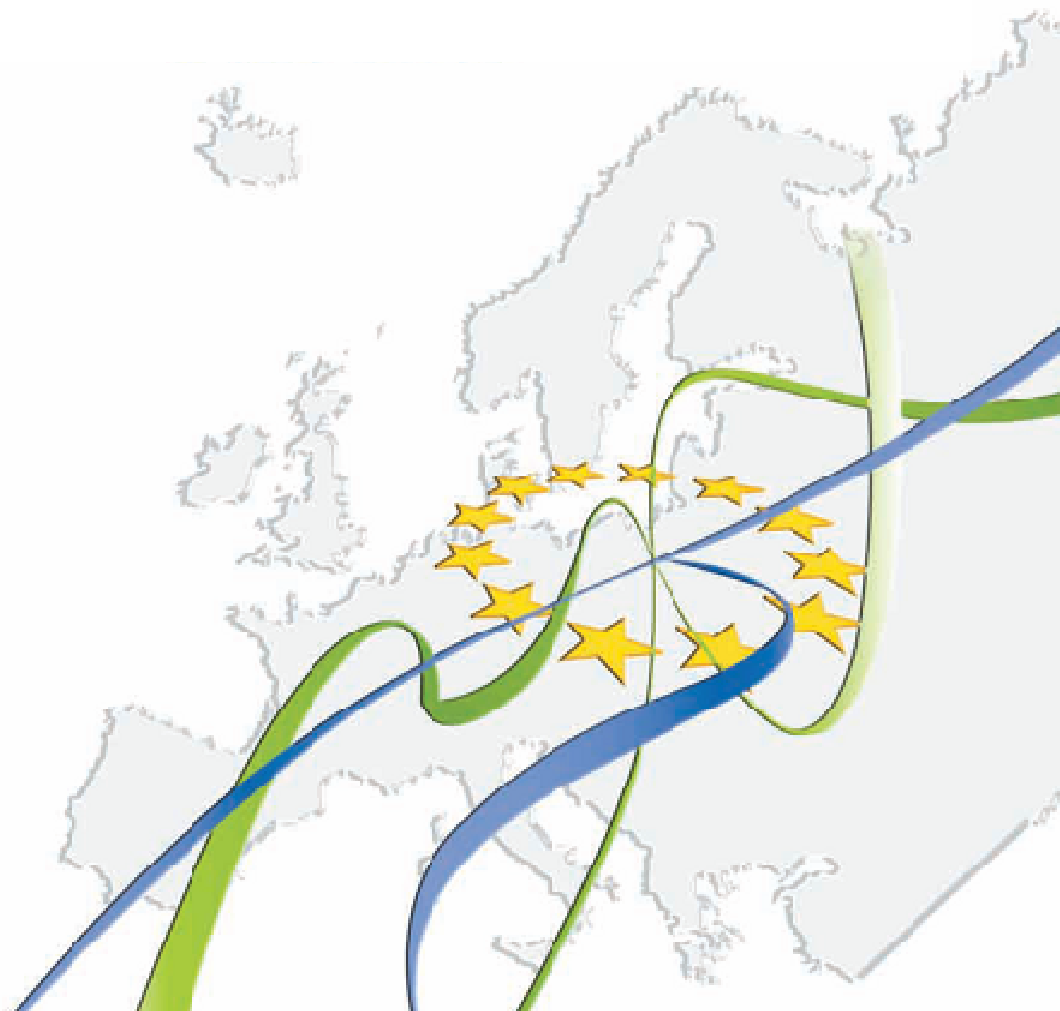




European Road Transport Research
Advisory Council

ERTRAC Research Framework



April 2006



ERTRAC Research Framework

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Executive Summary

After the publication of the “Vision & Challenges” and the “Strategic Research Agenda”, this is now ERTRAC’s third document, the ERTRAC Research Framework for 2007 – 2015 (ERTRAC-RF).

The ERTRAC-RF is divided into four main thematic fields of research or “pillars”, supporting two fundamental aspects of the road sector: The need to provide for free movement of people and the transport of goods, in line with the key objectives of the European Union, both at local and intra-regional levels. This is reflected in the sections for “Mobility, Transport and Infrastructure”, “Safety & Security” as well as “Environment, Energy & Resources”. The second is the competitiveness of the European industry, addressed in the section “Design & Production”.

Overall the ERTRAC Research Framework responds to the European citizens’ demand for road transport, to the developing needs of society and to the essential aspects of managing one of Europe’s greatest assets – its road transport network.

The document concludes with ERTRAC’s recommendations for the way forward. This includes an overview of both the organisational and budgetary requirements to deliver the clean, energy efficient, safe and intelligent road transport system and a competitive road transport industry as demanded by Europe’s citizens and enterprises.

ERTRAC believes that this ERTRAC Research Framework is useful for FP7 planning as well as for the planning of national activities. Therefore highly important research priority topics which should be part of the first FP 7 calls are explicitly mentioned. They are relevant for the research priorities

- Transport,
- Energy,
- Environment
- Information and Communication Technologies, and
- Nanosciences, Nanotechnologies, Materials and Production.

This document is a living document, and will be periodically updated.

1. INTRODUCTION

Alignment of Stakeholders

In 2002, high level representatives of all the major stakeholder groups in European Road Transport have launched the European Road Transport Research Advisory Council (ERTRAC). ERTRAC members represent consumers, vehicle manufacturers, component suppliers, road infrastructure operators and developers, service providers, energy suppliers, research organisations, cities and regions as well as public authorities at both European Union and national level. The aim of this cooperation was to develop a common vision for the sector and to specify respective research needs. This is the first time that such a holistic view of the road transport research needs has been taken. It is also the first time that all the major stakeholders have been aligned so effectively, agreeing a common vision and the way forward.

The Research Framework presented by ERTRAC in this document has been developed through extensive and intense workshops and reviews throughout the sector, involving hundreds of actors and SMEs. It is based on ERTRAC's "Vision 2020 and Challenges" and the "Strategic Research Agenda", which were published in 2004. The "ERTRAC Research Framework" focuses on the period 2007-2015. Research activities beyond this timeframe will build on early research result.

Importance of Road Transport

The "ERTRAC Research Framework" reflects the fundamental importance of the road transport sector. Road transport plays a key role in European society. It employs more than 9% of the work force (source: ERF, Road Statistics, 2005) generates a turnover that represents 20% of the EU's GDP. Road transport satisfies the majority of mobility demanded by Europe's citizens and businesses. It is responsible for over 75% of inland freight transport (source: EC, Energy&Transport in Figures, 2003), as such it plays a crucial role in all European industrial and commercial activities. In addition, the importance is reflected by high level activities such as the recent European initiative CARS21, which was set up to improve the global European automotive industry, of which research is one of the key pillars.

Challenges to be faced

It is clearly recognised that the services provided by road transport are not free of penalties. Despite significant improvements over many years, the number of fatalities due to road accidents remains too high. Air quality and noise continue to affect a substantial number of people and energy consumption in the sector contributes to global Green House Gas emissions and increases Europe's reliance on external fuel sources. Those challenges have to be addressed in a highly competitive environment. ERTRAC confronts those challenges head-on in it's Research Framework. By joining forces and acting in a coherent way, ERTRAC will provide practical solutions.

Bringing Europe together

ERTRAC proposes research that will support the free movement of goods and people throughout the EU and beyond. Mobility of people is a prerequisite for the social integration of Europe and is essential to maintain our standard of life. Personal mobility in the road transport system by means of personal motor vehicles, buses or non-motorised transport is fully covered by the ERTRAC systems approach. Similarly, future public transport systems, integrating road vehicles with other modes, play an obviously important role.

Road transport in Europe is - and will remain - the most practical means in most cases for transporting goods to markets, including in almost all cases transport to their final point of delivery. With seamless movement from one country's road system to another across the whole of Europe, road transport avoids many of the unintended barriers to trade associated with other transport modes. Many of the new Member States and candidate countries will rely on road transport for their links with the rest of Europe for the foreseeable future and research is needed to improve the performance of those links.

Safe and secure

Contrary to common perception, some important road transport modes are among the safest forms of transport. Thus, bus passengers and motorway travellers enjoy some of the highest levels of safety, although this varies across Europe. As traffic volumes increase, new safety challenges will be faced and dealt with by the research proposed by ERTRAC's Research Framework. However, road transport in urban areas will remain a significant safety challenge and require major research investment.

Influence on European research and innovation.

The central role placed on the road sector in Europe, is reflected in the critical importance of the research in the sector. Moreover, this research has a substantial influence on overall European research environment. Industrial R&D in the sector represents approximately 30% of overall EU industrial R&D (source: Joint Research Centre, R&D Scoreboard, 2004). Therefore, not only is the sector one of the most important actors in European research, but it presents also a unique opportunity for a realignment of public-private cooperation in the field. In partnership with the European Commission, ERTRAC has sought to ensure that this realignment can take place through its Research Framework.

Driving forward together

ERTRAC's Research Framework is structured into four main thematic fields of research or "pillars", supporting two fundamental aspects of the road sector:

The need to provide for unhindered movement of people and the transport of goods, in line with the key objectives of the European Union, both at local and intra-regional levels:

- Mobility, Transport and Infrastructure
- Safety & Security
- Environment, Energy & Resources

The competitiveness of industry:

- Design & Production

Clearly there is synergy between the pillars and hence some unavoidable overlap between them. Where major overlaps occur it is explained in the text.

Overall the Research Framework responds to the European citizens' demand for road transport, to the developing needs of society and to the essential aspects of managing one of Europe's greatest assets – its road transport network.

This document concludes with ERTRAC's recommendations for the way forward. This includes an overview of both the organisational and budgetary requirements to deliver the clean, energy efficient, safe and intelligent road transport system and a competitive road transport industry as demanded by Europe's citizens and enterprises.

The ERTRAC Opportunity

Over 28 billion Euros are spent each year on R&D in Europe's road transport sector. Today these activities are largely managed within individual stakeholder groups and member states. It is apparent that a good alignment between European and national as well as between private and public research activities can provide major benefits in terms of economic efficiency, quality of results and reduced time to application of innovation.

It is ERTRAC's mission to explore those opportunities and make specific recommendations for implementations. ERTRAC's inclusiveness of all major road transport actors makes it unique and allows to take a much more holistic and integrated view on road transport issues.

ERTRAC is therefore key to successfully and effectively addressing today's and future road transport challenges. Some of ERTRAC's specific opportunities relate to

- Making specific recommendations for large cross-stakeholder research topics
- Recommending international cooperation needs
- Defining priorities that are agreed by all stakeholders
- Aligning European and national research agendas and programs
- Monitoring progress and adjusting research road maps accordingly
- Providing a platform for continuous alignment and cooperation

2. The Research Programme

2.1 Mobility, Transport and Infrastructure

The research recommendations described in the Work Area *Mobility, Transport and Infrastructure* encompasses many of the major societal and business needs placed on the road transport sector. This includes accommodating the varied and changing mobility requirements of Europe's citizens. Careful and coordinated research will ensure that the growth in mobility demand will, through appropriate intra-modal redistribution, enhance the vibrancy of our cities rather than choke them. The research described in this section also reflects the needs of the freight transport sector which is crucial for the competitiveness of Europe's businesses. This research will decongest the major transport corridors allowing free movement of goods in a way that respects the safety and environmental concerns addressed elsewhere in this document.

The specific targets of this research activity are:

- The necessary solutions will be provided to improve mobility and satisfy the expected 32% increase in individual demand for travel by 2020 (EU-25 Energy and Transport Outlook to 2030).
- Solutions to enable fluid and efficient movement of an increasing quantity of goods within the overall freight transport system will be developed and demonstrated.
- In order that quantifiable targets can be set in the future, a series of robust indicators, such as transport efficiency for passengers and freight, journey time reliability, user service levels and network efficiency, will be developed. These measures, coupled with greater information provision, can allow appropriate choices to be made.
- Full compatibility of Member States' data and models relating to social trends and behaviours is necessary. Development and full integration of mobility forecast models into local and regional network management plans must also be achieved.
- Increased network efficiency through reductions in the impact of maintenance activities, prioritised road space and traffic management will be developed and demonstrated.

The research activity is structured into five key areas:

- Mobility & Vehicle Concepts
- Urban Mobility and Freight Distribution
- Long-distance Freight Transport
- Social Trends and Behaviours
- Mobility Management & Information Provision

Mobility & Vehicle Concepts

The research conducted in this theme will deliver innovation in technological and systems development to provide a more cohesive transport system. Concepts for vehicles and infrastructure will provide integrated vehicle guidance with appropriate road space solutions for motorised and non-motorised mobility. Research and Development of new concepts for the elderly and disabled travelling population will further contribute to delivering adequate provision. Research will also support the maximum availability of road space with quicker return to operation after maintenance and incidents.

New Concepts

- This research will develop new concepts for mobility systems that offer customers full “door-to-door” services, e.g. direct and safe links from residential areas to schools and shopping centres. Full, multimodal journey support from origin to destination (with maps, information, etc.), with customised HMI (Human–Machine Interface) and a range of additional services for the user will be demonstrated.
- Concepts for passenger transport vehicles, infrastructure and information provision will be developed and tested for the mobility, accessibility and comfort needs of elderly and disabled citizens. These will be supported by the development of business models and financing mechanisms.
- Development will continue of new transport services that fill the gap between private and public transport (car pooling, collective taxis, bus on demand). New car ownership systems will be explored.

New Vehicles

- Building on previous results, continued large-scale research in the design of buses, including Bus Rapid Transit (BRT), vans, private and shared vehicles, and guided vehicles will be carried out to meet customer requirements, improve safety and security, and human interfaces.
- Concepts for multi-purpose vehicles, for example passenger/freight carrying vehicles, will be developed and demonstrated. This research will be supported by the development of business processes to support multi-functional operation.

Highway Infrastructure

- The concept of dedicated lanes and networks will be further developed and tested for new applications. This large-scale research will include the development of light-weight and reconfigurable infrastructures designed for passenger cars as well as reconfigurable and dedicated lanes for freight and ‘e-Safety’ and Automatic Vehicle Guidance (AVG), enabled vehicles.
- As a first step to the Automated Highway, systems enabling the platooning of vehicles will be developed and evaluated for safety and capacity increase. Further research on Automatic Vehicle Guidance (AVG), in particular speed and distance management systems for heavy vehicles, will be used to demonstrate its potential to increase road capacity and support integration into road infrastructure.
- The upgrading of infrastructure monitoring and maintenance management systems will be supported by research into advanced software, sensors and data transmission, responding to real-time local needs and reducing the impact of road works on travel time. Low-cost, autonomous sensors for road condition monitoring will be further developed. Research will develop quicker, more

effective and durable road maintenance techniques with particular emphasis on improved systems for safe and efficient night-time maintenance operations. This research will include better coordination of national and regional activities in order to address geographic differences.

- The overall effectiveness of separate lanes for road operations will be evaluated, as well as the need for upgrading the secondary road network (safe alternative and diversion routes).
- New models will be developed for the financing of both new infrastructure and the maintenance of existing infrastructure. This will consider new forms of cooperation between public and private parties. The studies will also develop improved methods for developing cost-estimates, including statistical uncertainty, for large infrastructure investments. Such research will be appropriate for International Collaboration (INCO) with developing nations and international funding bodies.
- Marketing-based approaches for infrastructure use and entry into traffic streams (demand for slot entry) will be developed and evaluated for improving efficiency under saturated conditions and for encouraging more environmentally-friendly vehicle usage.

Urban Mobility and Freight Distribution

This research theme focuses on the mobility of people and distribution of goods in the urban environment. The aims will be to provide high-quality public transport, free-flowing traffic and efficient freight movements. The research will bring together all of these elements to ensure an intelligent, efficient urban road transport network. Priority in the research will go to less-polluting forms of transport which will link innovative organisational and mobility management schemes. The integration of public and private transport within the systems will have particular emphasis, with a particular focus on more flexible systems such as Bus Rapid Transit (BRT) in order to obtain a sustainable intra-modal balance. Research on Urban Distribution will reduce the impact of freight movements upon residents whilst maintaining, or increasing overall efficiency. This research will also consider the location of depots and relations with extra-urban road transport and other modes including the links with personal and public transport. New concepts for urban-friendly freight distribution vehicles, loading/unloading systems and infrastructure will reduce further noise and pollution.

Optimised Road Space

- Through coordination between cities and regions, coupled with demonstration activities, solutions for congestion will be found using new dynamic traffic management and infrastructure technologies in order to improve the existing infrastructure and to optimise its use. New Information and Communication Technologies (ICT) and ITS have a large potential for improving the efficiency of passenger and freight transport. Further research on the implementation and the assessment of these technologies for application in road transport, and how they support and respond to different policy objectives, will therefore be conducted.
- Assessment tools will be developed for traffic management strategies, based on dynamic capacity optimisation models, taking into account dynamic lane allocation, tidal flows, two-way communication with the users, ICT and ITS, and electronic parking management services.

- Dynamic, information led traffic management and control models will be created utilising embedded information, real-time data transmitted from the vehicles (position, speed, origin, and destination), individual route planning, access control to routes, lanes, and parking. Coordination of national research will ensure that integrated automation in traffic flow control will be developed.
- Methods for intelligent, dynamic lane allocation will be developed considering the effects of variable lanes and speed limits for different traffic flows. This research will take into account all types of vehicles (trucks, cars, busses, two-wheelers) private or public and improve the robustness of the system.

Urban Infrastructure

- Research will be carried out into the methods for redesigning and modifying the existing physical infrastructure. This will include pavements, road equipment, parking, access to stations, platforms as well as new concepts for new construction. Systems and models for designing the optimum prioritisation of the urban road space will be developed.
- New design, construction and maintenance systems to support the expansion of conventional and new types of Bus Rapid Transit (BRT) systems will be developed and demonstrated on a large-scale and under different circumstances. Systems to support optimum systems integration with private transport will also be demonstrated.
- Pilot studies and validation projects will be carried out for the practical installation of ICT and ITS, intelligent pavements enabling dynamic traffic management, allowing dynamic allocations of lanes, intelligent merging systems, speed control, guidance systems, and lane prioritising for collective transport, high occupancy and emergency vehicles. These pilot studies will include new technologies for electronic road markings, pavement surface colouring and dynamic lane barriers.
- New infrastructure concepts will be developed to improve the mobility of pedestrians, bicycles, and disabled persons (e.g. bicycle lifts on slopes, pedestrian conveyors and new forms of crossings). Demonstration projects together with international partners will be carried out.
- New technologies will be developed for maintaining underground utilities (cables, pipes for water, gas, electricity and communication technologies) with a minimum of traffic disturbance in urban areas.

Urban Delivery and City Logistics

- Innovative urban delivery systems will be developed that are tailored to the local needs of individual urban areas. Studies on alternative delivery scheduling will reduce congestion in streets.
- New systems will be developed for greater efficiency for street-based loading and unloading. This will consider vehicles, goods transport units, street design, traffic management, security as well as the frontages and interior designs of businesses.
- Methodologies and systems for the designation of specific urban truck routes, which may be variable in time, will be developed. The feasibility of full driving automation on dedicated infrastructures for commercial vehicles will also be evaluated.

- City logistics will be developed for sub-urban transshipment to quieter, lower-emission vehicles of appropriate size, or to other transport systems (conveyors, tubes).
- Public-private models for urban freight delivery will be developed.

New Vehicle Concepts

- Research will develop new concepts for quiet and clean goods vehicles for urban and night-time distribution. Multi-powered vehicles will be developed for urban and extra-urban use e.g. flexible catenary systems for light-trucks.
- New modular vehicle systems and load carrier concepts will be developed for different types of goods and all portions of the logistics chain.
- Development of new concepts and appropriate coordination activities will optimise the use of vehicle loading space for multi-drop loads.

e-Commerce and Home delivery

“Home” Delivery, where goods are delivered to a local specified by the recipient, is the final stage of the distribution chain and explicitly linked with personal mobility. Research in this area will provide solutions to problems of goods transport, including that by passenger cars, in residential areas. Coupled with studies of the impacts of e-commerce, new concepts for tracking and delivery systems can be developed.

- In-depth examination of the impacts of e-commerce on future freight transport will be carried out.
- The relationship between “home” delivery and personal and public transport usage will be investigated. This will include the consideration of the impact of home-delivery on residential traffic.
- Innovative systems to integrate personal and/or public transport usage with home/workplace delivery systems will be developed. This will include appropriate local area distribution points e.g. drive-in centres, park and ride facilities. Development of innovative tracking systems for goods throughout the home delivery supply chain will support this research.

Long-distance Freight Transport

With Road Freight transport being responsible for the overwhelming majority of Europe’s goods movements, it is vital that it is optimised in order to improve the efficiency and overall effectiveness, to avoid unnecessary transport and improve Business Processes, and to reduce the impact on the environment.

The transport of goods across Europe will be made more efficient with a better understanding of distribution practises. With appropriate infrastructure, new concepts such as road-trains could dramatically increase the efficiency of individual vehicles for long-distance journeys. Dedicated infrastructure could allow roads, bridges and tunnels to be optimised for particular types of vehicles reducing maintenance and environmental impact. This section should be considered in conjunction with Safety & Security and Energy, Environment & Resources as well as Design and Production.

Vehicle Related Issues

- Concepts for future types of trucks and modular goods carriers, for different types of freight, and effective road-rail combinations will be developed.
- Intelligent Inter-modal Transport Units (ITU) for modular goods movement on a European level will be developed. Research into standardised concepts for effective goods movement throughout the entire logistics chain, not just the transport portions will be carried out.

Infrastructure

- Development of network level systems will support the transit of larger goods vehicles (including those of 60 tonnes or more). This large-scale research will consider the issues of restrictions for bridges, tunnels, steep gradients and congested or environmentally sensitive areas. Real-time and seasonal effects will be examined to maximise the effectiveness of the system in all weather conditions. New tools and models for the efficient asset management of both overall network and individual sections will be developed to improve the overall life cycle costs. Appropriate road classifications for the efficient operation of modular vehicles and road-train combinations will be developed through coordinated activities with national and international programmes. Systems for platooned trucks in dedicated lanes will be investigated.
- Research and Development of new dynamic traffic management and infrastructure technologies will improve the use of the existing infrastructure and reduce bottlenecks.

Intermodality

- New solutions, operational throughout the enlarged EU and neighbouring states, will be designed and demonstrated for long-distance transport combined with efficient modal transfers. New concepts will be developed to encourage efficient use for multimodal connections, transfer, and service areas offering new functions for trucks and drivers.

Optimised Logistics

- Robust indicators on freight transport efficiency, journey time reliability, and network efficiency will be developed through coordinated activities.
- Studies of the optimisation of freight flows based on availability and real-time, multi-modal information will consider all modes including route and costs comparison.

Tracking and Information

- Development of tracking technologies will be carried out in order to establish a seamless information chain to increase planning efficiency, achieve productivity gains and foster security. Harmonisation of common electronic letters and tags will be conducted for seamless freight tracking and tracing across Europe. The use of existing open standard systems will be evaluated.
- Applications of navigation and positioning systems will be developed for tracking the position of vehicles and for collecting real-time traffic information. This will include investigations of the potential for improved and more accurate localisation to enable new functions such as parking slot identification, lane

keeping, distance relative to other vehicles (platooning) based on vehicle-vehicle and vehicle-infrastructure communications combined with the GALILEO satellite system.

- Studies will be conducted to identify the strategic value and the use of information for infrastructure managers and for agents competing on the market in order to understand the balance between transparency and competition. Research will identify the impacts of information provision on distribution practices and the effect on improved journey time reliability. The problem of confidentiality of data in the freight sector will be investigated, and solutions proposed.

Social Trends and Behaviours

This considers the broader understanding of the decisions taken by the population and how those decisions will change with time and region. The research is vital to consider how demographic and economic changes will modify mobility and accessibility needs as well as sustainability measures. This will include aspects such as the effects of an ageing population, an increasing mobile labour market, household budgets, housing issues, and personal security concerns in order to provide essential information for decision makers.

Behaviour

- Research to better understand social values will determine how they influence the choices people make relative to housing, schools, work, family and friends, and leisure activities and how they are related to mobility. The real individual criteria for transport decisions will be examined, taking account of the expected demographic changes, the influence of flexible working hours and holiday periods, and the impact of greater mobility and freedom of movement between member states.
- An understanding of the relationship between land use, mobility, accessibility and transport demand at both the local and regional level will be established through coordination of research.
- Studies of the factors affecting local decision-making processes for planning will be carried out, supported by methodologies for integrating land use and transport planning. Appropriate Geographic Information Systems (GIS) technologies will be developed bringing together all relevant data sources.

Social and Economic Trends

- Models will be developed to simulate, and determine the impacts of demographic, economic and social development and the entire mobility chain under multiple scenarios are needed to thoroughly test and optimise the system before making costly investments. These include the economical and social evaluation of the transport system and the economics of multimodal transport. The optimisation will reach beyond all borders (urban, regional, state, Europe) in order to avoid inefficient local solutions.
- The impact of new infrastructure on land and housing prices will be studied and consensus developed on the relation between land price and suburban expansion. Urban planning and architectural design research will integrate all elements: socio-economic data, the natural environment, housing, community life, and mobility and transport infrastructure.

Tools and Modelling

- Data will be collected through appropriate coordination throughout Europe and models of human interaction and user acceptance to various modes of mobility defined. Methodologies for collecting and interpreting mobility/ accessibility studies will be developed in collaboration with both European and International parties.
- New methods for data collection and treatment for demographic, mobility and transport demand patterns including origin, destination, time slot and energy consumption will be developed. These will be harmonised and interrelated / aggregated at the EU level through large-scale activities to provide the basis for understanding, modelling, and decision-making on demand management and land planning.
- Simulation models will be created to link the cause and effect of mobility and transport demand in relationship to land use and to accurately predict outcomes of alternative choices for optimising liveability, economic viability, and sustainability.

Mobility Management & Information Provision

Mobility Management includes a variety of measures including data collection techniques, business models, fiscal incentives and traffic management. Research will provide better systems for enabling investment to satisfy road usage requirements and manage the network.

Supported new Advanced Intelligent Transport Systems (ITS), innovative approaches to Road infrastructure needs to meet the increase in mobility demand of the enlarged EU, for both passengers and freight, making optimal use of an improved road infrastructure capacity in a safe, efficient, and environmentally-friendly way.

Information Provision research will support the development of a reliable, efficient road transport system. Journey-times will be more reliable with comprehensive pre-trip information updated during the journey. Vehicle-vehicle, vehicle-infrastructure linkages will ensure optimum integration with other traffic and with traffic management systems.

Design

- New concepts will be developed for multimodal connection areas that are all-mode friendly, allow seamless links, utilize real-time, multimode information systems, and offer other value-added services to the passengers (meeting place, multimedia, restaurants, shops). The dissemination to public authorities and the supply industry will support implementation.
- Further research will be conducted on technologies that can facilitate the transfer between modes (efficient interchange for passengers, people movers, more efficient park and ride).
- Studies will identify and analyse technologies that better exploit HMI at the various levels in terms of information access, mobility services, etc.
- Research will explore new forms of collective transport: community-based transport pooling for repetitive activities (leisure, shopping, trips to work or school) through information and communication technology (ICT) tools for local organisations (sport clubs, businesses, schools, community centres).

Optimised Road Space

Solutions for congestion need to be found using new dynamic traffic management and infrastructure technologies in order to improve the existing infrastructure and to optimise its use.

- Research coordination will enable links between traffic control centres across Europe to be improved in order to enable traffic management on long stretches including alternative routes, incident management and congestion management. Network-wide strategies and technologies for road traffic will be developed.
- Pan-European coordination will ensure that as traffic management becomes more dependent on information flows, the reliability against intrusions and other disturbances will be ensured, and fallback strategies will be specified.
- In order to reduce road closures, more effective and innovative traffic incident and emergency management methods will be developed and demonstrated, these will be based on full chain cooperation (transport authorities, road-side assistance, emergency services, insurance).
- Methods for mobility and traffic management in case of special events, man-made and natural, will be developed based on a thorough evaluation of significant events. Strategies based on risk evaluation will be developed.

Data Collection

New technologies are needed for cost-effective traffic data collection on all networks (urban, rural, main roads and motorways) with improved performance over existing technologies. Communication with the navigation systems in the vehicles, Traffic Dialog Systems (TDS), Floating Car Data (FCD) and anonymous data transmission will be further developed. Mobile communication may enable the collection of data from distributed, moving vehicles in real time and could allow more comprehensive assessment effects of traffic effects.

- Measuring methods for congestion, travel time reliability, network performance monitoring and service level indicators will be developed.
- Real-time travel time prediction methods and increased reliability of short term traffic forecasting models will be developed to improve information and management.
- Open databases for the simulation and optimisation of freight flows will be developed and their effectiveness demonstrated for efficiency gains in transport.

Policies

- New methods and organisational structures for cooperation will be developed to manage mobility and transport demand. Network-wide strategies and technologies for demand management will be developed.
- Research coordination will be conducted on the interrelationship between regional development and transport infrastructure, in particular in view of the EU enlargement in order to prevent the development of transport problems already experienced elsewhere.

Costs, Pricing, Payment and Finance

- The role of pricing in all its forms (road pricing, taxes, parking costs, subsidies, incentives) as a demand management tool will be studied. The effect of transport pricing policies and contribution of pricing practices towards accessible, equitable and sustainable transport systems goals will be measured. Coordinated activities will ensure that the relationship between quality and price elasticity of public transport and their effect on mobility choice will be evaluated.
- Further developments and implementation of electronic fee collection and dynamic road pricing will be assessed for impact on traffic and demand. The reliability of the data and protection of privacy will be assured through appropriate research. The development of new systems for automatic ticketing and fee collection will allow seamless mobility and goods transport within Europe. This will aim to stimulate an optimal distribution over all modes.
- Studies will include the assessment of the impact on environment, economy and social aspects. The impact of transparent transport charging on individual choice and collective interests will also be considered.
- New financing methods will be developed for the transport system as a whole and for infrastructure in particular to enable the implementation of new technologies, and support maintenance.
- Investigations into new options, including business and legal models, for private sector involvement in traffic control centres and data ownership, management and dissemination will be conducted.
- The links between efficient traffic management and community and environmental goals will be evaluated through appropriate coordination.

Information Service Delivery

- Research will identify what is the right information and when is the right time to optimise pre-trip planning and dynamic journey modification. Considerations include real-time, multi-modal arrival / departure information, travel time, route and costs comparison for all modes, events, weather and safety warnings, specific user constraints (accessibility, security). Assessments of the potential of various forms of Urban Intermodal Transport Management Centres will be carried out.
- New business models will be developed to meet the changing consumer demand and at the same time contribute to more sustainable transport solutions. Research to support effective education and awareness programs will be developed and tested to ensure that citizens can easily access and utilise the information to plan their trips. The willingness of travellers to use such services will also be assessed.
- Development of real-time traffic information systems, in combination with a European digital road map database, including traffic restrictions, road condition data, and parking availability, will be carried out to allow reliable travel time prediction and better route selection.
- Studies on HMI (Human-Machine-Interaction), both ergonomic and cognitive, as well as on consumer values and decision-making, will guide the development of mobility alternatives. Better information on real costs, safety, personal security multimodal solutions and impact on sustainability will improve informed

decision-making. Research will assess the effects of information presentation on understanding and behaviour.

- New mobile, two-way and multimedia communication technologies and systems will be developed and harmonised for use throughout Europe. The potential of personal electronic devices will be evaluated in view of the impact on multimodal transport. Standards will be developed for traffic information and routing systems in a multimodal transport environment, e.g. for location, timing, metadata common referencing systems.
- Research will be carried out into intelligent transport management and infrastructure systems integrated into broader networks (e.g. food distribution, energy, industrial production) that could allow a more responsive multi-modal transport system capable of resisting and recovering from shocks

2.2 Safety and Security

This research theme focuses on how an integrated R&D approach can improve safety and security in the road transport sector.

The European Commission's Road Safety Action Plan and the eSafety Programme have set a target for reducing road accident fatalities by 50% in 2010 (as compared to 2001). To help reach this objective, and with the further objective of the 75% reduction in fatalities formulated by the FUIRORE project by 2020 in mind, the ERTRAC Strategic Research Agenda proposes an integrated R&D approach covering accidentology, preventive and protective safety, co-operative systems and emergency management as well as human factors studies and network infrastructure improvements. Such an approach extends the focus of work beyond the vehicle to include the driver as well as the road and the underlying communication infrastructure.

Transport security issues addressed by this recommendation include border security, protection of critical infrastructure, crisis management, management of exceptional events and tracing and tracking.

Accidentology and Impact Assessment

Accident databases

- Building on existing efforts, further research should support the establishment of harmonised European accident databases capturing information relating to the vehicle, driver and infrastructure associated with the accident. It should be investigated how public and private sources of information can be combined.

Assessment methodologies

- Research and development activities are needed to develop predictive and statistical methodologies to support the assessment of the impact and effectiveness of measures that support road safety. The developed methodologies should encompass safety measures relating to the vehicle, driver and infrastructure and thus cover the full safety chain and all involved stakeholders. In this context, an improved understanding of behavioural adaptation should be developed allowing a more accurate estimation of potential safety benefits.

Scenarios

- A comprehensive overview of accident-prone scenarios should be made and a set of measures spanning all areas covered below should be developed. A comparative analysis of the effectiveness of safety measures and technologies can then be carried out.

Preventive and Protective vehicle systems including Vulnerable Road Users

Sensor and actuator technology

- Further research should be aimed at decreasing the cost and increasing the reliability and redundancy of sensor and recognition technology. Additional research is needed to ensure appropriate, hierarchical fusing of sensor data. The development of robust actuator devices supported by an open, scalable safety critical electronic architecture is also a high priority. The research should integrate sensors and actuators into systems that support interoperability between vehicle platforms. This information should also be used to feed protective safety systems

and features. Research on novel, intuitive in-vehicle information and input systems (e.g. virtual reality projections) as well as possible synergy effects between vehicle-to-vehicle and vehicle-to-infrastructure communication should also be conducted.

Assessment and certification

- Research on methodologies for creating and developing assessment procedures for preventive and protective systems should be carried out in order to establish future certification programs.

Children and elderly people

- It is necessary to further invest in the simulation, testing and verification of human injury biomechanics, vehicle crashworthiness and compatibility, as well as smart protection systems. Research in the area of protection of the vulnerable road users and in particular children and elderly people should be continued. Results of the integrated automotive safety programmes should be extended to mopeds and motorcycles.

Co-operative Systems

Scalable architectures

- There is a need for continued research on the development of a functional, open, scalable architecture that allows seamless communication between vehicles as well as between vehicles and infrastructure. In addition this architecture should provide the possibility for seamless data exchange between road data capturing and processing centres. Research should support the development of standards for co-operative systems and interoperability to favour compatibility and market take-up.

Added-value services

- The development of value-added services enabled by co-operative systems – navigation, safety and power train and energy management – should be conducted.

Demonstrations

- Large-scale demonstration/field tests of co-operative systems should be conducted in order to assess the benefits of co-operative systems.

Non-technical issues

- Research on all aspects of liability and privacy related to co-operative systems should be carried out.
- Research on the business cases for co-operative systems should be conducted, also considering all communication means relevant to transport, and the potential synergies with technologies for road charging.

Connected traveller

- It should be investigated how the connected vehicle can be extended to the connected traveller.

Post-accident & Emergency Management

eCall

- Future investigations of the synergy between eCall, emergency management and civil protection should be conducted. Furthermore, research on additional elements that could be included in the eCall message to improve the safety and security of European roads should be carried out.

Evacuation & rescue

- Research should be carried out to improve evacuation and rescue procedures, especially in the context of large events.

Human Factors

Human behaviour

- Investigations of human behavioural adaptations to the introduction of novel technological co-operative and driver assistance systems should be conducted. These should include studies of the influence of such behavioural changes on the overall system.
- Research should be conducted on driver conditioning through HMI feedback.
- Research on the specific human factors criteria that in-vehicle equipment should satisfy as well as the methods for evaluating these criteria is needed.

Common, adaptive HMI

- Adaptive HMI principles and systems that would allow the road user to interact optimally with the vehicle and infrastructure should be developed.
- Research on HMI integration should include an investigation of how different applications (including nomad devices, remote services, driving information & warnings and co-operative systems in general) could share a common in-vehicle HMI in a safe, efficient, and standardised way.

Certification and training

- Research leading to the development of methodologies for measuring safety effects should be conducted in order to create the basis for a future certification of in-vehicle and roadside safety and security systems.
- Research on the methodologies of how best to conduct driver training on the use of new safety features in an efficient and effective way need to be established.

Road Engineering and Network Operations

The importance of road engineering measures was recognised in the Sunflower (SWOF, TRL, VTI, SUNflower: A comparative study of the development of road safety in Sweden, the United Kingdom, and the Netherlands, 2002) report comparing road safety practises in the three best performing EU nations – Sweden, UK and Netherlands. This reported that general [road] engineering and other measures substantially reduced the fatalities among vulnerable road users in the Netherlands and

Sweden, contributing to about a third of the total reduction in fatalities. Despite this the report concluded that even in these countries, further efforts were needed. For example, Britain needs to find engineering solutions and speed and traffic management policies that will enable pedestrians and vehicle traffic to coexist at lower casualty rates. A major challenge for achieving Europe's road safety targets will depend upon research to develop road safety engineering practises that are appropriate for a the variety of conditions experienced in the regions of different member states.

Single vehicle accidents, where road infrastructure plays an important role, are recognised to account at least for 25% of all European road fatalities. Safety needs to be integrated into the planning, design and operation of road infrastructure. The underlying concepts are a self-explaining road and a forgiving road side. To further improve road infrastructure and network operations, research should be conducted on: accident data and decision methodologies (see earlier), road network safety management, road infrastructure systems and on effective means for sharing road safety knowledge.

Road surfaces

- Research into developing road surfaces and maintenance technologies will consider the fundamentals of vehicle/tyre/road friction and controllability. Bringing together public bodies and the tyre and vehicle industries, consideration will be given to the implications of future developments in infrastructure and automotive technologies as well as climatic change. The research will be supported by deeper coordination of research carried out in Member States to develop technologies for a future harmonised European friction measurement system that can be utilised in ADAS. Aspects of this work will also consider the issues relevant to EU neighbour countries and developing nations.
- The development of new surfaces able to provide improved performance for skidding and controllability is a relevant aspect. In this context, methods are needed to assess the performance of road infrastructures, and to improve standards according to in-service behaviour.

Preparing for change

- Coordination of national research will develop an integrated approach to the safety related aspects of preparing Europe's road network for change. This work will focus on demographic, climatic and traffic system changes to determine road engineering factors concerning, for example, road makings and signage, road maintenance, winter maintenance, road-side infrastructure (including safety fences and barriers, and drainage). This work will consider the engineering issues for all categories of roads and include the protection of vulnerable road users.

Pedestrian safety

- Research will consider the specific road engineering aspects of urban roads with relation to pedestrians. The research will develop appropriate low-cost, low-maintenance and flexible traffic-calming and self-enforcing roads concepts as well as specific infrastructure safety features for vulnerable road users.

Road lifecycle support

- Road network safety management should cover all the phases of the road life cycle. Safety impact assessment should be performed at the initial stage of a project, to approve a new road or a major reconstruction, considering not only

economic data, environmental and traffic effects, but also safety impacts. Methodologies should be developed allowing to carry out road safety audits at different stages. Advanced monitoring and maintenance technologies, including systems to detect possible dangerous situations should be developed, with a focus on high risk road sections.

System installation criteria

- Research on road infrastructure systems is related to the need to design and equip a road, according to the user requirements and capabilities, in order to prevent dangerous situations, or to reduce consequences when a driver has no longer control of the vehicle. Therefore, research is needed on system installation criteria, especially taking into consideration the road layout, the vulnerable users and the interaction between infrastructure and vehicles. Road marking and signing issues include the interaction with different vehicles and drivers, the improvement of visibility and understanding in different driving conditions, and an effective and harmonised use of Variable Message Signs.

Road safety knowledge

- Regarding road safety knowledge, it should be investigated how a road infrastructure safety community can be established to share and disseminate best practices and new research outcomes among different countries.

Security (Goods, Vehicles, Communication Networks, Infrastructure)

Risk analysis

- An overall risk analysis of the European road transport system should be made to identify the security threats as well as cost-effective measures to prevent, control, mitigate or respond to security threats. Measures should also be assessed in the context of European and national privacy legislation.

Border security

- For increased border security, research should be conducted on smart containers (seal integrity program; micro-devices integration) and standardisation combined with testing, evaluation and certification. It should be assessed how the customs code can be modernised and e-customs can be introduced.

Protection against unauthorised access

- Research should be conducted on how to protect vehicles and critical infrastructure against unauthorised access, using advanced sensing, as well as information and communication technologies (examples include biometrics for user authentication; novel cryptographic techniques for end-to-end security and cryptographic routers; guaranteed QoS for priority services; facilities and methods for implementing contingency plans and business continuity; data protection and cryptography).

Crisis management

- Crisis management research includes response scenarios for emergence rescues and evacuations involving all sectors concerned. Of special concern is research on how to ensure security at large and exceptional events as well as on the secure transport of dangerous goods in containers and by lorries through Europe (for instance through real-time traffic monitoring of critical transportations through tracing and tracking technologies).

2.3 Energy, Environment and Resources

The objective of this section is to identify research priorities leading to the vision of a cleaner, quieter and more energy efficient road transport system that has minimum impact on communities and natural habitats and can be adopted by the market.

The decision-making process in the transportation sector becomes increasingly complex at European level. This is due to the requirement for improved mobility without degrading the environment and preserving the energy resources. These sometimes conflicting needs can only be effectively addressed through a systematic approach considering the fuel and vehicle technologies available, the priorities for transport planning, the road infrastructure technologies and accurately quantifying the benefit and the cost of the different options in a consistent manner.

Strategic analyses using this approach are already well established in the European planning process. Examples are the European Auto-Oil Programme, the FUIORE roadmap on advanced vehicles, and the JRC/EUCAR/CONCAWE Well-to-Wheels study. To be effective in guiding future activities, these evaluations need to be updated and adapted as needs and knowledge evolve.

Clearly, the projected growth in demand for mobility of people and goods will have a significant impact on the ability to control Europe's vehicle emissions and energy demand. Forecasts show a 26% increase in vehicle kilometres from 1998 to 2010, and an even bigger increase in goods transport of 38% over the same period. These issues are addressed in the chapter on **Mobility, Transport & Infrastructure**.

This large growth has the potential to negate improvements in transport efficiency. Hence **social trends** and measures that reduce growth in demand for personal mobility and transport of goods while maintaining economic and social well-being can have a positive impact on both emissions and energy consumption. Vehicle and road technologies can contribute to fuel-efficient driving patterns, but **driver behaviour** is also an important contributor. These questions are central to the Mobility section of this report, and so are not considered further here.

In the longer term concepts such as **hydrogen fuel cells** offer great potential. But research is needed now to develop both highly efficient fuel cell vehicles and low-carbon hydrogen production. For the period to 2020, however, vehicles powered by **Advanced Internal Combustion Engines** (ICE) will continue to be the propulsion backbone, as powertrains for passenger cars, light duty vehicles and heavy duty trucks and buses. To realise the potential for lower emissions and increased energy efficiency, a **systems approach** is needed for research covering new advanced combustion processes with dedicated transmissions and integrated aftertreatment, together with optimum fuel formulations (including synthetic and bio-components). Within this framework, research needs to cover a broad range of **design and material elements** as well as **hybrid vehicle** concepts. As well as being an element in optimising vehicle emissions performance and energy efficiency, the potential for fuel contributions to reduced greenhouse gas (GHG) emissions also need to be investigated.

Moreover, a key factor to master and introduce new technologies is the use of a new generation of vehicle and powertrain design tools which should include multidimensional simulation techniques for detailed component and process design, multidisciplinary simulation and multi-objective optimisation methodologies.

How vehicles are used in service also has an impact on both energy use and emissions. There are opportunities to exploit **enhanced communication systems**, and improved **mobility management**, especially for heavy freight transport. **Road engineering and design** can contribute to reducing energy use and are also a factor in **non-exhaust emissions**, especially of particles, and control of **water quality**. As

for air quality and energy efficiency, a systems approach is important for control of **noise emissions**, including contributions from the road infrastructure, vehicle and tyre design, driving behaviour and traffic management.

Maintaining the performance of vehicles in actual service is an important element in achieving low emissions and efficient energy. Understanding the impact of real-world driving conditions on emissions and fuel consumption is an important element for environmental planning. Developments in communication systems offer new possibilities: the Framework Programme 6 (FP6) already includes projects to enhance the communication of surface transport with their environment by pointing towards the development of automated or driver-assisted road vehicles, improved telematics and on-board electronics for rail and waterborne transport. Communication systems also have the potential to complement traditional in-service controls, for example through vehicle positioning, which may serve as a tool to control traffic congestion and increase road safety, and environmental performance monitoring (energy consumption and emissions) which may assist in significantly improving air quality.

Summarising the Strategic Research Framework for Energy, Environment and Resources (EER), to achieve the targets as defined in the Strategic Research Agenda (SRA), the agreed main RTD topics are in particular:

- new advanced combustion processes incl. hybridisation
- together with optimum fuel formulations (including CNG, synthetic and bio-components)
- improved components incl. new materials and design
- less noise achieved by a systems approach
- road engineering and design
- mobility management, which also has an impact on the objectives of the EER research area

Strategic Analyses

Strategic analyses, applied in the framework of a Systematic Approach, are an important resource to guide research planning and policy decisions. Studies will be organised to bring together a critical mass of expertise in order to effectively address the various issues. In particular they will provide the means to synthesize basic and applied research in a systematic manner to produce a usable result for policy making. They will provide understanding of changing demographics and transport needs and realistic projections for the future, allowing a transparent exchange of information to enhance updates with new data produced in the framework of RTD or economic studies. Work is also needed to develop the tools to communicate the output in a way which can enhance policy making, i.e. development of indicators, classification based on cost-benefit figures, etc.

Well-to-Wheel analyses will be carried out for different fuels in order to characterise their environmental performance, and the efficiency and associated costs in the production and use of different fuel options. Studies of renewable energy including biomass and biofuel production will investigate the impact on land, water and habitats. Life-cycle analysis (LCA) for different vehicle and engine technologies will assess their cost, energy consumption, and emission performance. Such LCA studies should take into account conventional combustion concepts, alternative fuels, new combustion systems, hydrogen and fuel cell vehicles and hybrid systems which combine more than one propulsion mechanisms.

The association between emission performance and air quality will be studied, in particular for exhaust and non exhaust particulate matter (PM) emissions and nitrogen oxides. Such analyses will identify methods for the source-apportionment of urban PM,

establish the link between emission standards and urban concentrations of PM and promote studies to identify the main risk factors associated with particulate air pollution. In addition, the energy use and emissions originating in vehicles recycling activities will be assessed.

Studies will evaluate options for improved transport planning, including road infrastructure for the operation of private, public and captive fleets. Methods to achieve this will include the increase of the visibility of successful examples (demonstrators) around Europe and abroad (i.e. enhance the operations of networks, such as the city networks of captive fleets), and by facilitation and co-ordination of pilot-studies, taking into account the particularities of different environments.

Efficient Low Emission Internal Combustion Engine Vehicles and Advanced Fuels

The research targets of these activities for 2020 are to reach near zero exhaust emissions of pollutants and to enhance advanced technologies for an overall CO₂ emission reduction of 40% for Passenger Cars (PC) and 10% for Heavy Duty (HD) vehicles for the new vehicle fleet (based on 2003 figures).

Powered 2-wheelers are not especially mentioned in this chapter. Even though their influence on environment could rise in the future (especially in some inner cities and otherwise pedestrian areas), their importance relative to passenger cars and heavy-duty vehicles will be small in the mid-term perspective. Special research needs can be integrated in passenger car projects.

To achieve the emissions objectives, a systems approach will be adopted including engine, transmission, aftertreatment and optimised fuel formulations. The research that will be carried out for the Integrated System Approach includes development of advanced powertrain and new combustion concepts for high efficiency and low emissions taking into account the different operating conditions for Passenger Cars & Light Duty Vehicles, Heavy Duty Trucks & Buses.

A number of concepts exist for advanced combustion processes including Flex Mode Combustion (e.g. Combined Homogeneous Heterogeneous Combustion [CHHC] & Controlled Auto Ignition [CAI] and as combination of the advantages of Diesel- and Gasoline combustion the Tailored Fuel Integrated Combustion System [TF-ICS]). To enable these developments, variable and enhanced power train components (valve actuation, fuel injection systems, boost, lean operation, adapted ignition systems) will be needed as well as improved control (combustion mode change, information enabled drivetrain control, thermal management of engine and after-treatment system). High specific torque will allow the use of smaller engines, assisted by advanced air management (boosting, high Exhaust Gas Recirculation levels), and advanced transmission systems and controls. Developments for alternative fuels will also be needed such as efficient CNG engines and flexible CNG tank technologies. For Heavy Duty Trucks & Buses, research and development will include high EGR rates, λ – lowering and high injection pressure (in the region of 3000 bar)

Vehicle Exhaust Emission Reduction for Passenger Cars & Light Duty Vehicles, Heavy Duty Trucks & Buses will need research on model based closed loop emission control, and improved CO and HC reduction for light duty application. Exhaust aftertreatment developments will be needed in the areas of new substrates and catalysts, aftertreatment for Natural Gas engines, SCR system with NH₃ (urea) and NOx adsorber and emerging NOx removal technologies. Integrated hardware systems for NOx and particulate control will also be developed. On-board sensors are expected to extend the capabilities of today's On-Board Diagnostics (California 2nd Generation (OBD-II) systems by implementing On-Board Measurement (OBM) techniques. For

Heavy Duty Trucks & Buses, new developments are needed on diesel particulate filtering and second generation high efficiency SCR systems.

Vehicle Energy Management will play an important role, through factors such as vehicle aerodynamics, air conditioning and cooling systems, improved auxiliaries (clean APU for HD vehicles, more efficient ancillary devices) and braking/retarding energy recovery systems for HDT & Buses.

Improved materials will contribute lower weight and reduced friction, with the development of advanced lightweight powertrains (target 20% reduction), as well as enabling higher pressures and temperatures for ICE engines.

Research is also needed on fuels to improve engine efficiency and emissions. In particular adapted fuels for new combustion processes such as CHHC, CAI and TF-ICP. Work is also needed on production and performance of new fuel formulations, including Fischer-Tropsch (FT) diesel production cost reduction.

New combustion systems using high degrees of premixing, cool combustion and very high residual gas contents impose additional new challenges for the predictive capabilities of pollutant formation and after-treatment simulation tools.

Hybrid Technologies and Improved Components

Research will develop a Full Hybrid with All Electric Drive and Near Zero Emission Driving Mode. The research targets are to reach the most stringent urban emission targets (e.g. Enhanced Environmental Vehicle (EEV) emission levels) at competitive cost. Research into hybrid vehicles design and energy management will include design simplification and cost reduction, power split transmission optimisation, thermal and energy management, high efficiency energy recovery and vehicle energy management and control systems

Component development and ICE optimisation is a key part of this effort. High efficiency / low cost energy storage media and devices (batteries, materials, auxiliaries, converter) will be needed, and high voltage components such as wiring, connectors, switches and fuses improved. Electric motors need developments in packaging, cost, efficiency and specific power. The challenge for power electronics is the need to operate at high temperature at low cost. Development of low cost and high efficiency active materials and components for energy storage systems is needed.

Research is needed to decrease the environmental impact of battery manufacture and their raw materials/components, for example improved processes with reduced energy consumption and CO₂ emissions. Economic and reliable battery recycling processes are equally important. New materials and electrochemistries for energy storage may contribute to these aims.

Component integration is a further area for research. Improved integration and control of ICE, transmission, electric engines and exhaust aftertreatment is needed, as well as integration of power electronics into the e-motor. Standards will be needed for e-components and for energy storage systems. Systems for the determination of state of charge, state of health and state of function will enable effective battery management. Energy storage system design and packaging improvements will be needed to reach a high level of integration in the application.

Advanced Fuels from Biomass and Waste

This research is an important element of the programme, because biofuels are likely to be the most readily available alternative fuel in the short- to mid-term. Biofuels have the ability to be blended with gasoline and diesel and are hence compatible with advanced ICEs. The research will also consider the substantial improvement needed in the costs of biofuels production and efficiencies in GHG reduction and energy savings.

Research and development of the **Second generation of bio fuels pathways** will build on the well-to-wheels studies that show much improved energy and GHG savings for production of biofuels from cellulosic materials (wood or grasses including straw). Research will focus on two emerging technologies; enzymatic fermentation to produce ethanol, and gasification followed by synthesis to a range of products including Fischer-Tropsch products. However, these two pathways are difficult to industrialize and research is needed to address practical problems and reduce production costs:

For gasification, specific research activities will consider synthesis gas conditioning (treatment, separation, purification) including the performance of inorganics. Improvements are needed in the allothermic process, and the link between flash pyrolysis, gasification and the Fischer-Tropsch process needs study.

For cellulose to ethanol, study is needed on the enzymatic hydrolysis of straw and woods and production of C5 fermentation enzymes, as well as integration of the enzymatic hydrolysis process.

In addition, alternative and bio- and synthetic fuels, hydrogen enriched fuels, etc., will be subjected to concerted activities for the extension of presently available models in order to reflect the accurate behaviour of these fuels. More details are covered by the BIOFRAC technology platform.

Fuel Cells and Hydrogen Fuels

The research target of this area is that Fuel Cell Vehicles begin to contribute to carbon dioxide emissions reduction by 2020. Achieving this will require a focussed and sustained research effort that is being addressed in full detail by the Hydrogen and Fuel Cell Technology Platform (TP). The TP will also address in detail research needs on topics not covered by the ERTRAC Strategic Research Framework such as hydrogen production from non-fossil sources and from hydrocarbons with carbon capture and storage

For vehicles, Fuel Cell & Auxiliary Power Technologies are of special importance. Improved reformer technology will require studies into improved catalysts, new substrates and plasma reformers. High temperature PEM membranes, bipolar plates, improved air systems and humidity management will help achieve cost effective and reliable fuel cells for automotive application. Work is also needed on hydrogen component and system standards, balance of plant components, and components, such as air supply units, sensors, controls and power electronics.

Cost-effective low carbon-routes for H₂ production and distribution will also be needed. Developments in hydrogen liquefaction with high efficiency, reversible storage systems for transport applications will be essential for effective hydrogen production, handling and storage. Safety in hydrogen production, storage, distribution and use will also need effort.

Mobility Management, Road Infra-Structure Design and Advanced Traffic Management

Applying a systems approach to environmental improvement through network management (including traffic management, and infrastructure design and operation) will deliver reductions in all adverse environmental and social/natural impacts from the road transport system. This research area does not include the specific aspects of noise, rolling-resistance and water quality which are dealt with elsewhere.

Development of improved integrated traffic management procedures will produce lower traffic and vehicle emissions. This will consider the worse-case vehicles as well as the fleet average. Development of systems to utilise better vehicle 'labelling' systems will assist traffic management schemes, including access restriction and road-user pricing.

In addition, sensing techniques will be able to monitor the in-use performance of vehicles and respond to particular behaviours (e.g. issuing a pollution ticket in the same way that a speed ticket is issued today by speed-traps).

Innovative infrastructure design will produce lower emissions and reduced impacts. This includes road-side features such as combined noise/wind barriers and improved features to reduce habitat and community severance effects. Roads offer opportunities for energy recovery (solar, wind and vehicle, geothermic energy gained from tunnels, retaining walls and pavements from road infrastructure for both generation and to reduce the heat-island effect. Network design will take account of new vehicles and vehicle systems.

The greatest opportunities exist for long-distance freight rather than city traffic. The use of larger vehicles, for example use of 60 tonne vehicles, would improve the ton/km fuel efficiency of goods transport. New systems will need to be developed to allow such vehicles to operate safely with other road traffic and without damage to road infrastructure. The research will include traffic management systems designed to integrate extra-long, heavy vehicles into the traffic stream safely and efficiently. This research will also include special considerations for bridges and mountainous areas and incorporate Vehicle-Vehicle-Infrastructure Communications (including enhanced features of GALILEO).

Road Engineering and Design

Research in this area will focus on two major issues – reducing the adverse effects of road design on fuel consumption (and air pollution) and improving the sustainability of materials use. This work will support the network operations elements considered in Mobility management etc.

Regardless of the improvements gained through efficient engines, light-weight vehicles and good aerodynamics, the physics of energy losses ensure that a significant proportion of fuel consumed is a result of the vehicle driving across the pavement. This is particularly the case for trucks where 40% of the rolling losses of a truck travelling at 85 km/h arise from the tyre/road interface. At the European level, this is important because trucks are expected to overtake passenger cars as the largest single producers of CO₂ in the EU-30 by 2030. Little is currently known about the variability of pavement influence across Europe and an early target of research will be to quantify the variation and develop guidelines to improve on best practise.

Studies of road surfaces and **tyre/road interaction** and the development of low-rolling resistance pavements will be performed, with a target to lower overall losses by 10%. This research will consider the influence of the road texture and the evenness of the pavement and its stiffness. Rolling resistance can increase by 10-20% in wet conditions, so new road surfaces will be developed that provide reductions in both wet and dry conditions. Such systems will require improved tyre/road interaction modelling methods in order to utilise non-contact measurement sensors. New forms of road surfacing material will be developed and prototyped.

Rough and uneven road surfaces can increase fuel consumption by 10%. This unevenness might arise from the construction of the road, settlement after construction or from pot-holes, trenches, joints and patched repairs. Therefore research will seek to reduce the effect of uneven road surfaces by considering how to reduce the physical changes in road profile from construction and fatigue as well as developing new forms of high-quality surfacing and subterranean repair and reinstatement.

The majority of road surfaces in Europe are constructed from asphalt. Although under normal conditions, such surfaces are stiff, in hot conditions the surface will tend to soften (which is the cause of rutting). Under the influence of heavy trucks, such softening of the pavement causes further increases in fuel consumption of 10-20%.

Therefore research will be conducted to determine the extent to which road surfaces need to be modified to accommodate heavier trucks and the effects of climate change, to reduce unwanted increases in fuel consumption. Research will also be carried out to develop pavements that combine the mitigation of non-exhaust emissions, noise and other adverse factors.

Resource use: Research will consider methods for substantial reduction of the use of primary materials in road construction and maintenance. This research will consider the benefits to come from, reducing mineral extraction and transport, as well as providing paths for the use of waste materials from other sources. The research will develop new treatment methods and help understand its influence on performance. Specific elements of the research activity will include the use of industrial by-products in the use of cementitious structures, the use of asphalt and composite materials and development of improved in-situ recycling processes.

Non-Exhaust Emissions

With the considerable reductions in emissions derived from power train improvement over recent decades, the balance of emissions from vehicles is gradually shifting to other sources. There are a number of non-exhaust processes, involving mechanical abrasion and corrosion, which can result in particulate matter or vapours being released directly to the atmosphere.

Particulate Emissions: Research will consider the most important direct emission sources, which are tyre wear, brake wear (linings and rotors), and road surface wear. Clutch wear and corrosion may also contribute to direct PM emissions. Re-suspension is probably the single largest vehicle non-exhaust contributor to roadside PM₁₀, particularly where winter maintenance procedures are in place.

In the case of tyre dust the greater use of high-friction road surfacing for road safety benefits inevitably leads to greater abrasion of the tyre in the immediate vicinity. Therefore research will be carried out to develop appropriate technical solutions for tyres and pavements without compromising other essential factors such as safety.

New forms of high-friction (skid-resistant) treatments for road surfaces will be developed including consideration of new forms of tyres and braking systems (e.g. advanced ABS). Development of local traffic management and infrastructure solutions for mitigating tyre/road/brake dust that relate real-time traffic and ambient meteorological conditions is also needed.

The development of models of the use of tyre, brake and road surface materials and their effects will be investigated. This study will examine the interaction of the different brake and tyre types in use, the performance of different materials, and the use of different types by location, in combination with the use of different road surfaces used by road type and geographic location. An extensive examination of the composition of the current and next-generation tyres and brakes will be carried out to support this work.

Improved Laboratory-based and on-board measurement methods will be developed that can supplement the current generation of measurement systems that cannot be easily deployed for field measurements. The development of improved systems and replication of processes in the laboratory will be a prerequisite for studies to develop an adequate understanding under a range of real-world vehicle operating conditions and on-road measurement – e.g. performance of road

Systems will be developed to reduce re-entrainment, by for example, using plants, innovative noise barrier features and improved road cleaning management. In addition systems to mitigate particulate re-suspension will be investigated from receptor modelling studies at a varied range of locations, and based on new source profiles to develop the understanding of non-exhaust PM. This research may include comparisons

between receptor modelling studies inside and outside of road tunnels, which could assist in the understanding of re-suspension processes for the assessment of road deposit re-suspension due to wind/vehicles speed.

Systems will be developed to reduce heavy/precious metals deposition along high traffic axes (highways). This research will include the assessment of abnormal concentrations of metals deposit, drained by rainwater and development of improved methods and technologies for source apportionment of deposits at the road-side and in sensitive areas.

Evaporative emissions: Evaporative emissions from gasoline vehicles are controlled through carbon canisters that trap and recycle emitted vapours. As emissions from the vehicle exhaust decline, improved understanding of emissions from this source is needed. An update is needed of evaporative emission factors from vehicles and the fuel distribution system. The relative contributions of fuel permeation and breathing losses to evaporative emissions need to be established. These studies need to consider the influence of ambient temperature conditions and the performance of the vehicles currently on the road. Other sources of emissions, such as vehicle interior plastic materials also need study.

Low Noise Transport System

The vision for 2020 is to avoid harmful effects of noise exposure from all sources and to preserve quiet areas in cities and suburban areas. A research target of 10 dB noise reduction at hot spots, but in particular a substantial reduction of annoyance can only be achieved through a system-approach considering vehicles, infrastructure, and traffic management.

Research for advanced infrastructure and roads will be carried out in design, materials and production technologies. Low-noise roads and infrastructure research will also include advanced noise barriers and technologies for pavement maintenance including monitoring and appraisal systems.

Research on future tyres will concern the interaction of the tyre with the road surface, new tyre concepts (in particular for geometry, design and materials) and for trucks and busses the development of technologies for lower idle and acceleration noise.

The research areas for the road vehicle will be in low-noise light-weight structures (powertrain and vehicle), quiet materials for the engine and gearbox structures (damping) and alternative powertrain systems especially for urban services. In addition, active noise control for exhaust and intake noise and thermal management for more effective encapsulation or shielding of powertrains research will be conducted. Noise and vibration management and prediction methods will be developed that can be used earlier in the design process. Improvements in modelling will therefore be imperative, to provide noise and vibration design directions before the CAD design phase. Another issue is the reduction of community noise through research to develop the acoustic labelling of vehicles in the various operating conditions.

Noise will be further reduced by research to support measures which improve the driving behaviour. This will include efficient training programmes for quieter driving and also technological support by intelligent transmissions, engine management, etc. The research activity on advanced traffic management systems will be a further means to reduce road traffic noise.

Finally important generic research topics with impact to noise future research will include the development of improved noise prediction and measurement techniques with regard to annoyance, the investigation of the long-term noise reduction performance of various measures, and ranking of sound sources with special regard to their annoyance contribution.

Control of Water Quality

Road corridors can have a large impact on local water and soil quality. The road-side environment can form a valuable refuge for flora and fauna , but these (especially-aquatic life-forms) can be severely impacted by routine or accidental emissions and there is concern about some contaminants on human health through impacts on ground water quality with carcinogens and other compounds such as heavy metals.

Research will develop methods for determining the overall impact of road transport on water and soil quality and development of automated monitoring of groundwater contamination along roads. Methods to reduce the impacts of winter maintenance (de-icing and snow clearance) on road-side aquatic environments and vegetation will also be developed. Studies will also evaluate appropriate use of alternative de-icing materials, improved application methods as well as developing improved (intelligent) methods of predicting and sensing ice build-up so as to reduce overall application rates.

Systems will be developed for the reduction of splash and spray as a transmission path from the road to the verge and beyond. Research will consider tyre/road interaction and vehicle effects, as well as the capture of contaminated water after accidents and after heavy rainfall. This will include local water catchment and treatment systems.

2.4 Design and Production Systems (DPS)

The research and technology development activities in the area of Design and Production Systems address both the needs of the automotive and the road/infrastructure industry. Both differ in customers, time-to-market requirements and product life-cycles, however there are developing synergies and the existence of various communalities and complementarities associate a common process in the area of DPS. The broadness of items to cover over time calls for a carefully structured and consistent approach that allows the addressing of crucial industrial and societal challenges within a complementary set of problem-solving integrators that may be tackled in variable intensity, according to time-dependent business case scenarios.

The specific Research Targets of Design and Production Systems are:

- Cycle times from new product concept to market will be reduced by at least 50% from today's best practice standards.
- Evolution of virtual tools will reduce future development costs of vehicle and infrastructure products and their components by 10-30%.
- Flexible production and delivery systems will enable order-to-delivery times for passenger vehicles of less than 5 days by 2020.
- The application of robust, reliable and innovative manufacturing systems will allow 100% utilisation of production sites.
- Continuous production of road surfaces will become possible throughout the full spectrum of climatic and operating conditions.
- New solutions will enable reuse and recovery of materials of 98% for infrastructure and 95% by average weight per vehicle

A circular arrangement of the major challenges to competitiveness appears to be the most appropriate including the main areas of:

- Materials, Production Processes and Modularization Challenge;
- Environmental & Human Challenge;
- Global Competitiveness Challenge;
- Design, Data & Logistics Challenge;
- Quality, Costs, Standards & Controls Challenge.

It needs to be recognised that each of these sets of technologies (e.g. **Materials, Production Processes & Modularization Challenge**) would not become a free-standing description of the real situation, since any future situation would be likely to draw upon the other technologies (e.g. **Cost, Quality & Standards** and/or **Global Competitiveness Challenges**).

This section will support the objectives of the Aho report “Creating an Innovative Europe” particularly with the provision of tools for innovative technologies in Public Procurement. Further support these overall objectives, a strong interaction with other technology platforms, such as “**Nanotechnologies**” (ENIAC), “**Manufacturing**” (Manufuture), “**Materials**” (EuMat), “**Construction**” and “**Steel**” (ESTEP) will help to establish common research priorities and targets and may lead to joint RTD initiatives, combining the various disciplines, as appropriate. Cross-sectoral applications need to be responded to by cross-cutting “Calls for Proposals” that integrate new knowledge and technology developments on nano-, information and communication - , materials and production – technologies for the benefit of all relevant sectors involved.

Materials, Production Processes incl. Modularisation

Research in this area will focus on three areas; Nano-Sciences and Nano-Technologies; Materials and New Production Technologies.

Innovative Road Transport Materials (Basics)

In the case of Nano-sciences, the objective is to support the objective-driven creation of materials and systems with pre-defined properties and behaviour, based on increased knowledge and experience with matter at the nano-scale. This will lead to a new generation of high added-value, competitive products and services with superior performance across a range of applications in the “Road Transport Sector”, while minimising any potential adverse environmental and health impacts. Inter-disciplinarity, integrating theoretical and experimental approaches, e.g. with other transport sectors, are highly welcome.

- Research will focus on new knowledge-based materials with tailored properties. This requires an intelligent control of intrinsic properties, processing and production, and taking into account potential impacts on health and the environment throughout their entire life-cycle. Emphasis will be placed on new advanced materials obtained using the potential of nano- technologies and/or “learning from nature”, in particular higher performance nano-materials, multi-functional materials, as well as hybrid materials and more efficient Carbon-Fibre Materials.
- New materials and components will be developed that are active and reactive through the integration of sensors or actuators within high performance materials. Some research may include the functional integration of “active materials” inside matrix materials, touch sensitive plastics, biodegradable parts with “slow” surface and “fast” core.
- Research to develop high-performance materials at acceptable costs will consider multiple applications such as weight reduction and creep resistance. These activities will include Mg alloys, cast inter-metallic, titanium and aluminium applications, metal matrix composites, polymer glazing, nano-structures and new materials such as reinforced polymers for pavements and structures.

Innovative Road Transport Materials (Applied)

New advanced materials with higher knowledge content, new functionalities and improved performance are increasingly critical for industrial competitiveness and sustainable development of the road transport sector. According to the new models of manufacturing industry, it is recognised that the progress lies with the materials

themselves, which are becoming the first step in increasing the value of products and their performance, rather than the processing steps.

- Advanced materials associated with new processes will be developed for application on faster or shorter applications or final assembly:
 - Finished or semi-finished light weight materials,
 - Structural material systems incorporating innovative polymers and reinforcements,
 - Mixtures between metals, organic materials and an-organic non-metals on a micro-structure level.
 - Light weight finished or semi-finished materials,
 - Improved dispersion properties for colour and catalytic coatings,
 - Optimised bonding processes.
- Research on advanced materials for road infrastructure purposes will be conducted. The topics examined will include:
 - Self-cleaning and regenerating materials for bridges, tunnels and other road infrastructure,
 - Fluids for low-cost, safe (hazard-free) and green maintenance of infrastructures,
 - Materials and processing technologies for reduced frequency and cost of maintenance with a particular focus on increased quality during production under variable weather conditions.
- Research into High-Performance Materials for Vehicles and Infrastructure, will include the development of multifunctional materials that can “self-adapt” their range of properties depending on the requirements during application for example self-healing (abrasion or wear), variable strength, or micro-encapsulated materials.
- “Soft” materials for road-side curbing, to reduce pedestrian head injuries, and for pavements, will be developed. The research will focus on improving the construction techniques and durability but also consider the linkages with the Safety and Environmental aspects.
- Net shape engineering and topologic/structural optimisation tools will be developed for optimising use of engineered materials with advanced functional integration and reducing costs for advanced lightweight material processing.

Innovative Road Transport Production Processes

New Production Technologies will focus on a new approach to manufacturing that is required for the transformation of the EU road transport industry from a resource intensive to a knowledge-based industrial environment. This entails creating the right conditions for continuous innovation (in industrial activities and production systems, including construction, devices, and services) and for developing generic production “assets” (technologies, organisation and production facilities) while also meeting safety and environmental requirements:

- the development and validation of new industrial models and strategies covering all aspects of product and process life-cycle;
- adaptive production systems that overcome existing process limitations and enable new manufacturing and processing methods;
- networked production to develop tools and methods for co-operative and value-added operations at a global scale; tools for the rapid transfer and

integration of new technologies into the design and operation of manufacturing processes;

to develop new products and engineering concepts and the possibility of new industrial structures.

- Robust design and predictive engineering tools will be developed for efficient and flexible production with more options for individualisation, reconfiguration and upgradeability.
- Advanced rapid tooling and prototyping technologies will be developed, such as die-less forming, which are desired for mechanical and electronic/electric vehicle components and systems.
- Highly flexible, autonomous and configurable production systems, such as modular machines, assembly lines and facilities will be further developed and implemented. The results of this research will allow variable assembly and small batch production of specialised materials, components and systems, and vehicle and infrastructure modules at reasonable costs for customised orders, niche applications and markets, and small series.
- New modular design and construction concepts will be developed for vehicle body, powertrain and electronic systems for increased flexibility and faster upgrades. Module design will address the ease of assembling sub-systems. Modular systems and assembly / disassembly technologies will be explored to support vehicle and infrastructure recycling targets and the associated economic feasibility at reasonable costs. For increased flexibility the applications offered by alternative fuels are to be considered.
- Research into the modularity for road infrastructure, including the embedded ITS infrastructure, will be carried out in order to support rapid implementation of upgrades without detriment to other, often longer-lasting parts.

Flexible Production Systems

- Adaptable, integrated processes including machines and assembly lines will be developed that are readily reconfigurable in conjunction with new modular and multi-functional units.
- Machines and assembly lines will be developed that provide increased capability for configurability including part and process monitoring and joining and assembling technologies. This activity will include consideration of the ICT links needed for production and supply networks.
- New design concepts will be developed for modular road infrastructure to improve construction, upgrades and maintenance efficiency. This will include factory-constructed pavements and structures, modular bridges, and replaceable elements, especially joints and bearings. Such new concepts will include new materials and allow for the separation of the functions of different pavement layers. Integrated, prefabricated systems will also be developed for the reduction of road traffic noise and air pollution with passive and active control functions.
- Highly flexible and configurable production systems will be developed for variable assembly and/or the production of module based vehicles at reasonable costs in small volumes. The research will investigate the solutions for robust and reliable production systems that are 100% production capable.

- Research will be conducted into advanced automated process technologies support part and process monitoring and assembling/joining technologies. The new processes that are developed will be adaptive to new techniques and new materials.
- Research into Traffic-friendly Construction and Maintenance Techniques for road infrastructure will develop flexible site-based processes, materials and equipment which can continually produce high quality products under variable climate conditions. The role of automated guidance and robotisation utilising precise positioning systems and automatic steering will be investigated for its benefits for quality and durability including the accuracy of layer thickness and evenness.
- Research into construction techniques and standards for issues related to stabilisation and chemical improvement, will provide improvements in the performance (and durability) of roads with regard to their sub-grades and sub-base layers. The coordination of research links with infrastructure aspects in other modes including rail and aviation will be developed.
- The development of site knowledge management, data handling systems and ICT technologies will be carried out in order to support advanced processes for construction and maintenance of road and structures in both urban and inter-urban environments. These new knowledge management systems will enable automated guidance and pre-processing for construction and better methods for the localisation and recording of information on underground public utilities. The benefits of the use of such systems in congested cities will be demonstrated.
- A programme of research into Global Road Transport Life Cycle Analysis to develop eco-efficient production concepts, considering the fundamental material and energy studies, will determine the stability of supply, life cycle costs, and social and environmental impacts for improving the sustainability of the mobility and transport system.
- Research into electronic systems for performance monitoring will examine usage and structural monitoring for “Maintenance on Demand” and feed-back to the design & production process.
- Developments in rapid maintenance techniques for vehicles and infrastructure will allow the maintenance operations to be improved through the application of digital techniques including virtual factory and augmented reality. Systems and materials capable of self-diagnostics and repair should also be developed.
- Developments in knowledge management systems for construction sites and data handling systems for planning, design, construction and maintenance of road pavements and structures will include better methods for localisation and recording information on underground public utilities.

Environmental & Human Aspects

Conservation and sustainable management of natural and man-made resources are in the foreground of this activity, comprising recycling and re-use of materials, clean production processes, chemicals safety, built-to-environment, protection and management of raw materials and bio-diversity, data management and information services, as well as assessment and foresight relating to natural processes.

A multidisciplinary approach is called for, involving controls- and electronics (ICT), optics, chemistry, physics and increasingly the biological sciences. Materials characterisation, design and simulation are also essential to better understand materials phenomena, in particular the structure–property relationships at different scales; to improve materials assessment and reliability, and to extend the concept of virtual materials for materials design. The integration of nano-molecular macro levels in chemical and materials technologies will be supported for developing new concepts and processes such as in catalysis, and process intensification and optimisation

Another point of RTD activity will be the interaction of human – labour stress-factors addressing the identification of critical sources, links to new challenges resulting from new labour modes and the impact of risk factors.

Time-to-Market

- Research in Digital Techniques and Virtual Reality will lead to tools for stochastic and self-learning simulation and immersive virtual reality. This in turn will lead to advances in the validation of concepts and products and the ability to evaluate and select solutions in order to accelerate their implementation.
- Research into Comprehensive Decision-making Systems and Tools would ensure that Product and process development benefit from advances in self-learning simulation tools.

Flexible Production Systems

- In the field of Reliable, Integrated Machinery, user friendly and highly reliable production systems will be developed for consideration of high standards of health and safety.
- New infrastructure elements with multi-function capability will be developed that mitigate environmental impacts and facilitate relationships between users, administration, utility companies and toll operators.
- Research into new road maintenance management and rapid maintenance techniques will ensure that techniques for quick repair and renewal are developed. Road elements will be developed that are designed for easier maintenance and increased efficiency for night time working and coordinate with public utility work. This research will be supported by the development of new Traffic-friendly monitoring systems.
- Research in green manufacturing technologies will develop improved production systems that are modified and designed for low environmental impact: water and energy consumption, low emissions and noise levels, VOC / solvent free production, low temperature processing.
- Research will be carried out into workplace ergonomics to develop overall workplace design and enhanced human-machine interface levels that contribute to a better working environment of the industry and to a sustainable production.
- Research into Human Resource Management and Training will place a particular emphasis on the development of a comprehensive approach to skills upgrading and competence enhancement of the work force in both automotive and infrastructure manufacturing, construction and maintenance.

Lifetime Resource and Use

- Research to develop Decision-making Tools for Environment and Security will generate reliable methods and design, engineering and testing models to predict material, component or vehicle/infrastructure behaviour and performance over their entire useful lives. Such innovative “green” design tools integrating conceptual design, production, assembly will be developed for economic achievement of safer and more sustainable vehicle, fuel and infrastructure systems.
- Research into high-speed techniques for road and infrastructure inspections will develop systems and techniques that are needed during road construction and maintenance for more traffic-friendly management to reduce congestion and environmental impacts. Coordination of national and industrial priorities will support the development of standards.
- Simulation methods and models will be developed that forecast the environmental impacts of technology decisions and policy actions, which are needed. The creation of databases of sustainable development indicators will enable continuous environmental monitoring including remote censoring and geographic information system.
- Critical path analysis will be developed for holistic infrastructure scenarios to optimise decision-making.
- Research will develop design and simulation tools to better protect road pavements, embankments and bridges against natural hazards such as floods, landslides and earthquakes, and impacts resulting from climate change. International cooperation will be promoted through coordination with developing countries and European neighbour states.
- Research into lean, cost-effective recycling processes will develop clean, worker-oriented, flexible and energy-efficient recycling processes for materials. Such research will be conducted into the processes for management of vehicles and infrastructure materials. This will address the challenges of reuse and recyclability of materials including aging and reliability concerns.
- To support the development of multi-material vehicle, separation tools, techniques and technologies to recover post-consumer recycled materials from complex parts and modules will be developed. This will primarily focus on polymers, mixed materials and the shredder fraction. Further studies will also be carried out for robotic and automated processes that will support economically viable materials identification and sorting. Particular attention will be given to improving the quality of the material streams.

Global Competitiveness

Current industrial challenges invariably have a trans-boundary and global dimension. Therefore international cooperation is a crucial aspect in this respect. Particular areas relate to EU international commitments, such as Mobility, Safety and Security, Climate Change, Biodiversity, Chemicals and Wastes conventions as well as the Johannesburg Summit decisions on sustainable development. Attention will also be given to relevant research actions stemming from EU environmental strategies and action plans. Scientific and technological partnerships with developing countries will contribute to the Millennium Development Goals in several fields (e.g. reverse the loss of environmental

resources, provision of global mobility assuring harmonised safety and security standards, improvement of water management, supply and sanitation, and facing the environmental challenges of urbanisation), areas where SMEs could also play a key role.

Particular attention will be given to the relation between global environmental issues and the regional and local development problems relating to natural resources, biodiversity, land use, natural and man-made hazards and risks, climate change, environmental technologies, environment and health as well as on policy analysis tools. Co-operation with industrialised countries will enhance access to global research excellence.

Research on emerging needs in this theme may address questions such as the interactions between industries, people, ecosystems and the biosphere or new risks related to natural, man induced and technologically induced disasters. Support to respond to unforeseen environmental policy needs could, for example, relate to sustainability impact assessments of new EU policies such as in transport policy, environment, standards and regulations.

Highly individualised cars are perceived to be a crucial success factor on the market place of the future with shorter delivery time, e.g. 5 Day Cars Initiative.

Similar initiatives appear to become necessary for the road infrastructure to tackle the challenges emerging from the “Intelligent Road” concept appropriately. In order to achieve the ambitious goals defined for both principles the “Intelligent Road” and the “5-Days Car”, numerous RTD efforts from the whole road transport partnership are necessary, which address not only this area of the work programme, but apply to all challenges for industry and society.

- Studies in Performance Monitoring and Prediction will ensure comprehensive, flexible and co-operative real-time simulation techniques are developed that can be applied throughout the supply chain to address issues of cost, resources, time to market, production, customisation, disassembly and servicing.
- Further research will extend digital techniques and virtual reality in its application to manufacturing through the “virtual factory” to the prototyping and visualisation of new product concepts. This will reduce cycle times and improve product performance through pre-validation, technologies for high quality virtual prototyping which can be shared between customers and suppliers. There is a clear need for global co-operation in virtual engineering.
- Methodologies and models will be developed to integrate the networks between the material flow (the Physical Factory) and the information flow (the Virtual Factory). These will be flexible and adaptive to changing demands. New comprehensive, flexible and cooperative tools will be produced that ensure an effective systems approach to design and development between vehicle manufacturers and suppliers, and infrastructure and service providers. ICT tools will support research of new systems solutions and their evaluation and selection for implementation.
- Tools for the conceptualisation and design of multimodal networks and exchanges for local, regional, national and international levels will be advanced further.

Costs, Quality, Standards & Control:

Quality assurance is a key element to high value products that has increasingly become a decisive success factor for automobiles, as well as for infrastructure technologies.

In particular the emerging co-operative systems IC technologies for active safety systems can enter and penetrate the market only, if the requisite quality/reliability margins are complied with and can be guaranteed. And the customers are reluctant to pay extra for all these new functionalities, disregarding whether they're designed to protect the physical integrity of all road traffic participants. Since encompassing control- and inspection-loops are costly and at time extremely time intensive new techniques are called for that allow a step change in efficiency of quality assurance measures and standards that are operational at significant lower cost and time investment levels.

For the road infrastructure both the quality, as well as the costs are of increasing importance in times when public authorities and private service providers have to hold their purse strings extremely tight in order to keep public spending in control.

- Reliable methods and tools to predict material, component, or vehicle behaviour and performance will be developed for effective life cycle management.
- For developing tools for the monitoring and prediction of life-time performance of road pavement, studies on vehicle-pavement interaction and in particular tyre-pavement interaction will be conducted. The development of new testing technologies for the accelerated wear and aging of materials will support the life-time performance models and lead to standards for the rigorous assessment of new products, accelerating their application in the market. The levels of confidence for the testing will be developed and supported by conformity of production techniques.
- To improve the quality of infrastructure construction and maintenance, traffic-friendly monitoring and high-speed quality inspection capabilities will be developed. Innovative, high speed diagnostic testing for monitoring road conditions will assess evenness, skid resistance, deflection, and surface deterioration. New sensors applications will be developed to provide improved and / or self-diagnostic assessment for more effective maintenance and minimised traffic disturbance.

Design, Data & Logistics

The competitiveness of European industry and Europe's capability to master and shape the future developments of Information and Communication Technologies (ICT) in parallel to its industrial challenges depend on a step change progress in road transport related design, data and logistics technologies, so that the demands of its society and economy are met. Activities will strengthen Europe's scientific and technology base and ensure its global leadership in ICT, help drive and stimulate innovation through ICT use and ensure that ICT progress is rapidly transformed into benefits for Europe's citizens, businesses, industry and governments.

Information and communication technologies (ICT) play a unique, proven role in fostering innovation, creativity and competitiveness of the European road transport sector. They are essential for addressing key societal challenges and modernising public services and they underpin progress in all science and technology fields. Europe

must therefore master and shape the future developments of ICT and ensure that ICT-based services and products are taken up and used to deliver the maximum possible benefits for citizens and businesses.

These are the targets of the Union's Information Society policy, as highlighted in the i2010 initiative, aiming at a competitive convergent information economy in Europe, a significant rise in European investment in ICT research and innovation and a very high level of accessibility in the Information Society. New ICT technologies will open up many new opportunities for higher-value products and services, which express explicitly in the "Intelligent Car" initiative addressing the three major challenges of technologies that are "**Autonomous Decision Taking**" (**Smart**), "**Safe & Secure**", as well as enabling navigation controlled "**Clean**" driving. Cognitive technology research will also be covered by the activities targeted by ERTAC.

Initiatives – including selected aspects of research in the areas of Nano-electronics Technologies and Embedded Computing Systems – and national programme co-ordination initiatives – including in the area of Ambient Assisted Living. The priorities of the activities have to include topics relying, among other sources, on the work of European Technology Platforms. Thematic synergies will also be developed with related activities in other Specific Programmes.

New ICT technologies will open up many new opportunities for higher-value products and services in road transport, where Europe already enjoys industrial and technological leadership, but has to defend its position against fierce competition. Such systems and services are needed, including user-friendly applications and the integration of new technologies and initiatives such as ambient and co-operative technologies to support:

- rapid and adaptive design;
- production and delivery of highly customised products;
- digital and virtual production;
- modelling simulation and presentation tools;
- miniature and integrated ICT products.

Time-to-Market

- Functional requirements for road pavements and other infrastructure elements will be developed through coordination activities in order to allow for new types of construction and maintenance. This research will include further development of performance monitoring methods for road. Supporting this, research to develop pilot scale assessment tools for road construction and prototypes of infrastructure subsystems will be further developed to eliminate scale effect and allow accelerated testing.
- Research will be conducted into the development of harmonised simulation methods and models for forecasting the impacts of environment-related technology decisions and policy actions. Such Scenario Forecasting Methodologies will serve for the life cycle assessment of the road transport system.
- Research activities in the field of simulation and validation of product design, material selection, and production processes of all types will speed up implementation and avoid unnecessary costs or delays.

- Tools for concurrent engineering will be developed for achieving faster time to market and world class level of competitiveness.

Flexible Production Systems

- Research in the design and monitoring of factories will encourage the development of a virtual environment in order to plan and test changes and evaluate maintenance.
- Comprehensive, flexible and cooperative “real-time” simulation techniques will be developed for closed loop planning of the entire production process from suppliers to vehicle manufacturers to support “build to order”.
- Simulation tools covering the entire production chain will be developed for vehicles and components, fuels and infrastructure. This will include material supply, components and process modification, real-time process optimisation, verification and delivery
- Digital techniques will be developed and applied for instant data generation and processing inside virtual and networked companies to support decision-making.

Lifetime Resource and Use

- The development of integrated systems for knowledge management of road infrastructure, including pavement composition and structure, maintenance history, road equipment, and the location and properties of utilities placed in or under the pavements, will provide better input for design modifications and infrastructure upgrades including pavement systems
- Open architectures for both software and hardware will be developed for offering more options in the design and upgrades of the vehicles and transport and information infrastructures throughout their lifetime.
- Modular platform concepts based on clear definitions of use will be developed for specific or variable performance criteria such as emissions, long range or urban use, multi-modal exchange.
- Open and shared data bases and aspects on materials and production processes which have an influence on recycling will be developed to support use of separation tools/techniques for multi-material vehicles.

Enabling Priorities for Design and Production Systems (DPS)

- RTD in and implementation of cost-efficient and innovative new materials, which aren't available on the market, yet that can improve existing technology and will enable new functionalities;
- RTD in high-level standardized processes, which can easily integrate materials, production and products in order to achieve higher flexibility;
- Securing competitiveness on the global market place by developing, implementing and applying:
 - virtual reality processes,
 - global decision taking strategies,
 - global standards for all component and systems technologies,
 - developing and using local expertise globally;

- RTD in and establishment of efficient quality / reliability assurance measures that are cost efficient at the same time;
- RTD in all modular vehicle concepts and related influence factors (Cutting strategies, component and systems interfaces, electronic / electric architecture requirements, assembly/disassembly strategies, logistics, recycling, etc.)
- RTD in improved modularity, logistics / life prediction as well as structures;
- RTD in improved and new construction processes;
- RTD in “Preventive Maintenance”, as well as Modularity for the Road Infrastructure;
- RTD in higher structural operations

3. Recommendations for the 7th Framework Programme for R&D

The European Community's 7th Framework Programme for research, technology development and demonstration activities provides the first opportunity for implementing the ERTRAC Research Framework. The ERTRAC Research Framework goes well beyond the time frame of FP7 going from 2007 to 2013 and includes significant commitments for research funding by the ERTRAC stakeholders in their own activities. However, the following Recommendations suggest a funding plan appropriate for the period of FP7 in order to support short-term planning needs of the Member States, industry and the European Commission.

It needs to be pointed out that delivery of the Research Framework requires a much improved alignment and coordination of private/ public and European/ national activities in the sector. Many of the major road transport challenges demand well coordinated cross-stakeholder programmes. Only an integrated approach with balanced contribution of all constituents will deliver the projected results and efficiencies that can support the development of a more sustainable and competitive Europe.

Funding of the ERTRAC Research Framework will have to be substantial in order to generate sufficient momentum and to drive early implementation of solutions. Adequate investment will have an incentive effect for the heterogeneous stakeholder groups to cooperate within a common research agenda towards European standards and maximum resource efficiency. European grants will be most effective in promoting a cross-stakeholder approach and striving for pan-European standards and policies.

The private R&D investment in the European road transport research sector is more than 28 bn Euro a year (ref. Joint Research Centre), of which a significant part covers the research topics described above in ERTRAC's Strategic Research Framework. In addition to this industrial investment, the Member States invest several billion Euros of public money each year in road transport research through national or collaborative multinational programmes such as EUREKA.

Achieving the ambitious goals of ERTRAC, in particular implementing the objectives of its Strategic Research Agenda (SRA), will require the mobilisation of a critical mass of resources. This will require effective coordination between the various programmes at Community, intergovernmental and national levels.

This can only be achieved by means of a synchronized action, in which the **investment by the EC of 1.75 bn Euro in the road transport elements of FP7** for the time frame 2007-2013 will be a vital incentive.

In addition, ERTRAC's SRA intends to motivate regional authorities to make use of the EC's Structural Funds and Cohesion Funds more often for investment in road transport research and technology activities.

With the Commission's support, the ERTRAC Research Framework will ensure a concentrated action in Europe and fill the current gaps in the research landscape – which are costing lives and causing environmental harm - whilst avoiding unnecessary, and wasted, duplication of effort across Europe.

Considering the economic importance of the road transport sector in employment, contribution to GDP and exports, as well as supporting almost all commercial and social activity, the development of road transport solutions using European standards for worldwide use must be viewed in terms of its considerable additional value for society and economy.

The massive European challenges in road transport, defined by politics and widely accepted by society - safety, climate and environment, energy security and mobility – justify such a joint effort of the various stakeholders - industry, member states and the EC.

ERTRAC has carefully assessed the needs in its four Research Areas and is confident that the Research Framework can be implemented. However, there are a number of process recommendations that are critical for a successful and efficient execution:

- ERTRAC will continue through and beyond FP7. Strong commitment of all stakeholders to the ERTRAC process and their willingness to cooperate and consensus is mandatory and assumed throughout this document.
- The stakeholder associations adjust their research agendas for maximum alignment with the ERTRAC Research Framework to jointly contribute to the shared vision.
- Member States and European Community research programs are complementary and contribute to the ERTRAC Research Framework.
- Existing initiatives and projects that work well and support implementation of the Research Framework need to continue. As such ERA-Net has to be mentioned, providing major progress on European/ national alignment. A strong cooperation between ERA-Net and ERTRAC has therefore been established.
- The need for openness, transparency and contribution in this process is self-explanatory.

Priority Topics of the 7th Framework Program for R&D

The increasing environmental challenges, European competitiveness and global policies demand urgent research to answer some critical questions and to support future policies and strategies. Some of the open issues relate to:

- Both goods and passenger transport are projected to increase significantly, further congesting the road system. Investments should be made in vehicle and infrastructure technologies, together with supporting policies. The most effective solution for society to support sustainable growth should be considered.
- Emission legislation continues to limit vehicle emissions. However there is still too little knowledge about vehicle emissions, network management and air quality, and the effectiveness of different policies.
- Europe's energy needs continue to grow, with increased reliance on imported energy as Europe's indigenous supplies of oil and gas begin to decline. Increasing energy needs also impact Europe's ability to control and eventually reduce greenhouse gas emissions. Further research is needed to define the most economical solutions for Europe, including energy sources such as biofuels, coal and other renewables.
- The global competitiveness of European industry needs to be improved.

These issues are important, but by no means comprehensive. However, they lead to some highly important **research priority topics** to achieve the targets described earlier that should be part of the **first FP7 calls**:

- **Future long distance freight transport, including logistics.**
 - This topic includes truck design & production, RTD on powertrain systems for improved fuel consumption, emissions and noise, further more research on tyres, infrastructure, traffic and transport management and communication, as well as safety and security.
- **Urban freight and passenger transport**
 - Improving urban mobility with adequate traffic & transport management systems, communication systems, with integrated freight and passenger intermodal concepts, and with the development of innovative, clean secure and safe vehicle & infrastructure concepts considering advanced fuels, while reducing congestion and noise and improving local air quality.
- **The intelligent vehicle and infrastructure**
 - This topic integrates driver support by traffic management, communication, information and harmonisation for the improvement of urban freight and passenger transport. Also advanced databases and life cycle management concepts are needed
- **Road transport Safety**
 - Improvements in road transport safety will be achieved through an integrated approach for vehicle & infrastructure design, databases, accidentology, incidents, human-machine-interaction, ITS, etc.
- **Sustainable energy for road transport**
 - As a medium term topic the second generation of biofuels is essential. Further issues are coal liquefaction, fuel production, infrastructure and land use. Hydrogen is the goal of a longer term strategy. In particular processes, production, storage systems require further investigations.
- **Competitive EU Production in a global context**
 - The predominant research areas deal with the mastering of global engineering processes in a distributed global environment.

These priority topics are of concern for the FP7 themes relevant to road transport research:

- **Transport;**
- **Information and Communication Technologies;**
- **Nanosciences, Nanotechnologies, Materials and new Production Technologies;**
- **Energy.**