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Foresight Vehicle Technology Roadmap 2020
Technology and Research Directions for Future Road Vehicles
Foresight Brief No. 6

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Purpose

The exercise had the goal of identifying market and industry trends and drivers for the automotive sector over a 20 year time horizon. In addition, performance measures and targets for the road transport system were defined. The technologies needed to meet these targets and the research required to deliver them were discussed. This foresight exercise was carried out in the context of a £100M programme whose current phase started in 2001 with a revision in 2003.

PART I: Road-mapping the Future

Within the framework of Foresight Vehicle, which is a knowledge transfer network for the automotive industry, a collaboration between industry, academia and government, a 'technology road-mapping' initiative has been set up to provide a framework for ongoing investment in research partnerships and to focus efforts on achieving sustainable wealth creation and quality of life. Foresight Vehicle itself was established in the context of supporting the recommended actions of the UK Automotive Innovation and Growth Team (AIGT). The latter comprises major stakeholders from the automotive sector who came together to identify the issues most likely to have the greatest impact on the long-term profitability and productivity of the sector in the United Kingdom.

The foresight programme has three main objectives:

- Encourage technological innovation in road vehicle systems in the short, medium and long term,
- Enable communication, discussion and action within industry collaborations, academia and networks,
- Map future innovation paths for a number of key technology areas.

The foresight programme was based on a 'Roadmapping' process which brought together more than 130 experts from across the road transport sector. These came from more than 60 organisations, including industry, academia and government. The exercise was based on a series of workshops and supplemented by a web based questionnaire emailed to respondents.

The goal was to use the roadmap structure to capture and share the rich set of views about how road vehicle markets, products, systems and technologies would or could evolve over the next 20 years. One of the main guiding principles in

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this foresight initiative was to base the technology roadmap architecture on the relationship between technology developments and system performance as well as trends and drivers.

With regards to technology developments, a broad definition of technology as 'know-how' was adopted which emphasized the application of knowledge. This included 'hard' technology, based on science and engineering principles, as well as 'soft' technology, which includes the processes and organizational models required to exploit science and engineering know-how effectively.

Part II: Technology, Drivers & Trends

Five technological areas were identified by the experts as having significant potential to deliver high impact technology solutions to meet the social, economic and environmental goals:

Engine and Powertrain Technologies: These would lead to improved thermal and mechanical efficiency, performance, drivability, reliability, durability and speed-to-market, together with reduced emissions and cost.

Hybrid, Electric and Alternatively Fuelled Vehicle Technologies: Leading to new fuel and power systems, such as hydrogen, fuel cells and batteries to satisfy future social, economic and environmental goals. Activities are concentrating on reducing fuel consumption of conventional vehicles, together with developing alternative energy and power systems, such as hybrids, electric and alternatively fuelled vehicles. Hydrogen and fuel cells are of particular importance, although it is likely to be 15-20 years before such systems will become widely available.

Advanced Software, Sensor, Electronic and Telematics Technologies: Their development will lead to improved vehicle performance, safety, control, adaptability, intelligence, mobility and security. The content of electronics and software in new vehicles will continue to increase in areas such as control and intelligence, telematics, information and service provision, entertainment and user interfaces. Many of these functions will require parallel development of the infrastructure to enable communications and system level control. The development and agreement of international standards will be a key enabler.

Advanced Structures and Materials Technologies: These will lead to improved safety, performance and product flexibility together with reduced cost and environmental impact. Interesting new materials technologies include lightweight alloys and polymers, fluids, coatings, biotechnology and nanotechnology.

Design and Manufacturing Process Technologies: These will provide improved industrial performance, considering the full vehicle life cycle from 'cradle to grave'. Newer flexible, manufacturing technologies have the opportunity to service different industry sectors and provide better returns on investment.

Six broad trends and drivers were identified and used subsequently to structure the information contained in the roadmap. These trends and drivers were not treated independently however. Rather they were seen as interdependent (for example, the related issues of vehicle fuel efficiency and CO2 emissions have significant implications for society, economics, the environment, technology, politics and infrastructure). The main trends are as follows:

II.1: Social Trends & Drivers

These relate to the social systems we live in, include:

- Demographics,
- Life style aspirations and choices,
- Mobility requirements and behavior,
- Working patterns and
- Desires for health, safety and security.

With continued growth in GDP forecasted at 3% per year until 2010, there is growing demand for mobility of passengers and goods. This is stimulated by economic growth and development together with changes in lifestyles and working patterns. The road transport system plays a central role in this as 80% of journeys made by people are made by car. Associated road traffic growth is predicted to increase by 20% over a 10 year period. Living and working patterns are expected to change, with increasing mobile and home working enabled by improved information and communications. There is also a need to anticipate and provide for demographic changes brought about for example by the ageing of the population and by growth of industrial and urban areas. Social demand for improved health will continue to encourage efforts to reduce emissions and particulates.

II.2: Economic Trends & drivers

The economic trends and drivers relate to the financial systems that affect our lives. These bring together a number of global and national as well as corporate and personal economic considerations. The participants in the foresight programme considered that the following economic drivers would prove key determinants for the future of the sector:

- The development of advanced manufacturing methods is required particularly to take advantage of new materials and structures. The elimination of processes such as paint shops will bring both environmental and economic benefits.
- Design systems are required which will significantly reduce development time and raise value. The introduction of more sophisticated virtual engineering tools for all aspects of vehicle design is required with the ultimate target of 'zero prototypes prior to Job 1'.
- Technologies aimed at increasing the effective life of a vehicle whilst enabling the upgrading of emissions and safety systems are needed. Preventative maintenance via onboard diagnostics can reduce operational costs, whilst more durable components, capable of operation in a zero maintenance environment, are required.

II.3: Environmental Trends & Drivers

These relate to the physical environment in which we live. They include energy production and consumption, waste, emissions and pollution, as well as associated health impacts. Experts participating in the exercise believe that continuing legislation, technological developments and progressive replacement of the vehicle fleet by more modern vehicles will reduce vehicle emissions to less than 20% of their 1990 level by 2010, even though increasing transport demand and congestion will have a counter effect.

II.4: Technological Trends & Drivers

These relate to how technology affects the way we live, including development of new fuel and power systems, electronics and control technologies, structures and materials, together with manufacturing and business processes.

II.5: Political Trends & Drivers

These relate to policy, regulation and legislation, together with the political processes that lead to them. Government targets have been set for reductions in:

- Congestion,
- Noise,
- Maintenance of roads, bridges and lighting,
- Improved information, booking and ticketing systems,
- A 40% reduction in deaths/serious injuries, and
- An accelerated take-up of cleaner vehicles.

Energy and CO2: This is a major area where government seeks to influence the automotive sector. Clear targets are specified for improved fuel efficiency and the total level of CO2 and other greenhouse gases produced as a by-product.

Waste: End-of-life vehicle policy is shaping the future of the industry. Currently vehicles have one of the highest recycling rates - more than 75%. However by 2015 it is expected that 95% of vehicles will be recyclable, with only 5% destined for landfill.

Health and Safety: The UK 10 Year Transport Plan underlines a desire to reduce road deaths and serious injuries. Targets of 40% reductions in deaths and serious injuries, and 50% fewer children killed or seriously injured, have been set for 2010. This needs improvements to infrastructure as well as vehicles as required by UK, European and Industry agreements and standards and regulations.

II.6: Infrastructural Trends & Drivers

These concern the systems that support road transport, including the physical roads and infrastructure, together with provisions for associated services and information, as well as interfaces with other modes of transport.

Improvements in communications bandwidth and computer processing power will provide opportunities to improve the overall road transport system performance, in terms of traffic management, reduced congestion, information services, improved safety and security.

If alternative energy and power systems are to be developed and deployed widely in vehicles, then appropriate fuel distribution networks will need to be established.

The effectiveness of the overall transport system demands that infrastructure is dealt with and re-designed in an integrated way providing links between the road and other transport modes be considered. Integrated transport requires the synchronization of information systems that include systems for timetables & integrated ticketing, as well as accurate and up-to-date information services for both passenger and freight.

Part III: Partnership & Investment for the Future

The United Kingdom and European political systems and processes should underpin the delivery of an efficient and effective road transport system, which requires a partnership between the private and public sectors. The long-term capital investment associated with infrastructure requires stable and integrated policies, while environmental targets require a willingness to develop and abide by international agreements. Issues of particular importance in Europe, include the liberalization of markets such as the liberalisation of the

freight market by 2008 and the harmonization of legislation and standards.

Investments in road vehicle technology and research should be considered in terms of the contribution that the investment is expected to make towards the achievement of primary social, economic and environmental goals of:

- A socially sustainable road transport system that provides equitable, safe and secure road transport able to meets the needs and aspirations of UK society,
- An economically sustainable road transport system supported by a dynamic and successful UK automotive industry,
- An environmentally sustainable road transport system that has a low environmental impact in terms of energy consumption, global warming, waste and health.

The British Department of Trade & Industry has established a special unit to follow up on findings and recommendations made by the various initiatives undertaken in this sector, including those resulting from the Foresight Vehicle programme.

The Automotive Innovation and Growth Team (AIGT) called on supplementing Foresight Vehicle by other initiatives such as the set up of an automotive international academy to continue working on and developing the sector further into the future.

Sources and References

This brief was based on a publication entitled 'Foresight Vehicle Technology Roadmap Version 2.0: and research directions for future vehicles'. This was published in 2004 by Society of Motor Manufacturers and Technology Traders Ltd. Forbes House, Halkin Street, London.