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A STUDY OF THE UK AUTOMOTIVE ENGINE INDUSTRY

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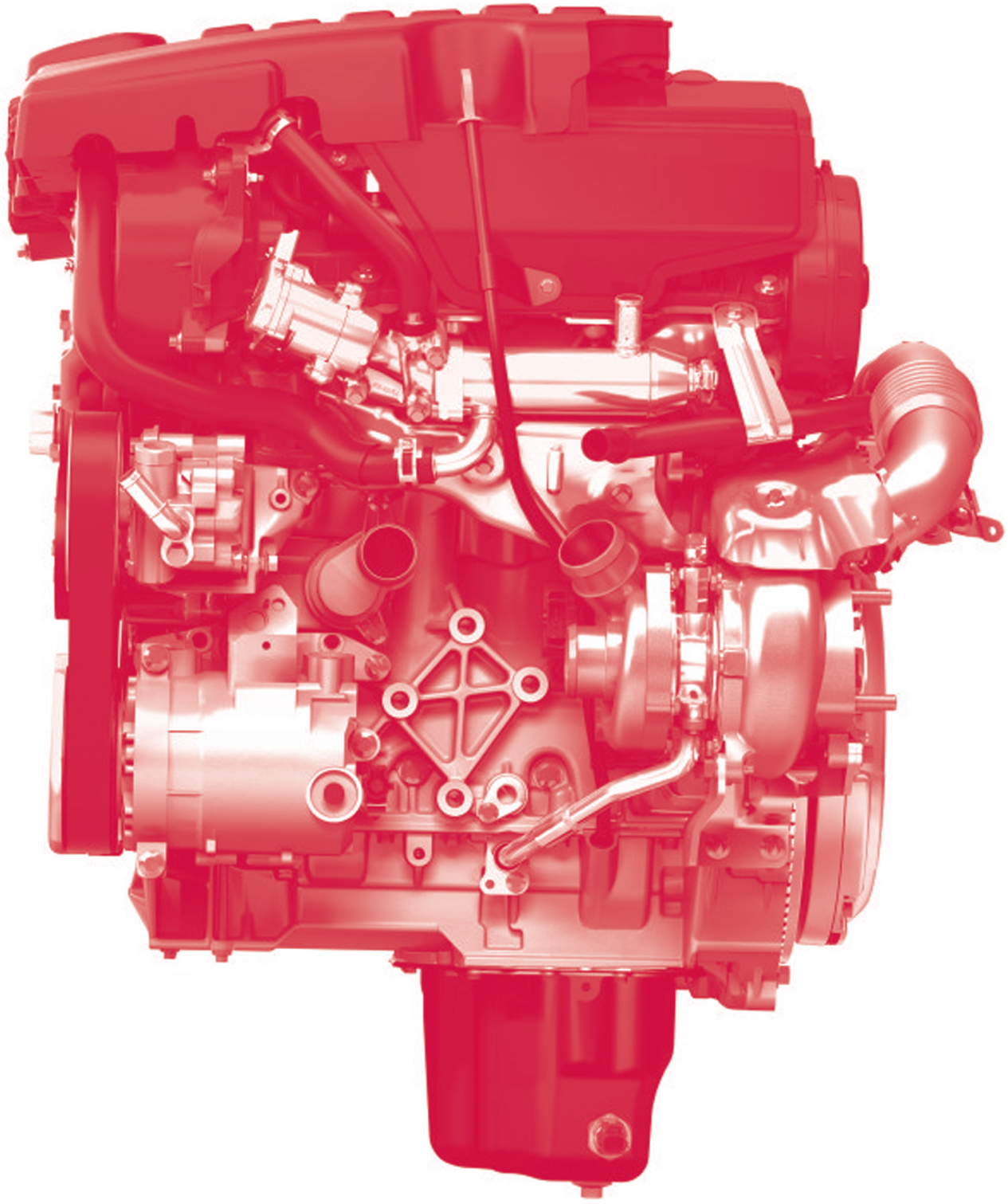
A Study of the UK Automotive Engine Industry



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Foreword

One of the most successful parts of the UK Automotive business relates to the design, manufacture and testing of engines, but it is the least well appreciated. We have a vibrant home market – the UK boasts more volume vehicle manufacturers than any other EU country, as well as a host of commercial vehicle, niche and sports car manufacturers. The engine sector also continues to develop and serve a very healthy export market. The UK has rapidly positioned itself as a global centre for automotive engine design, R&D and manufacture, with many of the world's leading companies having already invested here, using expertise developed by British companies. The UK's automotive manufacturing sector supports some 237,000 jobs in at least 3,250 companies, which includes a supply chain that is dedicated to continuous improvement and productivity in an increasingly competitive global market.

This report sets out the facts about the engine industry in the UK illustrating its strengths and capabilities. It places engine production and development in the context of the wider industry.

Global competition and the regulatory standards provide some tough challenges. By working together, government, industry, and academia can ensure that the UK builds on this automotive success story, and attracts more investment.

The Government, is committed to increasing industrial productivity by encouraging innovation. Our Foresight Vehicle Programme managed by the SMMT will continue to cement our reputation and drive forward gains in productivity, efficiency and lower emissions. The DTI's Technology Programme is supporting powertrain-related technology topics from a £350 million budget. Industry and academia are collaborating in a way that ensures the most effective progress of R&D while representative organisations such as the SMMT continue to service, support, and promote the industry both at home and overseas.

Engine production in the UK is a success. Engine production in the UK has a bright future.

Rt Hon Alun Michael MP

Minister for Industry
DTI

Christopher Macgowan

Chief Executive
SMMT

A Study of the UK Automotive Engine Industry

1. Introduction

The automotive industry is a pivotal part of the UK manufacturing sector. Automotive firms are leaders in global best practice in many areas of manufacturing and provide a key source of improvement for the UK manufacturing sector as a whole. The leading UK companies achieve world-class productivity quality, and energy use efficiency, and are role models for skills, training and labour flexibility. Within the UK's automotive sector, engine development and manufacture are major strengths.

This report describes:

- the UK's existing auto engine industry and supporting technological capabilities
- key technologies impacting on the sector, particularly in the context of regulatory developments and the structure of the global industry
- Government initiatives that contribute to the positive environment for investment and growth in this area, particularly in the context of research and innovation.

The report has been prepared by the UK Department of Trade and Industry (DTI)[1] in collaboration with the Society of Motor Manufacturers and Traders (SMMT)[2]. It draws on a number of inputs including research undertaken on behalf of the DTI by the Centre for Automotive Industry Research (CAIR)[3] and De Montfort Management Ltd[4].

The report necessarily reflects a snapshot in time and it is appreciated that its topicality, for example in terms of statistics and specific project initiatives, will soon be overtaken by further developments. Hence, rather than giving emphasis to transient detail, links are given to primary sources. Many of the web addresses will not only provide much more detail than presented in the report but also a route for updated information.

1 www.dti.gov.uk/ www.autoindustry.co.uk/

2 www.smmt.co.uk/

3 CAIR Centre for Automotive Industry Research, Cardiff Business School : DTI Engine Study

4 De Montfort Management Ltd: DTI Report on Diesel Engine capabilities in the UK

2. Description of the industry

2.1 Overview

The UK automotive engine manufacturing industry has undergone a period of impressive growth in recent years. Substantial new investments have been made at a number of locations, both in developing existing facilities and establishing new ones. As a result, the UK is now a significant net exporter of automotive engines to the tune of some £0.8bn per annum.

CAIR was commissioned to undertake a detailed analysis at plant level, to allow for a greater understanding of the factors and figures behind this headline, and to assist in the analysis of the future prospects of the industry. This has been supplemented by data from the SMMT and these studies have shown a strong long term growth trend. UK automotive engine output is currently running at some 2.7 million units annually.

UK engine production is principally for passenger cars. However, engines for commercial vehicles, agriculture, motorsport, motorbikes and non-automotive (marine, generators) are also of significance. The non-car applications, while of lower volume, are of higher per-unit value, as are those engines manufactured for the motorsport sub-sector.

By far the largest engine producer in the UK is Ford, with two major plants: Bridgend and Dagenham. There is a second group of high to medium volume car engine plants, generally of quite recent origin, manufacturing engines for BMW, Nissan, Toyota and Honda.

Other car engine plants produce in rather lower volumes: for example, Cosworth Techology, TVR and Zytek. The position for commercial vehicle engines is complex because many commercial vehicle manufacturers do not manufacture their own engines. Of course this practice occurs with respect to cars also but is somewhat less prevalent. The major independent commercial vehicle engine producer in the UK is Cummins. Perkins, which principally produces for non-automotive applications, is also significant. JCB too has started production of a range of off-highway engines. Triumph manufactures three-cylinder engines for motorcycles, albeit in low volume. Other producers have been identified, notably those involved in marine diesels, generating sets or engine remanufacturing, but these are outside the scope of this report.

Mention should also be made of the significant UK activity in engine design and testing. Several suppliers of contract R&D capacity are important here including Cosworth Technology, Lotus Engineering, Millbrook, MIRA, Pi Tech, Prodrive, Ricardo, TRW Conekt and Zytek.

2.2 Historical review

Over time UK engine manufacturing has grown, evolved and prospered, with many changes as old established companies have disappeared and new operations have been set up. Names such as Coventry Climax, Lister, and Gardner have been eclipsed, whilst Japanese and European companies now have significant UK operations. In some cases these have been set up in parallel with the establishment of new car factories such as Ford's facilities, which are long established and have grown significantly.

The reasons behind these developments are various, and in most cases plant-specific, but what is clear is that the UK is judged to be a good place to build automotive engines by the global industry players.

Over and above these factors, for a decade or more the European automotive industry in particular has invested significantly in developing diesel engines to perform to the advantage of both the environment and the consumer. Turbocharging of the diesel engine, the introduction of common-rail systems and the development of direct fuel injection have all played a key role in this progress. More recent developments in sequential multi-pilot injection, the introduction of diesel particulate filters (DPFs), higher pressure fuel injection and nitrogen oxide (NOx) reduction by exhaust gas control devices have also contributed to eliminating the historical deficiencies of the diesel engine in terms of emissions, noise and maximum power shortcomings. Again the UK is a major force in these areas of technical progress.

In addition, the development of racing engine capability is a significant UK strength that has boosted the UK's reputation as a location for engine development. Key companies associated with this success include Cosworth Racing, Ilmor, which builds the Mercedes engines for the McLaren-Mercedes F1 cars, Judd and Zytek.

2.3 Production and Trade data

2.3.1 Production data in the UK

During its study, CAIR took views from all the leading producers either through interviews or questionnaires. From this work it has been possible to construct a picture of UK automotive engine production as illustrated in Table 1 on the following page. At a headline level UK production has been steadily increasing. Latest data from the SMMT show a small downturn in 2004, but with investments in the pipeline, output is expected to return to the long term rising trend. 2004 production exceeded 2.7 million automotive engines, with non-automotive output taking the total to over 3 million.

The largest single producer is Ford with a large proportion exported. Toyota and BMW are also significant exporters of engines. All three of these producers have publicly stated growth plans for the UK.

Table 1: Engine production ('000s) by plant (Plant profiles can be found at Annex A)

	1999*	2000*	2001*	2002*	2003*	2004**
Automotive						
BMW	0	0	70	154	124	146
Cummins	45	47	43	50	55	44
Ford Bridgend	531	485	493	576	594	621
Ford Dagenham	520	670	670	615	620	682
Honda	108	63	109	160	180	188
Land Rover	200	200	210	220	250	47
Nissan	275	316	301	256	281	272
Powertrain	240	230	219	204	200	114
Toyota	100	133	160	351	420	580
Vauxhall	75	75	75	138	100	12
Others	5	5	5	5	5	5
Sub-Total	2100	2224	2354	2728	2829	2711
Non-automotive						
Perkins	300	300	300	300	300	300
Others	40	40	40	40	40	40
Combined Total	2440	2564	2694	3068	3169	3051

*Source CAIR **Source SMMT

2.3.2 Trade data

The SMMT publish a detailed analysis of HM customs data in their "World Automotive Statistics" publication. This confirms the results of the CAIR study showing that 2 million engines were exported in 2003, worth around £1.8 billion. Meanwhile the UK imported 750,000 engines worth just under £1 billion.

With UK vehicle production at around 1.8 million in 2003, this implies a total UK automotive engine output of around 3 million units.

The SMMT's analysis indicates that the UK automotive engine industry generated a positive trade balance in 2003 of about £0.8 billion from the net outflow of 1.3 million units.

2.3.3 Summary and outlook

It is clear from the data that the UK is a substantial net exporter of automotive engines, and output is rising.

The general outlook for the UK automotive engine manufacturing industry is good in the short to medium term. Despite uncertainties at the time of writing over the Powertrain Ltd operation at Longbridge, the UK plants all appear to have an assured future, with several having significant growth potential. BMW's Hams Hall plant is now producing engines for the new BMW 1-series and will produce engines for the next generation MINI. Toyota have ambitious expansion plans which will need increased engine capacity somewhere in Europe and Honda has also indicated that it will need a facility to produce diesel engines. The longer term is less clear and will depend crucially on the UK being the prefered location to manufacture the next generation of engines.

3. Technology contribution to engine development

3.1 Overview

The UK can boast a long-established tradition of innovation in engine technology embracing mainstream (e.g. diesel), high performance (e.g. motorsport) and future (e.g. fuel cell) systems. This tradition has led to the evolution of a comprehensive Research and Development (R&D) support infrastructure that includes vehicle and engine test facilities, design engineering consultancies, specialised new technology R&D companies and a vibrant academic community. In the case of the latter, there exist special networks, such as TxNet (Powertrain Systems and Driveline Technology) and FABIAN (Fuel Cells and Battery Vehicles) and programmes, such as SUPERGEN (Sustainable Power Generation and Supply), which aim to bring researchers together to tackle the challenges of the future. This critical mass of activity underpins a rapidly growing engine manufacturing sector that makes the UK a net exporter of engines (see section 2.3).

Whilst there is a competitive business environment, networks have a role to play in facilitating collaborative activities particularly in the context of national and international programme activity. Foresight Vehicle has been a cornerstone of this networking activity, initially through its management of a national programme of collaborative R&D projects and then, as SMMT Foresight Vehicle, by additional networking activities such as consortium building and the preparation of technology roadmaps (see Annex B).

3.2 Technology trends

The latest version of the Foresight Vehicle Technology Roadmap[5] describes how the future evolution of road transport is expected to respond to various social, economic and environmental drivers in the context of the technical, political and infrastructural enabling or constraining forces.

The main drivers of change are derived from the overriding domestic and international requirements for sustainable transport systems. This cascades down through the regulatory infrastructure (e.g. progressive decrease in tailpipe pollutant standards through the Euro stage regulations; introduction of End of Life Vehicles Directive) or voluntary agreements (e.g. Vehicle Manufacturers' agreement on CO_2 emissions at European level as a means of progressing towards Kyoto targets). Fiscal policies are significant drivers for change, for example influencing the petrol/diesel mix, the vehicle class mix and the penetration of alternative low-carbon propulsion technologies. Other drivers include societal pressures associated with sustainable transport (e.g. safety, congestion and flexibility issues) and the implications of the global operation of the main players on the nature and location of manufacturing supply chains. Superimposed on these are the inexorable cost-down pressures coupled with the delegation of R&D and design responsibilities down the supply chain.

5 Foresight Vehicle Technology Roadmap Version 2.0', SMMT Foresight Vehicle, 2004. www.foresightvehicle.org.uk

As well as technological developments an important factor in the relevant investment decisions will be the emerging shape of the diesel engine market. Factors impinging on this market evolution are presented in Annex C.

Much has been written about the likely route to the hydrogen economy. Whilst different views have been expressed by individual vehicle manufacturers worldwide, the consensus view appears to be converging on the route set out in a UK Government-commissioned report[6]. This route involves the continuing improvement in the efficiency and environmental friendliness of propulsion systems based on the ICE, the increasing utilisation of hybrid systems and ultimately the take up of hydrogen-based propulsion. This development path could culminate in fuel cell hybrids operating on renewable hydrogen. There is now widespread agreement over the general direction of this technical evolution as reflected in the European Community's strategy for the Sustainable Surface Transport programme within FP6[7] and the recommendations of interest groups such as the European Automotive Research Partners Association (EARPA) and the European Council for Automotive R&D (EUCAR). The remaining debate is focussed more on the precise time frame of the anticipated evolution of the technology since this is subject to a complex interplay of technical, commercial and political factors. A key input to this is the national energy strategy and some of the relevant issues to be considered have been addressed in a recent report on a strategy for hydrogen energy in the UK[8]. This study's recommendations included early implementation of demonstrator activity to stimulate vehicle and aftermarket development.

Superimposed on the predicted overall evolution of technology are likely to be differences in rate, and even the direction, of new technology options in different geographic markets. For example the Japanese industry clearly sees a market for hybrid gasoline-electric vehicles as its alternative to the conventional internal combustion engine. Toyota and Honda are both targeting substantial volumes of hybrid vehicles by 2008 and estimate that 5% of their total annual production volumes will be sold in hybrid form by then. A comparison of 2002 sales volumes of diesel-fuelled and hybrid cars, shows the clear difference in approach taken towards diesel and hybrids in the markets of Japan and Western Europe. Whilst diesel-fuelled sales volumes reached 5.8 million in Europe, only 4,807 diesel cars were sold in Japan. In the same period and on a different scale 6,819 hybrids were sold in Japan compared to a total of 882 in Western Europe. However the UK is leading the market transformation in Europe towards hybrids with almost 2,500 new hybrid registrations in 2004.

Whatever the ultimate direction of powertrain technology, many industry insiders predict that conventional or hybridised ICE-based engine systems will continue to represent the primary form of propulsion for passenger cars for the next thirty years or so.

Given the likely evolution of powertrain technology, how well is the UK placed to respond to the commercial opportunities arising from requirements for new types of system and components?

6 Carbon to Hydrogen Roadmap for Passenger Cars: Update for DfT/DTI', Ricardo, Nov. 2003 www.dft.gov.uk/stellent/groups/dft_roads/documents/page/dft_roads_026217.hcsp

7 Sustainable Surface Transport, Draft FP6 2002-2006 Work Programme', April 2004.

8 A strategic framework for hydrogen energy in the UK', www.dti.gov.uk/energy/sepn

3.3 UK technology strengths

The strength of the UK manufacturing base is summarised elsewhere in this report (see section 2.3). This strength is underpinned by a collective technology capability built on the foundation of a long tradition of pioneering activity from sources ranging from engine manufacturers and their suppliers through to cross-sector spin off (e.g. laser-based combustion diagnostics from the nuclear industry).

This collective technical expertise is spread across many types of organisation. These include:

- specialised independent consultancies
- specialised consultancies now owned by global enterprises
- small developers of exploitable intellectual property
- centres of expertise within global companies
- spin outs from universities.

Even these categories are somewhat arbitrary with boundaries blurred as companies migrate between categories in response to the continually evolving structure of the industry. Traditionally much of the expertise was concentrated in what was collectively known as the Design Engineering sector. The relationship of this sector to the global business environment in which it operates has recently been reviewed[9].

One of the keys to the future of the UK's overall strength in engine technology will be the degree to which capabilities in relevant new technologies are introduced into the collective capability. So far the signs are promising with for example in the case of fuel cells relatively new companies such as Ceres Power, Eneco, and Intelligent Energy making pioneering contributions to complement those of longer established companies such as Johnson Matthey.

The UK has a high academic reputation in the relevant scientific and engineering fields. This is illustrated for example by our performance in automotive-related European Community R&D projects where there is strong involvement of the UK academic community. Research is also carried out directly under contract to global VMs overseas.

The high reputation of the UK's scientific and engineering expertise is not in doubt. The challenge is therefore to channel this strength into high added value business activity in the UK taking account of:

- the global nature of the market and the operation of the multinational groups serving it,
- the overseas location of many of the key decision making and technology centres of the main players and
- the tendency for new manufacturing investment being located close to the markets to be served.

9 Likely impact of changes in the supply chain on the automotive contract design and engineering sector in the UK', CAIR for DTI/SMMT, May 2003

The ability of the UK's industrial and science and technology base to exploit the low-carbon agenda has recently been considered in an exercise aimed at prioritising R&D investment priorities[10].

3.4 Investment in technology

Value added, or the wealth generated by business activity, is an indicator of a company's competitiveness and value to its stakeholders. Effective R&D expenditure is a key factor in mobilising the innovation necessary to sustain high added value, which itself generates the resources available to invest in R&D. In the automotive manufacturing sector Ford is by far the largest investor in R&D in the UK with an annual investment approaching £1 billion (£870 million in 2003[11]) reflecting its UK operations' lead position in diesel engine development and in premium vehicles. R&D investment as a proportion of sales volume is typically of the order of 5%. For vehicle manufacturers this scale of investment is indicative of the development costs associated with developing new products in the sector. For technology suppliers to the sector the balance of R&D investment has to be biased more towards the Research end of the R&D spectrum. Whilst there is generic Government support for R&D via tax credits, Government agencies become more specifically involved in support as the focus moves away from product development towards underpinning research in generic technology areas. Major Government support instruments for this type of investment include the programmes managed by the Research Councils and the DTI's Technology Programme.

Any company seeks value for money in its R&D investment. Large global companies have choices regarding which of their technology centres should receive funding. Smaller companies and some component suppliers require very cost effective innovation in order to compete in the long term. For potential new entrants to the supply chain, lack of confidence in the potential market for new products outside their familiar territory can be a barrier to investment.

Whilst commitment to R&D investment may be a prerequisite for survival and growth it has to be accompanied by a route to market. This requirement often points to the desirability of collaborative R&D rather than the go-it-alone approach.

10 Defining the research, development and demonstration priorities for the centre of excellence in low carbon and fuel cell technologies', LowCVP R&D Working Group, 2005.

11 The 2004 R&D Scoreboard DTI, www.innovation.gov.uk

The DTI Automotive Unit has on a number of occasions been advised by relationship-managed overseas-controlled companies of the importance of involvement in Government supported schemes as a lever to retain internal investment in R&D in the face of overseas competition. In some cases there is likely to be a direct link between the retention of UK-based centres of specialised design and engineering capability and the retention/expansion of the associated manufacturing and associated supply chain activity.

All this indicates that there is a role for Government support for innovative R&D and for the mobilisation of appropriate consortia of companies to respond to programme initiatives. Some of the available instruments are summarised below. The challenge is to match these opportunities with the specific needs of the powertrain sector.

3.5 Government initiatives

The UK Government is committed to increasing industrial productivity and the encouragement of innovation is key to achieving this objective[12]

The DTI Automotive Unit's overall strategy for the automotive sector has been focussed on:

- maintaining and growing the existing high added value business activity and
- encouraging further inward investment in high added value business.

Its technology strategy for the sector is aimed at progressing these objectives and therefore includes:

- facilitating the exploitation of technology in the existing supply chain
- encouraging the entry into the supply chain of technology-rich companies reflecting the anticipated technical and structural evolution of the sector and
- showcasing the strength of the science & technology base and of the supply chain.

To date the DTI's main technology support initiative has been the Foresight Vehicle Programme (currently managed by the SMMT). This resulted in collaborative projects totalling over £100m of activity with a DTI investment of £12.5m, much of which was concerned with powertrain technology (see Annex B). In order to bid for DTI funding, this type of activity must now be progressed via its Technology Programme's new 'Collaborative R&D' and 'Knowledge Transfer Network' products[13] (see Annex B). These are operated via focussed competitive calls. The first of these (April 2004) included the topic of 'Technologies for environmentally friendly transport', and the second call (November 2004) included the topic 'Design, simulation & modelling' which included applications for environmentally friendly transport. Information on projects underway and on the content of current and future calls can be obtained from the Technology Programme website[14].

12 Competing in the global economy: the innovation challenge', DTI Innovation Report, Dec. 2003. www.dti.gov.uk/innovationreport/

13 www.dti.gov.uk/technologyprogramme

14 www.dti.gov.uk/technologyprogramme

The UK Department for Transport (DfT), in addition to its involvement in the Foresight Vehicle Programme, has recently supported the demonstration of new propulsion technology concepts via its New Vehicle Technology Fund initiative within the TransportEnergy programme (see Annex B)[15]. It included, for example, projects resulting from the Ultra Low Carbon Car Challenge. This programme has highlighted the magnitude of the gap between concept demonstration and the establishment of viable business activity. The Environmental Industries Unit (a joint DTI/Department of the Environment, Food and Rural Affairs initiative) is currently examining barriers to exploitation with a view to encouraging means of overcoming them. For further information contact: Environmental Industries at DTI

A key challenge for the deployment of Government support instruments has been the need to reconcile the real needs of the industry sector with the constraints imposed on the instruments, particularly in the context of State Aid rules. Amongst the needs are:

- the requirement for the large scale demonstration of production viability and reliability, the scale of which is difficult to reconcile with competitive technology calls and
- the importance of system integration, which is difficult to express in terms of an underpinning technology rather than product development.

The DTI aims to tackle these via enactment of one of the recommendations of the AIGT[16]. This involved the setting up of Centres of Excellence in the fields of 'Low carbon and fuel cell technologies' (Cenex)[17] and 'Transport telematics and technologies for sustainable mobility' (Innovits)[18]. These centres entered their launch phase in 2004 and became legal entities in 2005. Powertrain technology is central to the activities of the former of these and is also influenced by the activities of the latter.

In essence the aim is to use the two centres to translate the key elements of the Foresight Vehicle Technology Roadmap[19] into the formulation and execution of action plans that will leverage support from national (including the DTI, other government departments, Regional Development Agencies and the Research Councils) and international agencies to give critical mass to the required national effort. These centres will give the UK a chance to break out of the current piecemeal approach to the various support instruments in order to encourage the development of appropriate supply chains. This is with a view to making the UK the location of choice for technology-rich business activity based either on new inward investment or the retention of existing strengths.

15 www.transportenergy.org.uk/

16 Automotive Innovation and Growth Team – Summary, May 2002 www.autoindustry.co.uk/automotive_unit/aigt

17 http://cenex.co.uk

18 www.innovits.co.uk/

19 Foresight Vehicle Technology Roadmap Version 2.0', SMMT Foresight Vehicle, 2004. www.foresightvehicle.org.uk/

Cenex may also provide a mechanism for enacting the recommendation of the LowCVP Supply Chain Working Group that supplier database and information transfer tools be set up to help mobilise supplier involvement in the business opportunities arising from the low carbon propulsion roadmap[20].

A key instrument for activating automotive industry participation in national and international collaborative R&D programmes is the Foresight Vehicle network. Following a recommendation of the AIGT[21] this is now managed by the SMMT. The SMMT is therefore well placed to mobilise its supply chain membership to take advantage of the various collaborative R&D funding initiatives. The Foresight Vehicle network also provides a mechanism for the various SMMT committee membership interests to be channelled into the programme planning of the key instruments of public support for technology, such as the DTI's Technology Programme, the Centres of Excellence and the European Commission R&D Framework Programmes.

20 Progress report on activities of 'database' sub-group', LowCVP paper SCWG-P-04-003.

21 Automotive Innovation and Growth Team – Executive Summary, May 2002 www.autoindustry.co.uk/automotive_unit/aigt

4. Policy and regulatory drivers

4.1 UK Powering Future Vehicles strategy [22]

The Government intends that the UK should lead the global shift to clean, low-carbon transport. New vehicle technologies and fuels offer opportunities for radically reducing the impact of road transport on the environment both globally in terms of climate change, and locally in terms of quality of life.

They will also benefit the consumer, through more fuel-efficient motoring and help build competitive advantage for UK industry in the global shift to a low carbon transport economy. The Powering Future Vehicle strategy, launched in 2002, provides a framework for decision making to bring about this market transformation.

Its twin objectives are: -

- to promote the development, introduction and take-up of new vehicle technologies and fuels;
- and to ensure the full involvement of the UK automotive industry in the new technologies.

4.2 CO_2 voluntary agreements

There are currently CO_2 voluntary agreements between the European Commission and the relevant industry associations ACEA, JAMA and KAMA. These agreements have a target of 140g/km CO_2 by 2008 (2009 for JAMA and KAMA) for European new car fleet average emissions. This is considered to be the key driver for change in the sector and the future of the voluntary agreement beyond 2008 will be crucial. Technology developments will play a crucial role in the achievement of these objectives. This can only be achieved however through an integrated approach involving industry and government.

4.3 Emissions standards.

Currently "Euro 4" which came into effect from 2005 sets standards for regulated tail pipe emissions for petrol and diesel vehicles. Proposals for "Euro 5" are being considered to take effect from around 2010. These are likely to focus on particulate (PM) and oxides of nitrogen (NOx) emissions from diesel vehicles but it is not clear at the present time whether petrol engined vehicles will also be affected. Comparative emission standards for Europe are given in Table 2.

22 www.dft.gov.uk/stellent/groups/dft_roads/documents/page/dft_roads_506885.hcsp

Table 2

Diesel emission standards – Europe (expressed in grams emitted per kilometre)

Standard	Euro 3	Euro 4	Euro 5*
Year of introduction	2000	2005	2010
Particulate matter	0.05	0.025	0.013
Hydrocarbons/NOx	0.56	0.30	0.155

* Anticipated proposal

4.4 Biofuels Directive

The Biofuels Directive requires member states to set targets for the use of biofuels. The Directive sets "reference values" for member states of 2% of total sales/consumption of fuels for 2005 and 5.75% for 2010, but these are not mandatory targets for member states. The UK has set a 0.3% target for 2005 and is still considerering the target for 2010 (see below). The UK has introduced fuel duty differentials to promote new cleaner fuels. This includes a 20pence per litre fuel duty incentive for biodiesel, which has stimulated sales of around 2 million litres a month from over 150 retail forecourts. A similar incentive for bioethanol (which can be blended with petrol) started on 1 January 2005. The UK consulted on its biofuels policy in 2004, and it is currently considering a biofuels sales target for 2010 and what further support measures could be introduced for biofuels. Possible policy measures include a "Renewable Transport Fuel Obligation". This would require the major fuel suppliers to ensure that a certain percentage of their total fuel sales was from renewable sources. The UK Government is conducting a feasibility study and consultative process with stakeholders on the prospects for such an obligation (as announced in the 2004 pre-budget report[23]). This study will report as soon as possible in 2005. Biofuels are a relatively expensive way to save carbon compared to action in other sectors (energy efficiency, wind power etc). However, renewable transport fuels will be required to help deliver the Government's carbon reduction objectives.

4.5 Other factors

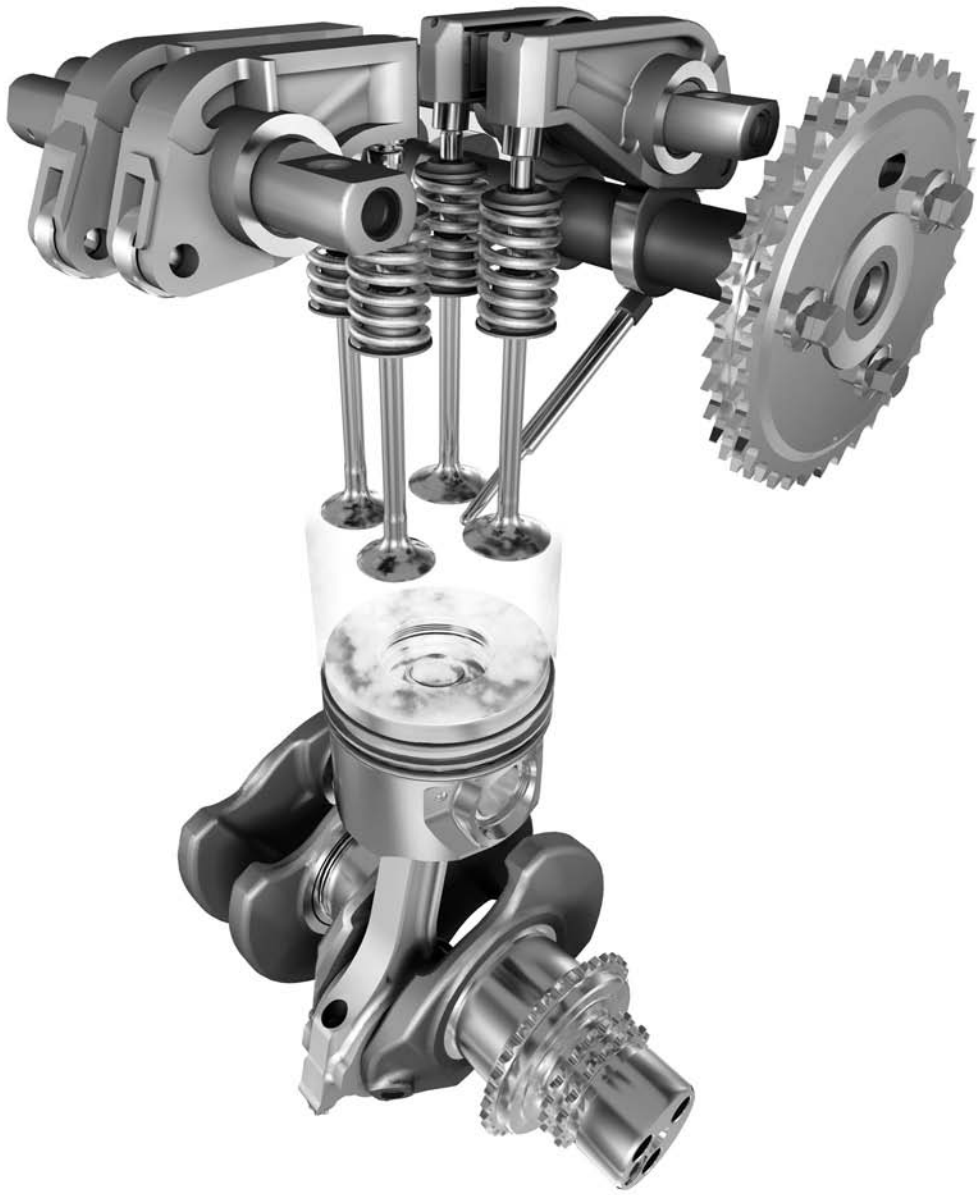
Some other regulatory requirements or driver comfort parameters make progress towards lower carbon propulsion more difficult to achieve since they inevitably add weight to the vehicle package, placing larger challenges on the industry in its drive to achieve the above requirements.

However other factors, such as the lower sulphur fuel standards, can help achieve low emissions and taxation and customer information (such as eco labels) help drive demand for lower CO_2 vehicles.

Taxation measures include Vehicle Excise Duty and company car tax based on CO2, and fuel-specific initiatives such as the Government's announcement in 2003 that, subject to the outcome of the Green Fuels Challenge project, it intends to exempt hydrogen from the fuel duty for a limited period in the future to encourage further development and early take up.

23 UK Government Pre-budget report 2004 outlines the Government' s spending priorities – www.number-10.gov.uk/output/Page6705.asp

Annexes



Annex A

Plant profiles

This annex presents brief comments on the main plants.

Bentley Motors Ltd

Bentley Motors headquarters in Crewe, Cheshire, designs, engineers and builds luxury vehicles for some 45 markets around the world. It also produces the necessary engines to power these cars. In 1998, the company was acquired by Volkswagen and announced an investment of £500million into new facilities and product development. The company now employs 3,500 people, including an engineering team of 550, all of whom are dedicated to Bentley products.

Bentley Motors is the world's largest single producer of the 12 cylinder engine, with a 33% share of the global market. In 2004, the company built 7,686 engines in Crewe, manufactured to power the Bentley Arnage, the Continental GT and the newly launched Continental Flying Spur.

BMW Hams Hall

This plant is highly automated, built to manufacture BMW's worldwide demand for in-line 4 cylinder petrol engines. Total investment to date is reported to be around £400 million investment.

In 2002, Hams Hall produced 154,000 four cylinder Valvetronic engines. The plant supplies engines for BMW 1-series, 3-series and Z4. These engines are supplied to the following vehicle plants; Regensburg, Munich, Leipzig, Rosslyn (SA) and Spartanburg (USA). Hams Hall currently employs 650 people. The decision to assemble a new generation 4-cylinder petrol engine for future variants of the MINI will mean that both volume and headcount will increase.

The new engine is the result of BMW's collaboration with PSA Peugeot Citroen, announced in July 2002, under which the firms agreed to team up on a new family of gasoline engines. There will be a combined investment of some €750 million on R&D and manufacturing over the period to 2007.

Caterpillar

Caterpillar of the US own Perkins and F G Wilson. Perkins Engines Company Limited manufactures over 300,000 engines a year and is a leading supplier of off-highway diesel and gas engines in the 4 – 2000 kW market. Perkins has facilities in Peterborough, Stafford and also in Brazil and North America.

In 1999, Caterpillar acquired FG Wilson, based in Larne, Northern Ireland. FG Wilson is the largest generating set manufacturer in Europe and one of the largest in the world, with the capacity to manufacture over 50,000 generating sets per annum. The company is one of the largest employers and exporters in Northern Ireland with over 90% of generating sets exported to over 170 countries worldwide. Caterpillar also has an engine remanufacturing facility in Shrewsbury.

Cummins

Cummins is a large group based in the US. It is a leading worldwide designer and manufacturer of high performance Euro 3 diesel engines for trucks, buses and coaches. OE customers include DAF, Foden, Leyland, Marshalls, Seddon Atkinson and Transbus Dennis.

Cummins has two wholly owned diesel engine manufacturing plants in the UK. The Darlington engine plant manufactures the B3.9/5.9, B4.5/6.7 and C8.3 diesel engines whilst the Daventry engine plant manufactures QSK45/60-G, QSK78, QSV81/91-G and QSK19 powerpacks. Cummins' European Technical Centre is based in Darlington and the company is a joint venture partner with Iveco and New Holland in the European Engine Alliance (EEA) that has its Technical Centre in High Wycombe. Following a US$300 million investment in this UK facility, EEA has developed a range of diesel engines for use in the automotive, agricultural, industrial, marine and construction sectors. These are three, four and six-cylinder diesels with power outputs ranging from 38kW for the three-cylinder version to 202kW for the six-cylinder.

Current diesel engine production is 40,000 units per annum.

Cummins' Ramsgate plant makes diesel and gas powered generator products in outputs of up to 2MW(e). They also have a plant in Glasgow, re-manufacturing engines and components, employing over 100 people, servicing a range of industries.

Ford Bridgend

The Ford Bridgend plant started production in 1980, and by 2001 had made ten million engines. In 2001 the plant had some £225 million invested and an announced plan to double output by 2004, potentially reaching about 1.1 million units per annum.

The Ford Bridgend engine plant has nearly 1,500 staff. The plant makes Zetec petrol engines for the smaller cars in the Ford range including the new Fiesta, Fusion, and Focus, also V8s for Ford Premier Automotive Group models. The plant was expected to have production cutbacks as the European car market softened during 2003, but the new models introduced by Ford in the smaller car segments held volumes up at the plant. In 2003 the plant also underwent preparations for a new I6 engine, which is expected to add a further 600 jobs within two years.

Ford Dagenham

Dagenham had a £375 million investment programme to build a new assembly hall to increase diesel engine capacity from 650,000 to 900,000 when mainstream car assembly ceased at the site in 2002. The production launch engine will be the 2.7 litre common rail diesel V6, developed with PSA Peugeot Citroen. The first application is in the Jaguar S-Type that has hitherto lacked a diesel. A total of 400 new jobs have been created at the plant for this engine.

Dagenham also produces two other diesel engine families. The first is the Puma Duratorq, in 2.0 litre and 2.4 litre variants , used predominantly in the Transit, but also in the Mondeo. The second is the 1.8 litre Lynx, whose performance has attracted acclaim for the Focus TDCi. These two accounted for 650,000 units in 2003. In addition a petrol engine for the Galaxy is manufactured in volumes of 20,000 a year, though this is likely to be phased out. A decision has also been taken to manufacture the DV4 and DV6 engines at Dagenham.

Honda Swindon

The engine plant was the first Honda production facility to be built in Swindon, pre-dating UK Honda car production by three years. The plant has been operational since 1989 and has produced over 1.5 million engines. The engine plant began with production of engines for the Honda Concerto and Rover 200/400 series. Now the majority of output is for Honda alone. The engine plant also produces the gearbox and complete transmission assemblies to feed into the car production lines.

JCB

In 2003 JCB (the world's fifth largest manufacturer of construction equipment) announced an £80 million investment in a new engine plant in Derbyshire. JCB used much of the UK specialist engineering base to assist in the design, development and production engineering, including Cosworth Technology and Ricardo, of a new off-highway diesel engine range. Production started towards the end of 2004, employing 200 people.

Nissan Sunderland

The Nissan Sunderland engine plant was installed when the plant as a whole was built, producing in-line 4 cylinder petrol engines of various capacities for the majority of the petrol-engined cars built in Sunderland.

Powertrain

Powertrain Limited is a subsidiary of Phoenix Holdings that acquired it from BMW in 2001, following the previous year's acquisition of MG Rover. This plant produces K-series petrol engines for the majority of the MG Rover range, and also L series diesels for the 25/45 model ranges. MG Rover also supplies engines to third party customers, notably including Caterham and Gibbs, Land Rover and Lotus. The future of engine production is uncertain at the time of writing, the company now being in administration.

Toyota Deeside

The engine plant currently employs about 700 staff, and has a capacity of 450,000 units per annum. In 2003 Toyota celebrated ten years of car and engine production in the UK. Over the period 1993-2003, some 1.32 million Toyota cars have been built in Burnaston and about 1.1 million engines have been produced in Deeside. Toyota produced an estimated 330,000 petrol engines in 2002. Toyota produced about 70,000 diesels at the facility on Deeside for European market cars in 2003.

Annex B

New technology initiatives

The Foresight Vehicle Programme

Foresight Vehicle was launched in 1995. Since 1997 it has administered over 100 collaborative R&D projects part funded by UK Government Departments and Agencies. These projects have been grouped in five thematic areas:

- engine and powertrain
- hybrid, electric and alternatively fuelled vehicle technology
- software, sensors, electronics and telematics
- structures and materials
- design and manufacturing processes.

Whilst all these thematic areas bear on vehicle propulsion, the first two are directly related to powertrain. Topics covered by current projects supported in these two thematic areas include:

- laser ignition for SI engines
- controlled homogeneous auto-ignition engines
- drivetrain NVH refinement
- infinitely variable transmission
- powertrain thermal management
- electrohydrodynamics of friction in thin lubricating films
- particulate emission aftertreatment
- 2/4 stroke switching
- recuperated micro-turbine for hybrid propulsion
- turbo-generator energy recovery system
- torroidal generator for hybrid powertrain
- battery pack control and optimisation
- supercapacitor materials
- battery optimisation for 42V systems
- series and parallel hybrid drive systems.

Further information can be obtained from the Foresight Vehicle website[24].

24 www.foresightvehicle.org.uk/about_us.asp

The New Vehicle Technology Fund

This Programme was established in 2003 to develop and demonstrate new and innovative low-emission vehicle technologies as part of the Government's Powering Future Vehicles strategy. It is managed by the Energy Savings Trust on behalf of the UK Department for Transport as part of a suite of programmes under the TransportEnergy banner. Technologies covered in projects supported to date include:

- diesel electric series hybrids
- long range electric vehicles
- series/parallel hybrids
- mild hybrids and stop start systems
- hydrogen powered vehicles
- LPG series and parallel hybrids
- advanced engine control systems
- lightweight vehicles
- variable compression diesel engines.

Further information can be obtained from the transport energy website[25].

The DTI's Technology Programme

This programme was launched in 2004 and is the UK DTI's mechanism for administering its main products for promoting innovation and the exploitation of technology. These comprise funding for Collaborative R&D and for Knowledge Transfer Networks and they are currently managed and executed via six-monthly competitive calls focussed on specific technology areas. Technology priorities for the allocation of the £370 million budget for the period 2005 – 8 are determined by an independent Technology Strategy Board. The two calls for proposals in 2004 included topic areas of relevance to powertrain developments including 'Technologies to support environmentally friendly transport', 'Sensors and sensor systems for industrial and environmental applications' and 'Design, simulation and modelling'.

Powertrain-related technology topics supported, following the April 2004 call, include:

- switched 2-stroke / 4-stroke combustion mode gasoline engine concept
- system approach to design of lightweight fuel cell hybrid vehicles
- electrical machine, battery chemistry and modelling developments for electric urban transport
- lubrication system approach to reduced engine friction losses
- materials for high integrity lightweight rheo-diecast components.

Further information can be obtained from the technology programme website[26].

25 www.transportenergy.org.uk/

26 www.dti.gov.uk/technologyprogramme

Research council programmes

Research in Higher Education Institutes is administered by the Research Councils. The Engineering and Physical Sciences Research Council (EPSRC) is the research council whose activities most closely align with powertrain-related technologies. Information on current research grants can be obtained from the EPSRC website[27] under its 'Grants on the Web' heading. This can be searched under topic headings where powertrain-related projects can be found under, for example, the "Combustion" and "Electrical motor and drive system" headings. Alternatively it can be searched under industrial sector, one of which is "Transport/Manufacture of motor vehicles, their components, and related products".

27 www.epsrc.ac.uk/default.htm

Annex C

The Diesel Vehicle Market

Diesel-fuelled vehicle sales in Western Europe (EU and EFTA combined), which represented less than 15% of the total market in 1990, stabilised at around 22.5% from 1994 through 1997, before growing steadily year by year to 45% of the total market in 2003. Data for 2004 show diesel penetration of the UK new car market at 32.5%.

JD Power-LMC forecasts that global sales of diesel-fuelled cars and light trucks will increase from 12.5 million in 2003 to 27 million in 2015, with 60% of that growth coming from markets outside Europe. If this rate of increase is achieved by that time, 28% of light vehicle sales will be diesel-fuelled.

While sales of diesel-fuelled light vehicles in Europe, Asia and South America are anticipated to continue to grow steadily, a significant increase is forecast for the North American market. Whereas diesel-fuelled light vehicles accounted for only 4.5% of North American sales in 2002, J D Power-LMC expects this to grow to 16% by 2015. For such market growth to occur there will be a heavy dependence upon the extent to which the diesel engine suppliers are able to convince the US vehicle manufacturers that their diesel technology can meet the 2007 US emissions standards but with plentiful supplies of gasoline and without the presence of the level of fiscal advantages for diesel fuel that are apparent in most Western European markets it has been questionable whether the North American diesel-powered car market would grow significantly. However with oil prices at record levels and continuing to rise even the USA is starting to reconsider all alternatives and diesel is on the agenda again particularly for the SUV sector.

India and South Korea are markets that are forecast to be at the forefront of future demand for diesel-fuelled cars in Asia whilst China and Japan are considered likely to show only moderate increases in this segment. China and Japan are expected to be the last major markets to experience significant diesel penetration. The Japanese vehicle manufacturers, in particular, look to have committed themselves to the development of hybrid technologies and more efficient gasoline engines for their domestic market. The Chinese government, however, is demonstrating a concern about long-term fuel economy that could lead to a progressive increase in interest in diesel technology. As described in this report the UK is well placed to take advantage of opportunities in these areas through its technical development expertise.

Annex D

Automotive Innovation and Growth Team (AIGT)[28]

The Automotive AIGT was the first of a series of Innovation and Growth Teams which the DTI set up following the 2001 White Paper on Enterprise Skills and Innovation[29]. The AIGT brought together major stakeholders from the automotive sector to identify the issues most likely to have the greatest impact on the long-term profitability and productivity of the sector. Sir Ian Gibson, former Chief Executive of Nissan Motor Manufacturing (UK) headed the team and its findings were published on 16 May 2002. The team made seven recommendations, which were welcomed by the Prime Minister. The DTI has committed £45 million towards implementation of the recommendations, which were: –

1. The creation of an Automotive Academy
2. Funding for the extension of Supply Chain Groups across the UK should be put in place
3. The Foresight Vehicle programme should be refocussed with a strong emphasis on the potential for commercial exploitation
4. Two Centres of Automotive Excellence and Development should be established.
5. A low Carbon Transport Partnership should be established
6. A pilot mobility services project should be established in London
7. The establishment of a working group to monitor developments to maximise the benefits of change and innovation to the UK as a whole.

The most recent progress report was published in 2004[30].

28 www.autoindustry.co.uk/automotive_unit/aigt

29 www.dti.gov.uk/opportunityforall/

30 www.autoindustry.co.uk/docs/aigtprogressreport2004.pdf

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