the charge paid, optimisation of full life costs of providing rail services becomes a possibility. Such an understanding will provide operators and infrastructure providers with real incentives to reduce costs and hence increase the sustainability of rail in the longer term.

The European rail industry, together with policy-makers, needs to examine scenarios for the future pattern of rail use to help produce robust plans based on a clear understanding of the factors driving growth. Research is needed to link these scenarios for passenger and freight traffic with options for managing demand through improved scheduling of operations, enhancement of infrastructure and managing demand through better targeted fares and charges.

Rail budgets are under pressure. In the view of some politicians, rail has high fixed costs and limited potential. However, using its assets optimally, rail can be a highly economical, ecological and safe means of transport. There are freight examples in abundance around the world in North America, India, China, Brazil and Australia. Europe must not lag behind and should aim to develop a better understanding of how rail can contribute to economic development and strengthen the case for investment in schemes where rail is the most effective solution. And by raising more of the costs of the scheme from the direct beneficiaries, the subsidy from government is reduced.

By demonstrating how best to implement programmes for interoperability, the value for money delivered by the setting of standards will be improved. The short term objective of developing LCC models for infrastructure and the provision of the information to reduce costs to make rail a more sustainable mode. This will have the added benefit of enabling a true cost comparison between transport modes for investment purposes and encourage the establishment of level playing field.

Infrastructure research new priorities

In order for the freight and passenger growth targets of the SRRA to be achieved by 2020, infrastructure managers must be able to meet the market needs of train and freight operators and provide safe and secure infrastructure at a price which enables rail transport to be competitive. At present of the capacity of the rail network in Western Europe is restricted by bottlenecks and the ambitious growth targets will be impossible to meet without unblocking them. The cost of providing new infrastructure can be prohibitive but with careful management of resources, value for money can be delivered. In each case investors must face social and economic requirements which can only be met on the basis of certain criteria.

ERRAC as the railway technology platform has a major contribution to make in this debate within the SRRA by suggesting how to remove limitations on the ability of the infrastructure managers to increase capacity by building additional lines. In Central and Eastern Europe spare capacity is available, but here the affordability of maintaining the existing network is a key concern, as it is also in much of Western Europe. The implementation of well targeted LCC-strategies can provide an important part of the answer.

In addition to delivering affordable increases in capacity, the growth in traffic density on infrastructure networks will demand far higher levels of reliability and availability. This will need to be managed through improved designs of a high quality under LCC and RAMS-criteria and by predictions of mitigation.

This all needs to be viewed within the context of the future rail network. This seeks to segregate national networks into different market based segments and optimise utilisation of both trains and infrastructure. Besides track infrastructure, particular emphasis must be placed on the role of stations to attract passengers and provide safety, security and reassurance.

The main targets for infrastructure managers are to:

- Reduce the maintenance cost of infrastructure both to sustain the competitive position of railways and to release funds for investment in additional capacity. This can be achieved by fewer maintenance interventions, the use of more reliable track systems and the automation of maintenance activities
- Identify ways of building new capacity on the existing network at less cost through cheaper methods of grade separation and the replacement of level crossings with low cost bridges
- Develop the use of new train control technologies such as ETCS level 3 to increase capacity
- Develop specifications and hardware for a new generation of interlocking systems to facilitate the introduction of ERTMS

- Improve traffic operation and timetabling to allow increases in capacity, co-ordination of services and reduction in costs.
- To develop rolling stock and infrastructure standards based around a market-differentiated railway optimised for heavy freight, light freight or passenger rail serving the following rail market segments:
  - high speed
  - long and medium distance including international, national and inter-regional
  - short distance including regional (and rural) and suburban
  - urban rail (metro, Light Rail...).
- To develop track train and track designs to maximise the reliability of both, maximise capacity and minimise maintenance cost
- To improve station design to attract passengers and improve personal security and access and ensure lowest life time cost. Interchange has to be organised not only between the various rail market segments, but also between rail and other modes of transport
- To optimise operations at freight traffic nodes.

This cluster is dependent on collaboration between ERRAC with the leading European infrastructure manufacturers and suppliers who have an understanding of the integrated rail system and the European Construction Technology Platform. Currently, much of the European railway infrastructure reflects a heritage of 19th century station and bridge building and the conflicting needs of preservation and modernisation need to be balanced, requiring sensitive new construction especially at major stations.

The ageing of the population will be a driving force in changes to railway infrastructure maintenance. Presently this is still partly a manual activity, but as the availability of qualified people prepared to work on the railway declines, more automated inspection and maintenance techniques will be needed. This should also aim to reduce the cost of railway maintenance while increasing safety and security.

Achievement of the RBS 2020 targets for infrastructure LCC performance and value for money will depend on research into cost-effective maintenance and diagnostic systems and the implementation of appropriate track maintenance regimes. Research themes include:

- Automated track and structures inspection and maintenance ultimately leading to zero maintenance through the use of high reliability equipment
- Comprehensive implementation of LCC-strategies for infrastructure
- The 'station of tomorrow' in relation to defined market segments and the need to improve the interchange with other transport modes
- Low cost infrastructure construction methods
- The development of infrastructure and rolling stock standards to support the market based segmentation of the European railway network
- The development of train control systems to increase capacity

- Development of new operational rules and timetables for the railway that optimize capacity and interchange between rail services
- Development of procedures that allow greater flexibility in track access
- Development of low cost methods to increasing the quality of infrastructure
- Reduction in infrastructure failures causing delay
- Tools that can predict deterioration of both track and train as traffic levels increase, leading to scientifically based track access charges including classification of vehicles and track that reflect the damage inflicted on track and train.

This research cluster underpins the SRRA targets relating to passenger and freight growth which cannot be achieved without improved and additional infrastructure. Expected deliverables include:

- Higher reliability and availability of the railway system improving performance, customer satisfaction and available capacity as traffic levels increase to meet growth targets
- A commitment by all stakeholders to a global application of LCC and RAMS criteria
- Creating a sustainable market environment for both self-financing and public supported railways
- Developing incentives for vehicle manufacturers to design track friendly vehicles and for infrastructure managers to provide vehicle friendly tracks
- An increase in market share through increased competitiveness and attractiveness in freight and passengers rail transport
- Improvements in the European urban environment as city centre stations are redeveloped.

Impacts

These may be stated in the form of the following aspirations:

- A high capacity European railway network that meets the needs of all its customer segments
- An affordable railway network that meets market needs and enhances rail competitiveness
- A capacity increase of 20 per cent through the elimination of bottlenecks on trunk routes, especially on the Trans-European Network
- Maintenance costs reduced by 30 per cent in real terms between 2000 and 2020
- A 10 per cent increase in the availability of the network due to increased reliability and a reduced requirement for maintenance possessions.

Benchmarking

The modal shift and growth targets set out for the EU's rail networks are already being met in some Member States. Benchmarking will form an important tool in determining the factors behind their success and exporting these to the other European networks. Benchmarking will form an important tool in monitoring the overall progress of the SRRA targets and identifying areas for further research linked to their achievement.

It is also realised that other transport modes and industries carry out substantial research that is often directly applicable to railways. Benchmarking of these sectors will identify research of general applicability to railways and aid its transfer into the rail sector.

CHAPTER 4

Achieving the vision

This SRRA has identified the products and services which should be available in 2020, the likely political and business environment at that time and the customer focused research priorities. There are several key innovations to turn the vision into reality.

Intelligent mobility

A European-wide Intelligent Infrastructure is needed to support customer information systems offering a higher quality of service through seamless transport technologies between Member States and across transport modes.

High-performance Telematics systems to better manage passenger and freight traffic will demand better interface protocols to safeguard existing national investments while offering greater cross border utilisation.

The secure transmission of passenger information will need to balance civil liberties and security needs.

Future traffic management systems will include train positioning and related traffic management.

Independent databases will be developed with the ability to pool relevant information for operations management and logistical planning.

Innovative Communications Technologies, will exploit Galileo and mobile broadband to deliver all the above at affordable cost.

Energy and environment

Reducing dependence on fossil fuels

This will be achieved by increasing energy efficiency through improved route planning and optimised timetable. Other new developments will consider innovative fuels and vehicle propulsion systems and new power train technologies.

Improved energy utilisation on vehicles and track

Research will be based on a system approach at the wheel rail interface examining the potential benefits of lighter vehicle and reducing overall track forces.

Control of exhaust emissions

Detailed investigations will reveal methods to reduce diesel particulate generation and propagation.

Design for the environment

Due consideration must also be given designing for the environment which will include measures like closed cycle waste management systems for a high level of recycling.

A system approach to noise and vibration

Only a holistic approach will help reduce emissions and external perceived noise levels. Efforts will concentrate on reducing noise from individual sources and on technologies for active noise and vibration control. Additionally software tools will assist the development of methods to reduce noise at source, to derive technologies for active control and to enhance system assessment and decision-making processes.

Personal security

New concepts will be introduced to optimise personal security for customers and staff against acts of aggression, terrorist attack and vandalism.

Test, homologation and security

There will need to be an increased acceptance of European Homologation and Acceptance procedures to speed up product approvals while reducing risk through improved safety management philosophies. Specific issues to be addressed will include tighter interface management and risks associated with operating in degraded modes. There also needs to be increased emphasis on the impact of human factors relating to cross border and intermodal operations and on improving safety for trackside staff.

Competitiveness and enabling technologies

Rolling stock and sub-systems

New concepts will be introduced based on improved commercial models, the removal of barriers to interoperability and intermodality and improved vehicle and sub-system certification methods. New technologies will be developed for vehicle structures and components and production methods for cost-effective application of new materials and integrated functions. Virtual product development technologies will provide increased modularity, reducing R & D and maintenance costs.

Network Integration

The development of the integrated European network will be speeded up through improved investment models, sub-system certification and operational models.

Operations

Competitiveness will improve as a result of improved certification processes, capacity optimisation, new ticketing systems, innovative maintenance technologies and investment in intelligent mobility and interface harmonisation.

Strategy and economics

New accounting and planning models will provide a better understanding of the costs of operating and maintaining rail infrastructure and how these costs vary with changes to the frequency and types of train service. This will provide policy tools to encourage optimising the provision of infrastructure and services. Combined with an analysis of how train operators respond to track access charges which link the cost of damage caused and capacity utilised to the charge paid, then optimisation of full life costs of providing rail services is possible. Operators and infrastructure providers will then be able to respond to real incentives to cost reduction leading to an increase in the sustainability of rail.

Infrastructure

Cost efficient maintenance and maintenance-free infrastructure systems should be developed which would yield increases in traffic capacity, loading and track stability. New monitoring and diagnosis systems should be derived covering diagnostics, maintenance and life cycle cost assessment. Improved infrastructure conditions should be achieved for interoperability within and across modes and strategies to maximise integration of networks

Benchmarking

The development and implementation of these technologies will play a key role in achieving the Vision 2020. It is essential that consideration is made of product, service and technological developments outside the rail sector. Regular benchmarking of emerging technologies and monitoring of their deployment in other industries must be undertaken to pinpoint areas of possible transfer. This could identify research fields where co-operation with other transport research institutes could be beneficial to the rail mode.

EU transport policy has resulted in major institutional changes for railway companies and the railway system. Much progress has been made with EU legislation on competition between railway companies. However, much still has to be done to achieve the full potential of the railways and to ensure they are the backbone of the transport system.

Training and education

The development of the European Railway sector will need well managed and collaborative research and targeted research-led education. By addressing the needs of the sector the European University of Railway- EURail could provide the conditions to develop, at European level, high quality training and education activities for the railway community of tomorrow.

In line with the SRRA of ERRAC, EURail is expected to promote interaction among its associates and to define clear and realistic objectives in view of the creation, dissemination and transfer of knowledge within the railway sector.

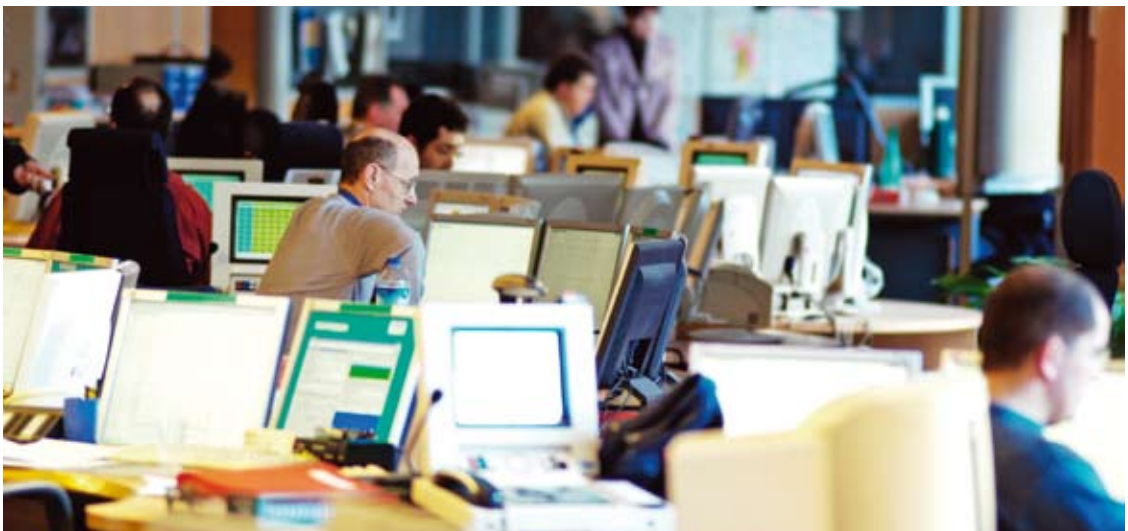
Based on knowledge, experience and people from "real" universities in Europe, EURail is "virtual" in nature and aspires to foster excellence by gathering and networking the different relevant organizations and institutions around educational projects suited to the technical and commercial needs of the European Rail sector. EURail's unique feature is this concentration of high-level knowledge and expertise in one single sector/problem-oriented institution. It is expected that EURail will form a coherent community able to define lines of actions and conduct sustainable business in close liaison with the all the industry stakeholders.

Conclusions – the vital role of innovation and cooperation

Innovation is needed to support all these initiatives. While the European rail supply industry is the world leader, there is still an issue over the speed of application of innovation within Europe. Better coordination between different aspects of rail research, standardisation and TSI development need to be established to make better use of scarce technical resources and accelerate the market take-up of new products.

Many product, logistics and service innovations for use in infrastructure are already ripe for accelerated implementation. In addition, major new developments that consider the track system from a holistic point of view are continuously being made. For instance, deeper research into the area of rail and wheel mechanics and interactions, and the implementation of measures countering phenomena such as Rolling Contact Fatigue are of paramount importance.

Achieving understanding and cooperation between leading system stakeholders, including railway infrastructure managers and specialist suppliers, is fundamental. So is increasing the efficiency of R & D through sharing technology between transport modes to find solutions between modes in fields such as passenger cabin comfort, sustainable materials, human factors and stimulation of radical technological changes. The research could involve the relevant stakeholders from aeronautics; rail; road and water transport and take into consideration the global dimension.



www.cer.be

www.eimrail.org

www.uic.asso.fr

www.uitp.com

www.unife.org

www.errac.org

Contact

ERRAC Secretariat, UNIFE

Tel: +32 2 626 12 60

e-mail: errac@unife.org

ERRAC Project Management, UIC

Tel : +32 2 21 30 832

e-mail : schut@uic.asso.fr