Major Projects of Joint European Railway Research

Imrich Korpanec

1. Introduction

Greater coordination of R&D which combines human and financial resources in a cost effective manner is becoming vital. In this context the European Rail Research Institute (ERRI) plays an important role in the initiation and management of major European railway projects aimed at:

- Increasing the productivity and profitability of railway companies,
- Optimizing infrastructure use of the Trans-European railway network,
- Increasing the attractiveness of passenger services,
- Enhancing safety, and protection of the environment.

This article briefly summarizes the major achievements of the past, gives reasons for the changes to respond to future challenges and describes the future role and dimensions of ERRI.

Some examples of innovation and rationalization of railway technology as a result of ERRI's past and current work are also presented.

In view of the future objectives, the priorities for a UIC (Union Internationale des Chemins de fer) R&D programme have been defined and the following major projects commissioned from ERRI:

· ETCS	European Train Control System
· CITHER	Communication and Information Technology for Harmonizing European Railways
· INGOTRA	INnovative GOods TRAffic and handling systems
· ENVIRAIL	ENVIronmentally friendly RAILways

Finally, this article describes the initiation phase and the ERRI approach to the execution of these major projects.

2. Major Achievements

It would have been almost impossible to achieve and implement technological innovations in international traffic without the coordinated efforts of railway engineers within the UIC and the support given by its Office for Research and Experiments (ORE). Despite all the differences in current collection, signalling and safety systems, ORE work also enabled both passenger and freight conventional trains to operate internationally without special technical obstacles. Nevertheless, the latest changes for the railways required a new approach to further development and R&D needs. Formulation of clear R&D objectives reflecting business orientation for both railway operators and infrastructure, and the consequent transformation of ORE into ERRI were a response to future challenges.

As assessed by railways themselves, the most valuable ORE activity was work on standardization of goods wagons. Starting with the standardization of components, standard wagons were subsequently developed and manufactured according to unified drawings administered by ORE. Since the bogie wagon increased in importance even in goods traffic, the Y25 and 65 bogies were standardized. Of course, these can also be fitted to standard and special wagons. At present, there are more than 100,000 standard wagons operating in Europe and more than 500,000 standardized bogies have been produced. The advantages of such application of standardized products are evident, e.g. substantial cuts in costs of development, building and testing prototypes on individual railways and facilities operation, maintenance and overhaul of the standard rolling stock.

To meet different comfort criteria and service requirements, standardization of passenger coaches was limited to ensuring functional compatibility and interchangeability of components. ORE was mainly concerned with standardization of the mechanical parts, unification of air-conditioning and electrical equipment and also carried out work on fire protection and improvement of cleaning procedures.

Many other ORE investigations contributed to increasing the productivity and safety of the new rolling stock, e.g. investigations into the stability of running, prevention of derailment, adhesion and braking problems.

To meet the railways' demands for higher speeds and axle loads, investigations into the most efficient way of adapting the infrastructure to those requirements were also necessary. These investigations resulted in draft recommendations and specifications for the design of track components, railway substructure, bridge construction, tunnel profiles, etc. On the basis of ORE tests, for example, the UIC 60 rail was standardized and new calculation, design and maintenance methods were developed enabling the service life of bridges to be extended and maintenance of railway infrastructure to be minimized.

ORE also contributed to solving different problems involved in the wider application of telecommunications and electronics on railways. For example the characteristics of data transmission links between railways, together with the characteristics of different modems were tested by ORE, proving the technical feasibility and viability of the HERMES network (the European railways' interconnected data transmission system).

Finally, just one of the most striking examples—the world record speed on rail of 515.3 km/h, set by SNCF,

recalls the study on maximum speeds attainable on wheel/rail systems carried out by ORE more than 20 years ago. The results of this study, published in 1972-73, predicted that commercial speeds of 300 to 350 km/h would be technically possible, with speeds of over 400 km/h attainable in special tests. These predictions were greeted with considerable scepticism at the time, but they have been completely vindicated by developments in Europe since then, emphasizing the importance of ORE as a forward-looking research body for the railways of Europe and the world.

3. Need for Change

Despite these very remarkable achievements, the changing environment for European railways had a serious impact on ORE's potential to continue the work efficiently. The railway experts provided to ORE free-of-charge were more-and-more needed at home to work on national projects to increase the competitiveness and attractiveness of the railways. ORE did not have its own resources and was fully dependent on the availability of railway experts, and therefore it was almost impossible for it to continue to fulfill its original mission.

To follow up the strategic objectives of railways, it became evident that the R&D programmes and their execution had to be more business-oriented and had to meet customer needs. This also required the implementation of a clear customer-contractor relationship in UIC and ORE work; this work resulted from a definition of R&D strategic objectives based on customer needs for joint R&D projects. In addition, the new EU Directives provided access for different operators to the railway infrastructure; directives on interoperability placed a new emphasis on technological development for the railway industry, operators and infrastructure owners.

To clearly demonstrate the change in philosophy and the European character of this new body, there was a proposal to change its name to the European Rail Research Institute.

4. Role and Dimension of ERRI

The principle role of ERRI is similar to that of ORE, i.e. to conduct research, studies and tests on railway topics for the benefit of railways, with particular emphasis on new technology. However, there is a principle difference in the way ERRI is to organize, manage and execute such work not only for the UIC, but also for specific railways, railway industry groups and any other third parties. A professional and commercial approach is required for ERRI to provide high-quality service for its present customers in a competitive environment. All ERRI work has to be carried out under contracts or internal agreements, including relations with the railways providing specialists.

It is expected that ERRI will take on some new tasks, for example:

- Participation in drawing up the programmes for test facilities which, by virtue of their unique or specific nature or the quality of service which they provide, are of strategic importance to the development of railway transport.
- Approval and certification of rolling stock and new technical products, which will probably involve cooperation with industry and recognition by the relevant EU bodies.

To fulfill its role, ERRI will employ personnel with expertise in railway technology, who are also proficient in the fields of project management and contract administration. This will constitute the main in-house expertise.

ERRI will also employ specialists for major projects to form the project teams working on a permanent or semi-permanent basis.

External resources will be used on the basis of contracts awarded following competitive tendering and issued to the railways, national research bodies, universities, industry and similar bodies.

The size of ERRI will be determined by long-term business plans. In principle, ERRI should remain a small organization —initially, at least—drawing most of its resources from external suppliers under contract (for example, railway specialists, research centres, universities, industry, specialized test facilities).

However, increased marketing and project management activities will be necessary. ERRI should also be prepared to get involved in the management of selected laboratories and test centres or to create joint ventures with the aim of providing specialized services (e.g. approvals and certification). Specialized facilities will therefore be necessary.

5. Objectives-Present Activities

The need for research at ERRI will be dictated by the market, i.e. by our customers, with the orientation primarily towards:

Cost reduction—increase in productivity

The following ERRI studies are particularly aimed at these objectives:

- Increasing the maximum speed of wagons with 22.5-t axle loads, acceptance tests with the automatic draw-only coupler for freight traffic,
- Possibilities for weight reduction of passenger rolling stock, fault diagnostics for and on trains,
- Decision support system for permanent-way maintenance and renewal, extension of the service life of track components, in particular rails and bridges.

Increased attractiveness and improved performance

The following are examples of ERRI work contributing to these objectives:

- Ride comfort, in particular with a view to improving passenger comfort in curves and in tilting-body coaches.
- Braking conditions at high speeds,
- Detection system for locating irregularities on running trains, etc.

Safety

Most current ERRI work is related to this task, for example:

1. Safety in freight traffic

- Assessment of new braking systems,
- Reducing risk of derailment for longer and heavier freight trains operating at speeds above 100 km/h.

2. Safety in passenger traffic
· Improvement of fire prevention of passenger rolling stock,
· Increasing crash resistance of vehicles.

Environment

Extensive studies on reducing wheel-rail contact noise have been carried out by the C163 Specialists' Committee which is now supplementing its programme to cover the very urgent problems connected with noise pollution by freight traffic to be incorporated in the ENVIRAIL project.

Interoperability

Since one of the principle objectives of ORE was to execute joint research and testing with a view to harmonizing technical solutions, e.g. by drafting UIC leaflets, many of the present ERRI questions are also related to interoperability. This particularly applies to the work of the committees dealing with:
· Standardization of wagons, coaches and their components,
· Unification of air conditioning and electrical equipment,
· Standardization of wheelsets,
· Transmission of information in the train by a central data line,
· Acceptance tests of diesel engines,
· Pantograph-overhead line interaction,
· Loading diagrams for bearing capacity of bridges,
· Testing and approval of railway vehicles.

6. Train Control System-ETCS

The major project executed by ERRI is the complex task of drafting specifications, designing and implementing the new generation train control system known as the ETCS Project.

ETCS has to satisfy high safety requirements, but this does not exclude the possibility of low-cost solutions. An open system should allow flexible adaptation to various future operating requirements: high speeds, denser traffic on conventional lines and operation on secondary lines. In addition, compatibility of ETCS vehicle equipment with the currently-used infrastructure is required because this will continue in use for some time.

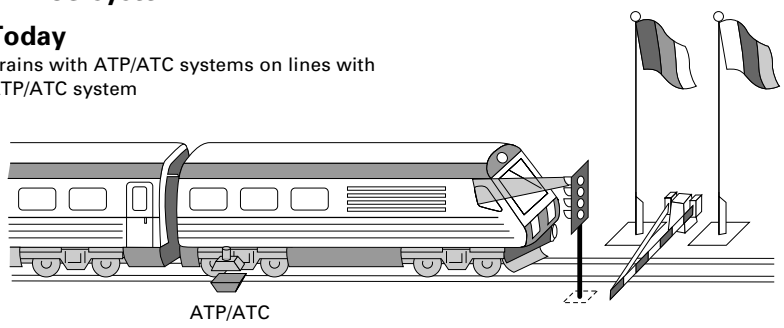
To date, the ERRI A200 Specialists' Committee, composed of specialists from the major European railways, has completed drafting FRS (Functional Requirements Specifications), and work on SRS (System Requirements Specifications) is well advanced. At the same time, the European signalling industry—with the financial support of the European Commission—is working on the EUROCAB, EUROBALISE/EUROLOOP and EURORADIO R&D programmes as integral parts of the future ETCS system.

The large functional flexibility means that a modular design is needed for the ETCS hardware and software, in particular for the EUROCAB vehicle equipment, the main components of which are:
· ETCS Computer system and ETCS bus,
· Interface device and antennas for existing ATP (Automatic Train Protection) and ATC (Automatic Train Control) systems,
· Man-machine interface,
· Speed and distance measurement device,
· EUROBALISE/EUROLOOP receiver,
· EURORADIO interface,

■ ETCS system

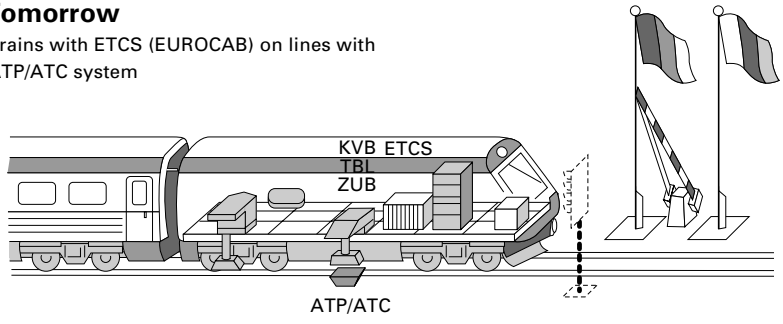
Today

Trains with ATP/ATC systems on lines with ATP/ATC system



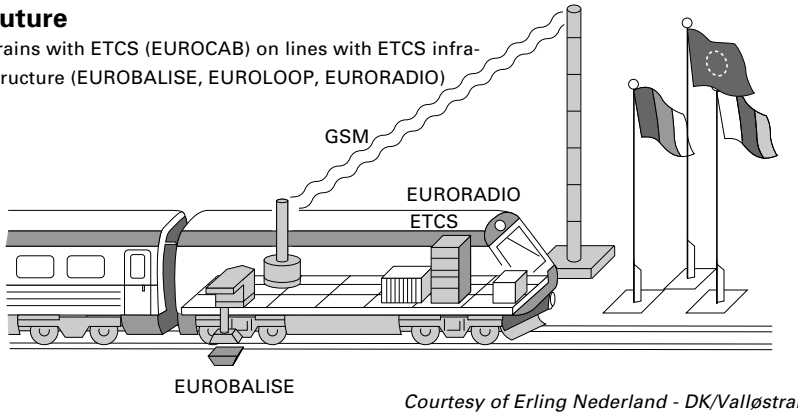
Tomorrow

Trains with ETCS (EUROCAB) on lines with ATP/ATC system



Future

Trains with ETCS (EUROCAB) on lines with ETCS infrastructure (EUROBALISE, EUROLOOP, EURORADIO)



Courtesy of Erling Nederland - DK/Valløstrand

- Brake driver,
- Train integrity checker,
- Recording device,
- Route map,
- Interface with other functions (automatic driving, fault diagnostics, door control, etc.).

EUROBALISE uses a fixed-installation transponder which sends data as soon as it is activated by the vehicle device passing overhead. On the track, the EUROBALISE module is either directly connected to a signal box or to a block system.

The EURORADIO module is an interface for radio transmission of safety data. It is envisaged that data will be transmitted by the future digital UIC train radio (application of GSM-UIC EIRENE Project) in the 900-Hz frequency range.

EUROLOOP presents an alternative to radio transmission. The messages are inductively transferred by loops in the track or via a circuit formed by the rails themselves. It is used to activate specific procedures.

Coordination of railway and industry activities is specified by DG VII of the European Commission who also intend to provide financial support for railways contributing to completion of the specifications and to testing.

Three levels of applications are envisaged by the modular approach of ETCS, namely:

1. Automatic Train Protection (ATP)
This provides continuous speed monitoring:
- with or without cab signalling,
- with supervision of line speed and braking to restrictive taregets,
- with or without target information updating.

2. Automatic Train Control (ATC)
This provides:

a. ATP plus continuous display in the cab of variables helping the driver to drive as closely as possible to the monitored speed limit, and or supervision braking:
- with line-side signals at block limits,
- without line side signals,
- with reduced number of line-side signals, and

b. Continuous train location (radio block).

7. Communication and Information Technology-CITHER

The main purpose of the CITHER project is to ensure the telematics interoperability of the railway communication network and compatibility of international applications in order to allow user-friendly access to the network for any clients in any European country. CITHER should make national solutions and applications homogeneous and compatible, as well as offer new low-cost possibilities to the European railways by extending the market for industry and decreasing procurement costs.
The project has four major topics:
- Telematics interoperability,
- Interaction of networking technology,
- Trackside underground network,
- Multimedia application

The main objective of telematics interoperability is to define how to use computerized communication to link all major national railway applications and projects to optimize European railway productivity using the latest information technology: teletransmission, radio transmission and data processing. One practical example of the project's output will be the interconnection of the national reservation systems, such as KURS 90 on DB AG in Germany with RESARAIL on SNCF in France.

The work on the interaction of networking technology is aimed at developing and testing the principles of a multimedia idle private network, but using public communication facilities where appropriate; this will blend state-of-the-art and more conventional technology for Wide Area and Local Area Networks.

The purpose of the trackside underground network for European railways is to develop a wayside communication network meeting specific requirements, particularly related to safety issues, for example:
- Linear distribution of European train control system access points (railway radio base stations, transponders, signals, track circuits and axle counters, Automatic Vehicle Identification ground stations, switches, level crossings, warning devices, telephone sockets, etc.),
- The demand for very high availability and the high level of safety required,
- A traffic pattern which is locally sporadic but consistent over a track section with dynamic allocation of resources,
- Transmission over widely-available copper cables with an aggregate data speed lower than 2 or possibly 8 Mbit/s.

The work on multimedia applications and networking will demonstrate the feasibility of an application project which relies on the possibilities made available by the progress achieved in the above tasks. The pilot demonstrator will make it possible to have an international transit train equipped to monitor passenger safety using data compression techniques to transmit semi-moving video pictures of only those views where safety appears to be endangered over various transmission units to a remote ground surveillance facility.

8. Innovative Goods Traffic -INGOTRA

The purpose of this programme is to define technical possibilities for improved and more economical transport quality in rail freight traffic. Freight operations will provide market-oriented and efficient transport services by giving top priority to adapting their activities to customer and market requirements. This, plus cost reduction measures, will ensure the future of rail freight. The emphasis must be placed very definitely on customer needs. This will require the development and introduction of new products and improvement of the existing ones.

The major technical opportunity comes from automated logistics. The current progress in logistics and automation should allow these operations to be done more quickly and cheaply in the medium term. Moreover, it is very often necessary to have a quick intermediate transfer of the load (loads of various sizes - container/

■ The intermodal future of freight *(K.IWASA)*

swap body to cargo box) between two carriers (rail/rail and rail/road).

This applies firstly to combined transport: maritime terminals have already made a lot of progress in making container handling easier. This progress should be extended to the continental market.

Another opportunity lies in the operation of heavy and long trains. Profits can be made using radio-controlled locomotives and new control-command systems, etc.

The proposed projects within the INGOTRA programme address this business potential by proposing a modular, interoperable freight system for Europe taking into account the opportunities for improving the performance of intermodal freight traffic. The interoperable and flexible trans-shipment techniques are therefore the main issue to be investigated.

The first project sets out to improve and demonstrate an advanced terminal system and to evaluate a European integrated transport chain. This will be done by developing a limited number of types of trans-shipment depots and a limited number of types of wagons to provide a modular, interoperable system for handling intermodal traffic load units. These are a range of standard containers, swap bodies and semi-trailers.

The second project studies a number of issues related to the possibilities of carrying entire lorries or semi-trailers on a railway, in the meantime including technological innovations to be incorporated in conventional wagon load traffic. The sub-projects include the design of wagons to allow lorries to drive onto the train from the side along the full length of the train, the performance and stability of such vehicles, the need for a low noise system and considerations for an optimized loading gauge. Other parts of the work are related to the design and operation of the terminals and to the relevance of the technical concepts to the market requirements.

The EU within its 4th R&D Framework Programme also emphasizes future Rail Freight and Passenger Management, focusing on particular aspects of high-speed mixed traffic. ERRI intends to respond to the call by proposing:

- To study the requirements for high-speed rail freight transport,
- To increase reliability and safety in high-speed freight transport,
- To evaluate the effects of shared utilization of the high-speed network,
- To assess the optimum balance of investments between advanced rolling stock and the construction of new track.

9. Environmentally-Friendly Railways-ENVIRAIL

The objective of the railways in carrying out environmental research is to support a sustainable transport business in the medium and long term. There are two kinds of benefit: benefit to the environment, and benefit to the railway organizations themselves.

Economic benefits include increased competitiveness, reduced remedial environmental costs, reduced investment costs, reduced liability to damages claims.

A number of areas of environmental concern have been identified as possible research topics:

- Noise and vibrations,
- Electromagnetic interference,
- Energy consumption and air pollution,
- Substances and materials,
- External safety when transporting dangerous goods.

ERRI has carried out extensive studies on reducing wheel-rail contact noise, in particular the noise emitted by high-speed passenger fleet trains. A very sophisticated model was developed by TNO, Delft at ERRI's request and validated for this purpose by railways working within the ERRI Specialists' Committee C163 on high-speed lines in France, Germany and Italy.

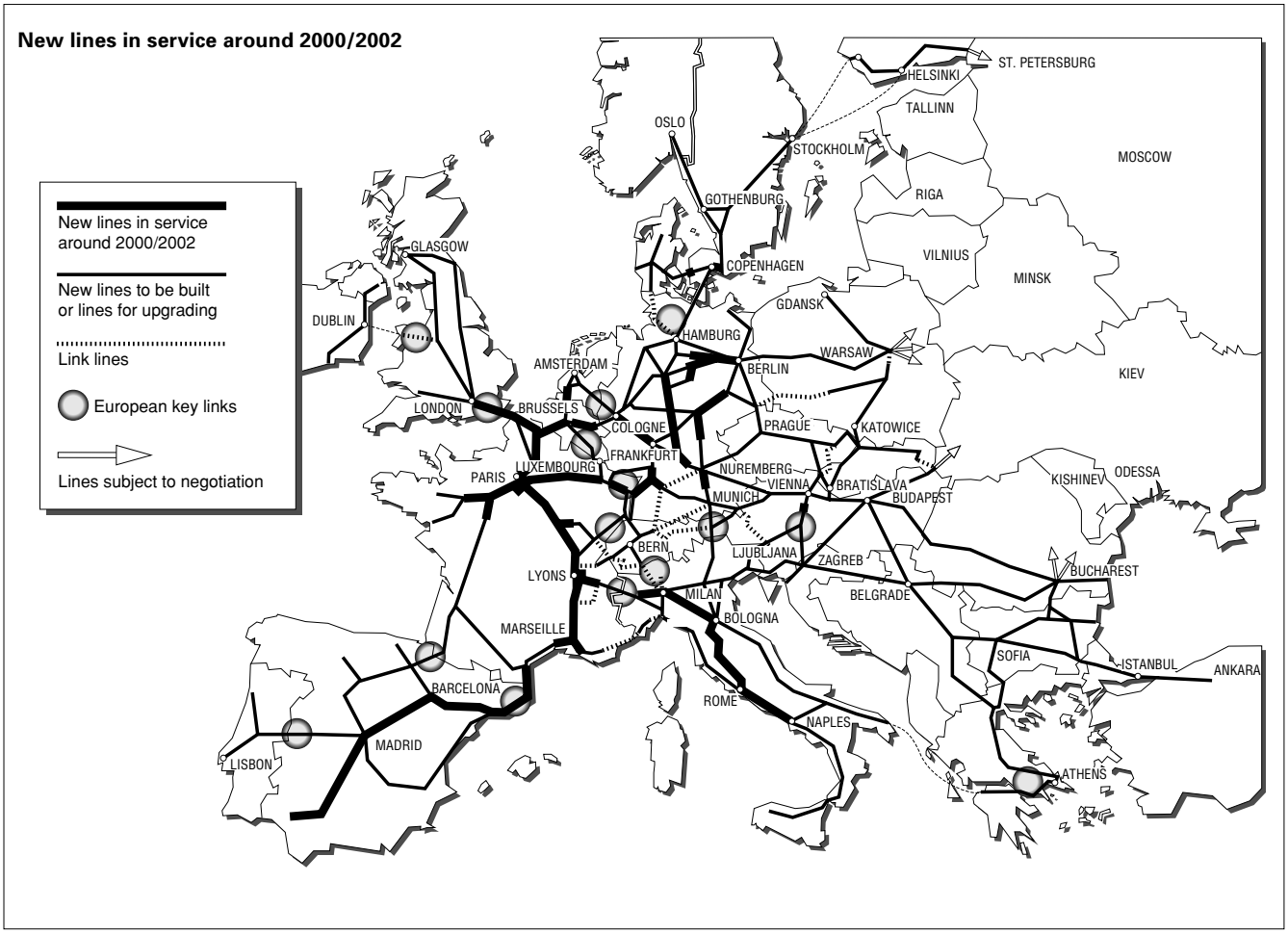
A major problem at present, particularly in countries with heavy freight transit traffic and countries operating freight traffic during the night, seems to be public reluctance to accept the present level of noise annoyance caused by the increase in this type of freight operation. The ENVIRAIL programme addresses these sensitive issues by proposing to concentrate efforts on the following two projects:

- A silent freight train with the emphasis on contact noise, brakes and vehicle design with low noise components.
- Silent track with the emphasis on investigation of components contributing to noise emission in the wheel-rail contact zone.

The objective of the silent freight train is to develop a number of innovative solutions applicable to existing freight vehicles and making it possible to reduce their contribution to railway noise by 10 to 15 dB at reasonable retrofit costs, or even by up to 23 dB by optimizing new components in the train set. A similar solution to be investigated for the design stage of future freight rolling stock would include appropriate techniques for predicting the noise level which has to be decreased by about 15 dB compared with current typical values.

The list of tasks comprises topics such as the acoustic of wheel-rail interaction, specific requirements for silent brakes, shielding, behaviour of the vehicle superstructure, etc. A particular sub-project to be incorporated at a later stage is a demonstration model of a low-noise freight train fitted with optimized existing components.

The objective of the silent track is to develop a number of innovative technical solutions for existing tracks, enabling a reduction in their contribution to railway noise by about 3 dB. Similar solutions applicable for the future infrastructure and including prediction techniques must be developed. The aim is to reduce the component contribution to



railway noise from new structures by up to 10 dB with parallel optimization of vehicles with respect to noise.

The main deliverables for both projects will be as follows:

- Development of models and tools,
- Measurements for collection of reference data on noise levels,
- Application of tools for design of low-noise solutions,
- Assessment of industrial feasibility and realization of prototypes,
- Harmonization, guidelines, standardization,
- Test and validation of models and prototypes.

10. Conclusions

The demands for transportation in Europe will increase dramatically due to the latest political and economic developments.

European railways are meeting this challenge and are prepared to invest in the research which can increase their market share both in transportation of passengers and goods.

Optimization of infrastructure and rolling stock construction and their utilization to increase the productivity and thus profitability of railways, enhanced safety and protection of the environment are topical issues for which the technological research conducted by ERRI can offer good value for the money railways invest in their futures.

ERRI is prepared to contribute to the general objectives of the majority of European railways as formulated at the 2nd World Congress on Railway Research held last November in Paris, i.e. to achieve an interoperable European network with a railway that is light, gentle, low on energy consumption, quiet, clean, efficient and productive. ■

Imrich Korpanec

Dr Imrich Korpanec, the current Director of ERRI/UIC, was born in 1944 in Uzhorod. He completed his doctorate thesis in railway infrastructure in 1970. He has been Senior Lecturer and Scientific Assistant at the Prague Technical University; Technical Officer responsible for planning and supervision of R&D including research and testing centres with Czech governmental support/funding; Technical Adviser for Infrastructure Questions at ORE/UIC, and Director of the International Department of the Czech Federal Ministry of Transportation.