

Automotive Innovation and Growth Team

Design, Development and Manufacture Report

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Summary

- The UK automotive industry faces a number of key challenges and currently is reacting to cost pressures; medium-term investment decisions, to bolster profits in the sector, are under continuous review.
- The primary issue, identified by all survey participants, was the need for the promotion of the benefits associated with currency integration, and, ideally, the establishment of a timetabled plan from which industry can prepare and invest to exploit the new trading opportunities presented as a result.
- Cost management processes, resulting from a lack of revenue, for investment and the strength of sterling, are postponing and delaying investment decisions and motivating supply source switching to non-UK locations. Investment decisions already taken will see a loss of business from Britain and the demise of some domestic businesses in the automotive supply chain.
- The preferred destination of supply contracts is biased towards movements to the Eurozone in the short term and, over time, low cost labour regions (mainly Central European Economies) are also growing and set for rapid expansion.
- The extent of lean manufacturing skills in the UK and self-sustained improvements within UK suppliers is a major cause for concern and is symptomatic of a wider 'skills and training' issue related to technical and engineering grades of employees. The lack of quality employees with engineering skills is a major concern for UK industry and the supply of students, perceiving engineering as a desirable career route, is not at levels necessary to sustain the automotive and other manufacturing sectors. This has implications for the duration of the 'engineering skills base vacuum' and how quickly the UK economy can recover.
- The industry would also benefit from a new approach to the training of management grades in the industry in order to redesign and implement changes to the automotive supply chain that will enhance the performance of the sector. In addition, the UK automotive industry would benefit from a greater integration of university education and research efforts (through promotion of these services and research results) to enhance company performance and for the commercial exploitation by the university sector.

Introduction

The Automotive Innovation and Growth Team (AIGT) is the first of several IGTs to be initiated by the Department of Trade and Industry (DTI). They represent the start of a new approach to policy making with Government working in partnership with industry and others in key sectors to formulate and deliver policy. The concept is linked to the policy developments outlined in the recently published *White Paper on Enterprise Skills and Innovation – Opportunity for all in a world of change*. **The White Paper is available online at <http://www.dti.gov.uk/opportunityforall/>**. Sir Ian Gibson, former Chief Executive of Nissan's UK and European operations, was appointed Chairman of the AIGT in April 2001.

The primary role of the AIGT has been to identify the key drivers on which competitiveness will turn over the next 5 to 15 years and to develop a vision for a future automotive sector in Britain. Its aim is to ensure that the UK automotive sector makes the most of its opportunities as the global industry restructures and develops so as to provide a good deal for consumers and ensure that it continues to make a major contribution to the UK economy. The AIGT has made recommendations for changes in specific areas of policy. It is also proposing changes to the way in which policy is made. We want to establish a continuing dialogue between industry, Government and other stakeholders such as environmental and consumer groups. The objective of this is to promote a greater mutual understanding of current and future challenges and to ensure that the future policy making process is as effective as possible thus ensuring that the UK provides a supportive environment for the industry.

The Automotive Industry Growth Team (AIGT) has two main goals:

- To make recommendations about specific areas of policy and industry strategy based on an analysis of the key factors that will drive the automotive sector in the next 5 to 15 years.
- To ensure that the future policy making process is as effective as possible and that there remains a continuing dialogue between industry, Government and other stakeholders such as environmental and consumer groups.

The Design Development & Manufacture Sub-Group of AIGT is one of four established to examine a particular set of forces shaping the future of the industry.¹ It set itself the goal of understanding the main factors affecting the competitiveness of the industry in the UK and identifying the measures which need to be taken to give the industry a competitive edge. It is chaired by Professor Dan Jones Cardiff University and includes representatives from the auto sector and government officials.

¹ The others are: Environment; Technology; and Distribution, Competition and Consumer.

Design, Development And Manufacture Group

This document represents the results of the Design, Development and Manufacture Group (DDM) and explores the trends in the automotive industry, the current approach to investment cycles and the major enablers and inhibitors to the progress of the industry as it seeks to compete and prepare itself for the future. This report therefore encompasses some major issues including currency integration, skills and development and the management of the supply chain. These issues are automotive-specific in that the research of the group has focused exclusively upon the needs and issues within the industry. However, the automotive industry is a barometer and a microcosm of general manufacturing - as such the findings presented here have applicability to British industry in general. Where possible, this report validates its findings with research conducted by other organisations (in the general manufacturing sectors) to provide a rounded and robust interpretation of the findings for automotive and other sectors.

The remainder of this report will set out the automotive industry current state and finally will set out an 'agenda for change' to align the activities of industry stakeholders in a focused manner of benefit to the industry and the economy.

The Methods Employed during the Study

In conducting this survey, a number of techniques were used to solicit expert opinion and general industry sentiment as well as views from key industry stakeholders. Many people have given of their time without direct reward. The process adopted by the team included parallel and synchronous research activities commencing with expert opinions that were tested with a structured questionnaire to key organisations in the UK supply chain. This first round of research concerned the issue of business planning, forecasting and investment patterns.

The second parallel phase of research involved the development of a detailed questionnaire which was sent to key businesses and selected firms at different levels in the automotive supply chain. This questionnaire addressed issues such as business perceptions and performance, human resource management and supply chain management practices including intentions to resource purchases and/or restructure the supply chain.

'One-to-One' research, involving panel interviews was conducted with the major assemblers, supply chain and raw materials converting companies to provide a greater depth to the issues facing each level in the supply chain. These activities involved interviews in a less formal manner in which key business issues could be explored. The interviews included companies with intentions to divest their British manufacturing facilities and those designated as 'at risk' to supplement the main concentration of the research on the development of the domestic supply chain and those operating with large supply bases.

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To ensure a balance in the research design and to gain further support to the issues uncovered in the preceding research activities, the team also engaged a series of telephone interviews with senior managers at UK manufacturing businesses. These interviews were used to confirm the findings of the study by targeting directly the perceptions of a broad range of suppliers (not included in the previous activities).

Finally, a series of panel group discussions held at various regional locations throughout the United Kingdom was conducted to allow key 'thought leading' senior managers and regional groups to engage in the AIGT DDM research.

Secondary information was collected via industry databases and trade association reports to provide the 'joined up' testing of the primary data collection processes. The secondary information also included accessing and participating in automotive events such as the Foresight Vehicle meetings, university research networks, trade association reports and Trade and Industry Select Committee recorded minutes.

Automotive Industry Trends

The British automotive industry is a microcosm of general industry - the pressures and challenges faced in this sector are those experienced in most other general engineering sectors. Within the automotive industry, new management practices and innovations have formulated that have influenced the management of productive assets throughout the world and throughout British manufacturing.

The global automotive industry, for volume passenger production vehicles, is dominated by a 'competitive' oligopoly within which there is both direct competition and collaboration. To date, over 80% of world car production lies under the control of six major global groups each operating in the major regions of North America, Europe and Asia. American, German and Japanese businesses dominate the ownership of the volume vehicle manufacturers and the trend is to consolidate the industry and enhance inter-group alliances in order to remain profitable. The commercial vehicle sector, within which the UK has a strong presence is also a contracting oligopoly and has only five major groups dominating the production and sales of trucks and buses.

A similar process of consolidation has occurred in the component sector, which is increasingly dominated by large multi-national firms, each seeking to gain business from an increasing smaller customer base. These 'super tier 1' were previously owned by the vehicle assemblers and now have to contest for business as quasi or fully independent concerns. The plight of the tier 1 firms is aggravated by the changes in assembler requirements and the re-tiering of the supply chain to reduce the number of direct suppliers to each vehicle assemblers through a process of 'systems supply' rather than components purchases that are configured at the assembly track. There is a fear in the automotive industry that the new first tier 'super suppliers' will inevitably grow too big and bureaucratic and this will lead by 2015 to a restructuring of these organisations and a dismantling of the current 'supplier power groups' in Europe. The remaining companies, at the different tiers and stages of production (including manufacturers of components and smaller vehicle subsystems) are typically Small and Medium-sized Enterprises (SME). It is the SME sector that has the greatest population of companies engaged in automotive engineering and these companies are

more vulnerable to the overall changes in the industry than the larger companies who will follow their key customers on a global basis. For smaller companies, outside of the direct influence of the vehicle assemblers, life in the automotive industry is confusing, uncertain and focused on productivity improvements combined with ongoing pressures to reduce costs of supply. UK suppliers are working hard to adapt to these pressures and seeking to place the necessary business investments, in new organisational capabilities, with which to compete in the future.

A choice for suppliers, in the face of supply chain restructuring and is either to develop and protect a niche whereby customers will seek to do business with the firm (technological superiority) or to globalise. This process of transition is difficult and poses a structural uncertainty for decision-makers at every business and at every level of the supply chain.

Britain's Automotive Industry

The current scene is characterised by pessimism and there remains only one UK-owned volume car manufacturer, MG Rover. In consequence, it is frequently suggested that the automotive manufacturing sector is insignificant and in terminal decline. This opinion conveniently ignores the fact that the UK provides a home to 7 of the world's leading volume vehicle manufacturers, a further 9 commercial vehicle production facilities, and 17 of the world's top tier one suppliers. The country is also strong in terms of engine manufacturing and design with around 20 specialist and world's leading independent automotive design engineering firms supporting customers in this country and beyond. These features, unique in the European context, reflect the importance of the industry in the UK. However the UK has tended to lag behind the productivity of other European countries despite continuous improvements over the past decade. The general lag in the performance of the sector contrasts sharply with the best firms such as Nissan, Toyota and Leyland which rank as the most productive sites in Europe.

"To suggest that the closure of Dagenham and the Luton car plants, together with the disruption to Rover means that automotive production has had its day is not tenable"

Garel Rhys 2001 Automotive Bulletin Autumn 2001

Assembler-led inward investment in UK manufacturing continues; notable recent examples include the decisions by Nissan, Honda and Toyota to increase their investments, plus increased investment by Ford in both Jaguar (Halewood and Coventry) and Land Rover, while GM have invested £130m to produce the X83 van at IBC Luton. However, concerns about the unfavourable £/Euro exchange rate are already causing many vehicle manufacturers to source an increasingly large proportion of their components from elsewhere in Europe and may threaten the prospects of future investment. This concern is shared at all levels of the supply chain and has a major impact on the competitiveness and sourcing strategies operated by UK businesses in the supply chain. The Euro is therefore shaping the quantity and type of products that the UK will make in the future.

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The key issue, affecting the entire industry, is how best to drive up performance as a means of increasing the margins and profitability of all members of the supply chain especially in the face of uncertainty concerning currency integration. The general 'return on capital employed' in the UK vehicle and component industries is low and many companies are now making a loss adding new fervour to the passion for cost reduction. The renewed emphasis on cost reduction has had the benefit of encouraging firms to look at areas other than shop-floor productivity improvement. Many cost saving programmes however have been misguided and represent short term attempts to remain profitable. The challenge for the UK supply chain, which is intricately dependent, is to improve flow and to generate the profits to invest in new human, technological, design and supply chain management capabilities.

In aggregate terms the UK automotive sector has a turnover of £45 billion and is a significant contributor to GDP and employs 715,000 people of which over 300,000 are engaged in the supply element of the chain. Further figures reveal that about half of added value comes from manufacturing and assembly, which represents about 15% of total UK manufacturing value added. The components sector, the great majority of automotive engineering business, accounted for a turnover of £12 billion. The export contribution of the industry totals almost £20bn (year 2000) and 65% of UK automotive output is exported although (74% of UK car registrations are imports). The automotive industry is a leader in many aspects of 'best practice' management, technology/process transfer, and, is a major source of innovations for general manufacturing industry. The British industry is, through increasing globalisation, a sector of high national worth and importance in driving forward the manufacturing side of the economy.

Within the industry, the UK has enjoyed large-scale investments as well as a valuable influx of additional investments in the supply chain. Investments by the major and global Tier 1 firms (TRW, Johnson Controls, Lear Corporation, Magneti Marelli, Denso, Visteon, Delphi and Thyssen) have been sustained and have complemented the supply opportunities available to the 7,000 (estimated) automotive component companies that operate in the UK.

The automotive sectors of assembly and supply are affected by a great many pressures including an uncertainty about the directions and implications of change in the retail distribution operations of the assemblers ('block exemption' and 'end of life vehicles') as well as the increasing sophistication of customer lobbies and internet access.

There are also pressures related to product manufacturing, even though the sector is technologically advanced, both in terms of manufacturing processes and in its products. Key issues include the necessary volume of throughput to achieve economies of scale and low unit costs in a competitive environment that demands product diversity. Manufacturers still face the competitive demands of volume and variety and have sought to differentiate products through technology and branding as a means of protecting margin. 'Added features' particularly electronic devices (GPS, in-car entertainment etc.) have increased. In addition, new electronic innovations have been introduced to manage vehicle sub systems such as the engine and wider applications include broader 'telematics' and vehicle communications. The extent of

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these innovations are likely to rise² and since these added features also add weight to the vehicle and this 'weight' issue has resulted in assemblers seeking new materials to substitute the traditional (such as steel) especially the application of aluminium and composite polymers.

'Added features' in vehicles open opportunities for UK suppliers. These opportunities reinforce changes driven by the general trend of the assemblers to outsource systems and to devolve design responsibility to the supply base. Another problem for the general automotive supply tiers is the threat of displacement by lower wage economies, as customers decide to trade-off proximity and Just In Time (JIT) capability for comparatively inexpensive long haul sources. These pressures fall within a context of every assembler seeking to compress the time between receiving customer orders and the delivery of a customer-specified vehicle. Firms in lower parts of the supply chain will have to develop new skills, technological competencies and an ability to manage effectively their own supply chains. Each of these features must also be enveloped in a 'total' company and supply chain approach to continuous improvement.

The UK is increasingly becoming a centre for engine production excellence in both petrol and diesel variants (with recent decisions by Ford, BMW and Toyota to invest in significant engine production facilities here). The industry is also renowned for "premium and niche" cars (from the new Mini, through Jaguar and Range Rover and super-luxury cars such as Bentley and Aston-Martin). The engine manufacturing capability in the UK is divided into 'wholly owned' businesses and private businesses with no equity relationship with the final vehicle assemblers. The major trend in the engine manufacturing sector is to bring suppliers closer to the point of engine manufacturing and a number of facilities have been extended or land purchased close by to allow the development of supplier parks (Ford Bridgend and Dagenham). Engine manufacturing has a long life cycle (10 years and more) compared with other aspects of vehicle production and therefore volume of production is critical to the success of this capital-intensive sector.

At the raw material level, beneath the main automotive supply chain, the same pressures for volume and cost economies exist. These businesses have terminated unprofitable mills and have engaged in wholesale mergers of major metals groups. The UK has not escaped this drive with British Steel merging with Hoogovens to form Corus. These primary suppliers distribute materials to all tiers of the supply chain and face more demanding customers, a diversity of supplier evaluation systems and the pressure to improve cost and delivery performance to the supply chain. Overall, the supply chain context of the automotive industry is fragile and there exists a dependence, in sales volume terms between businesses. Changes and consolidation at the assembler and primary stages of the chain pose great threats to the domestic suppliers of systems and components. It is this back-drop that sets the current scene.

² It is difficult to estimate the aggregate impact of electronics within a vehicle but all major subsystems (engine, instrumentation, Steering, braking, climate control etc.) will all be subject to such innovation and electronics will account for an increasing percentage of the added value of vehicle purchases.

Key Changes to the Assembler & their Supply Chains

- Development of systems suppliers to reduce the transaction costs of large supply bases to the vehicle assemblers.
- Transaction cost reductions are paralleled by a general trend towards on-going quality and delivery improvement targets for British suppliers and a process of on-going improvement in business performance including high levels of reinvestment to sustain improvement despite poor levels of profitability in the sector.
- The expectation that suppliers will invest in new processes and capabilities (design and supply chain management).
- Changes in the raw materials used to manufacture vehicles.
- Time compression to move closer to the 'build to order' vehicle assembly system rather than the current and costly 'make to stock' systems.
- Changes in business relationships as moving to systems supply displaces former first tier suppliers to lower tiers.
- The trends towards 'full service supply' requiring suppliers to take on new design and supply chain responsibilities.
- International competition from suppliers located in foreign countries.

These issues will be explored in later sections.

The Raw Materials Supply Chain Explored

The final element of the automotive supply chain involves the raw material producers, many of whom are resident in the UK and these institutions are central to the viability of the current automotive supply chain system. To date, the raw materials sector mirrors that of the vehicle assemblers and shares the increasing concentration of the industry into another 'competitive oligopoly'. The raw materials industry is characterised by large-scale re-structuring and merger activity. The current competitive environment in which the British 'metals' industry faces is complex and subject to high levels of uncertainty as global metals producers continue to consolidate (MICE Report 2001³). In Europe, new industrial conglomerates are being formed and the European Commission is reviewing alliances developed between producers and it is likely that many of these will pass through the regulatory boards to form 'super-conglomerates'. Even these large-scale organisations will face competition on a global scale as international sources, trading electronically, with UK consumers, can land metals into this country at, or less than, the domestic cost of production. Some of these metals, notably from Russia, China and Korea are equal in quality to those produced domestically.

The process of consolidation has already been associated with a general pattern of reducing productive capacity and 'moth balling' plants. The most obvious manifestation of this process has been the strategic consolidation of the Corus Group in the UK that has affected every UK steel making/processing mill of the company. The reduction of capacity by this organisation alone has witnessed the downsizing of all plants and the closure of the Llanwern 'heavy end' and Ebbw Vale. Further

³ The MICE Report concerned a review of the competitiveness of the metals industry and included measures of supply chain performance, strategic directions and gaps/shortages that inhibit performance improvement throughout the industry.

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consolidation is also expected as distribution centres are consolidated. These organisations will also seek to increase their added-value within the automotive supply chain and could take on work currently conducted by SME businesses at the periphery of the automotive industry.

The source of these metals industry closures, on a European scale, is production capacity in excess of domestic demand. Short-term issues, such as the strong pound relative to the Euro, have aggravated this situation by making UK metals comparatively more expensive. At the heart of the British problem though is the reconciliation of capacity, output performance and customer service. Overall, primary producers represent a great potential to improve the flow of materials in the automotive supply chain and 'On Time In Full' (OTIF) performance. In 2001, the OTIF measure for the metals industry rarely exceeded 60% of 'delivery to time' (within a week of first agreed delivery date) despite operating production facilities as 'make to stock' operations. These problems cannot be ascribed solely to the management of the mills but reflect a general failing in the 'supply chain management' capabilities of general and automotive manufacturing supply chains⁴.

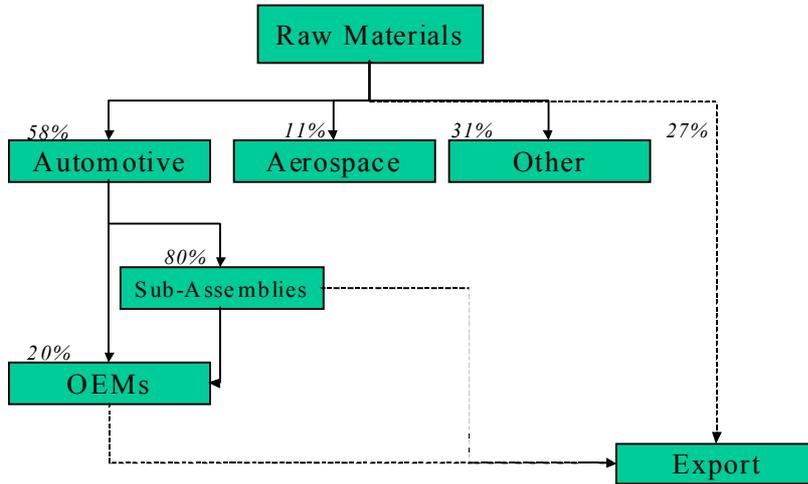
For the raw materials providers, who also operate extensive R&D activities on behalf of the automotive industry, the environment is complex and uncertain. The industry faces a consolidating customer base and a concentration of buying power, consolidation of the industry itself and a decline in traditional steel products (through substitution of steel by other metals in the automotive supply chain). These issues all complicate an already uncertain and volatile market for the British metals industry and it should be noted that improvements in this area of the supply chain have positive benefits for all subsequent automotive tiers to the assembler level due to the levels of dependency that exist. The issue of dependency is important and implies that the UK has a dominance of sales volume at the mill level (such that a few major industries and major customers account for the majority of mill output. In reverse, the majority of finished product costs (automotive manufacturers) is made up from metals and other materials. This feature of the UK supply chain presents many opportunities for collaboration and benefit to the future of the automotive sector.

The forging sector, a member of the raw materials chain, is a good example of the dependency relations that exist and the fragility of the supply chain when these dependencies are threatened (plant closures). Two to three major conglomerates dominate the entire domestic capacity for forging metal with the remaining volume being supplied to SME organisations converting local niche products. These major customer organisations are consolidating as a result of issues within the automotive supply chain and together produce over 70% of total forging output in that industry sector. This level of dependency in the supply chain offers great risks as customer force pressures down the chain and the metals industry closes operations and restructures to achieve such cost reduction.

⁴ It should be noted that, in comparative terms, the automotive industry is better at supply chain control than the general manufacturing and SME sectors. The latter struggle with issues such as minimum order quantity purchases and also tend to buy from stock holders and leave the stock holders to interface with the mill production schedules.

Input-Output Analysis: The Forging Supply Chain

The Forging Supply Chain



Based on 2000 figures, the UK forging industry employs approximately 53,000 people in the UK (23,000 in suppliers) and is estimated to contribute £1.34 billion to the UK economy. Productivity has risen continuously over the recent decade and at a rate that is faster than the UK average level for manufacturing yet the industry faces significant challenges to remain competitive (not least from Eastern European competition).

The forging sector is not alone, a similar dependency pattern affects the strip products for steel and for speciality steels in the UK. This concentration is also found to operate at aluminium mills, glass works and to a lesser extent in the production of polymers and composite materials. These materials are used extensively in vehicle and aerospace sectors.

The British Metals Industry: Output Dependency Patterns

Main Markets for UK Steel (1998)	
Construction	28%
Automotive	19%
Mechanical Engineering	19%
Metal Goods -Including Wire & wire Products	14%
Packaging	6%
Electrical Engineering	5%
Oil & Gas	3%
Others	6%

Source : Iron & Steel Statistics

Of 9 metals companies profiled during the MICE Report 2001⁵ it was found that the single largest customer to a mill varied from 46% of total annual sales volume to over 71%. The same dependency relationship is also true of aluminium supply. As such, the metals industry, in all its forms such as aluminium, is an area of industry that will be instrumental in the improvement of the total automotive supply chain.

The industry is also changing as a sector and there are trends that negatively and positively impact upon different UK metals operations. The major automotive trend is to substitute steel for aluminium (primary to light weight the vehicle) and cars such as the new Jaguar are formed from aluminium. Industry experts believe that the aluminium products will eventually be substituted for polymer composite materials as the industry seeks introduce new forms of automotive power sources (hybrid/fuel cell/hydrogen engine). The extent of steel substitution for aluminium is currently in process and will be dependent upon vehicle model changes. There are few indications concerning the substitution of composite parts for vehicle production in the UK.

In 1990, there were no aluminium structured production vehicles (exception of the HMMV 'Hummer' military vehicle). By 1997, seven production vehicles relied upon aluminium as a body structure and the future predictions of the industry suggest that executive class and luxury vehicles (Jaguar) will quickly be followed by mass production cars in using new 'light weight' materials. To highlight the rate of adoption, Ford Motor Company was predicting for it's P2000 (Mondeo class) vehicle that the steel content of the vehicle would reduce, by almost half, its current content despite concerns regarding the predicted energy cost rises of alternative materials (aluminium) between the years 2000 and 2005⁶.

Overall, the metals sector is changing and responding to calls from the automotive industry for greater integration with the supply chain. The process is however slow

⁵ It should be noted that the MICE Report investigated the 'metals industry' rather than the automotive supply chain in isolation.

⁶ This prediction was made in year 2000 but substitution has not reached the levels predicted at the current time 2002.

and complex. The industry faces many EU regulations, notably for environmental management and most of the primary metals industry has task forces working on compliance to the ISO14000 standard. Interest in adopting 'best practice' within the metals industry has also been stimulated by the high profile promotion of 'lean production' at Alcoa in America and more recently the integration of Alcoa's UK key manufacturing bases⁷.

The change processes at Alcoa are designed to return the corporation into sustainable profits and also to engage with customers in a new way. By re-deploying stocks and operating pull systems for metal supply, Alcoa intends to integrate with customers in a way that prevents competitors from entering and displacing the company as preferred supplier.

Lean and the Metals Industry: The Alcoa Production System

After 2 years of planning, the American giant metals converter, Alcoa announced that it had gained widespread operational success and customer service improvements as a result of implementing the 'Alcoa Production System' (APS). This production system was based entirely on the lean approach to internal operations and the lean approach to supply chain management.

The headline of the financial pages of the Wall Street Journal read:

“At the company’s plant in Davenport, Iowa, Alcoa says its new business system is already reaping major benefits. At its core, analysts say the Alcoa system mimics one used by Toyota Motor Corporation. It seeks to ‘pull’, rather than ‘push’, goods through the manufacturing process. That means for example, that products will be made in response to a customer order, not churned merely to keep the machines running”

Wall Street Journal Monday 10th May 1999

The system was also reported by Goldman Sachs as “...*marking the beginning of a major sea change in fabricated metals manufacturing*”.

The achievements of Alcoa have been impressive and most major metals groups have followed suit in terms of implementing lean systems. Across Europe there are extensive numbers of employees engaged in projects to improve mill performances. The potential benefits of the lean change programme are huge and Alcoa has been quick to promote the size of the gains to its shareholders.

Alcoa Production System: The Results 1999-2000

1999 – Alcoa reports annualised cost savings of \$728 million from the improvement initiatives and highlights over \$1.1 billion will be saved by year 2000.

Herando Facility

- Delivery performance rises to 93% (from 76.7% in 1997 and 84% in 1998)
- Lost work days are held at zero for 2 years (6 lost days in 1997)
- Recovery rates improve by 3%

⁷ At the same time as implementing lean manufacturing at aluminium processing plants, Alcoa is also rationalising the number of mills it operates. This process is designed to eliminate the weaker and unprofitable plants within the group. In 2001, at least one mill, in the UK, has been closed.

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- Inventory turns increase by 38%

Cressona Extrusion Plant

- Metal inventory reduced by 32% against 1998 levels
- Productivity figures at all time high

Sorocaba (Brazil)

- Delivery performance reaches 97.9%
- Lead time reduces from 7 to 3 days
- Extrusion costs reduced by 17% in 1999 and by 19.7% in 1998

Drunen (Holland)

- Flat rolled products achieved 30% improvement in inventory by simplified logistics & better flow management of metal. Each press achieved an improvement of 100KG per hour

Szekesfehervar (Hungary)

- Throughput time reduced by 70%

Lafayette (Indiana)

- 100% on time in full delivery achieved by ingot plant
- Tube mill delivery performance improved by 29%
- Drive shaft shipments reached 99% on time delivery
- Inventory decreased by 38%
- Overall plant volume increased by 12%
- Productivity (pounds per work hour) rises by 23%

Portland and Point Henry (Australia)

- Pull system introduced and vacuum crucible performance rises from 12 per day to 14
- Capital savings of \$400,000 with annuity of \$100,000 in on-going savings
- A million saved in coke inventories and further \$560,000 from other plant inventory savings.

Davenport (Iowa Pilot Plant)

- 1998 Savings of \$134 million with cold mill inventory down by 50% and lead times reduced by 50%.

Primary Metals

Inventory reduced by 17% with lead-time reduction from six weeks to seven days with a 50% cut in inventory.

The MICE Report 2001

Despite the changes in the worldview of metal conversion and the high interest in lean manufacturing techniques, the British sector has been comparatively slow to roll out programmes of change. The MICE Report (2001), was compiled by Cardiff Business School in 2001, and highlights a number of trends and issues that face the sector. The research found that very few large-scale metal processors had a formal supply chain strategy to integrate with key customers to the mills nor did the mills operate with a senior manager responsible for the management of the supply chain improvement process. The key performance measures employed by the mills concern internal measures of production efficiency and capacity utilisation rather than a broader approach to quality, cost and delivery measures. Customer relationships with the mills

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tend to focus on price considerations and this is not conducive to developing supply chain management improvement initiatives with customers to improve overall quality and delivery performance. Further, it should be noted that the mills have to deal with large-scale customers, such as the vehicle assemblers and larger companies, who each operate their own and largely independent supplier management programmes. The mills must therefore conform to all these requirements whilst seeking to demonstrate improvements in a market-environment that is complex and uncertain. Any stability and improvement programme aimed at this level of the supply chain would therefore be a worthy investment of effort from the national perspective.

The MICE report found that progress in the UK metals industry was inhibited by a number of factors including a lack of time, lack of trust in the intentions of customers and a general lack of certainty in the results that can be achieved by buyer-supplier improvement programmes. Overall progress in the sector has been slow and without sufficient profitability, future progress will also be slower than is needed by the automotive industry. There exist however, many areas of opportunity to protect this sector and to leverage the volumes of the automotive market to support these mills as they adapt to change. The mills will require extensive assistance and, to date, individual consultancy projects have not managed to change the metals industry and therefore a broader and more fundamental initiative is required. To improve the metals industry, a co-ordinated effort by a collective of regional agencies, universities and training institutions is required. Only when these elements are brought together can the complexities of metals production and scheduling be optimised for customer service. This issue is a contemporary need and such an initiative would be broadly welcomed by the industry.

Metals In Japan

The need to improve is not a British phenomenon and even the Japanese industry has engaged in changes to the structure and practices it offers to customers. In July 2000 Japanese manufacturers were using new technologies to improve supply chain performance. The “Kozai Club” is attempting to promote EDI-system intensive transactions in the sale and distribution of iron and steel products through the development and improvement of EDI standards in the fields of steel and its related activities. The initiative covers organisations from steel-makers, steel traders, service centres and relay centres to warehouses and other distribution sectors.

The “Kozai Club” covers all information generated through jobs – from order to invoice across all types of steel products. The focus for their activities is to reduce information costs, moving from push type data transfer to pull type systems. This helps facilitate the sharing of information across supply chain companies. The programme promotes EDI across a diverse range of firms. The EDI standard has been established in over 100 larger companies, however the emphasis is now on promoting EDI with small and medium sized firms in order to establish a common supply chain management platform for the iron and steel industry in Japan.

In the past the steel supply chain in Japan was based on one to one relationships between the steel manufacturer, the service centre, the component supplier and the trading company. This system was not only inefficient but was a high cost solution

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that had a higher chance of errors being made between the parties. In contrast information sharing between the parties leads to a more responsive system.

The system also develops the role of the trading company as they develop their role in the management of the supply chain. The Sogo shosha are often described as business enterprises that handle everything - they are trading houses. As their customers seek new value the Japanese producers feel that managing the supply chain opens new business opportunities and value adding prospects. A system that enabled information to be shared was first developed in 1996 and put on the web. This has been continuously enhanced so those plural databases allow simultaneous retrieval of data. Total inventory and master (parent) coil inventory can be managed across the supply chain and a specific material can be searched for across the system.

From the perspective of the British economy, improvements in the productivity and quality of the vehicle assemblers and the overall profitability of the whole sector can only be undertaken using a total systems approach to industry issues. Individual piecemeal improvements at individual businesses are not enough to guarantee viability and sustainability - it is the general (average) performance, at each tier, of the supply chain that must be improved. To achieve this improvement, initiatives must exploit the dependency relationships in the supply chain and stabilise these 'volume' input-output product flows. Stability at the level of the raw material producer is also important as uncertainty that leads to poor or sub-optimised allocations of capacity and inventory will cause problems with overall flows of materials in the supply chain.

Summary of the Industry

This section sets out the context of the automotive industry and has identified a number of issues of important when determining recommendations for the DDM study. The following issues must be considered:

- Any initiative to stabilise the current environmental uncertainty affecting the industry will lead to improvements in the performance and investment patterns.
- Industry decision-makers would benefit from a stability and regularity of information exchange with government especially where such information contains Treasury and SMMT forecasts of economic performance. The industry is a significant contributor to GDP and employment so such a process would offer benefits to both parties in terms of a regularised meeting of senior industry figures.
- The industry has an oligopoly at the beginning and end of the supply chain. Integration of these oligopolies in terms of information exchange, especially planning information and forecasts is important. The 'competitive oligopoly' scenario generates significant pressure to enter into price competition. Profit instability will erode profits and further threaten the viability of certain UK facilities.
- The final form of the automotive supply chain is still being worked out and many assemblers have not yet finished their restructuring initiatives. Many of the existing vehicle assembly operations are not optimised (in terms of location) and this is adding to the difficulty of restructuring and Just In Time supplies in order to meet cost pressures.
- The industry has high levels of dependency throughout the British automotive supply chain but lacks the 'quasi-ownership' of the Japanese supply chain system. So, without ownership, then influence is the only means of exerting pressure to change.

The British Automotive Market

Output figures for vehicles suggest that the UK automotive supply chain is not in a 'melt down' phase but is holding up against international competition. A vibrant vehicle sales base is needed as a means of stabilising the planning cycles for the UK supply chain. At the current juncture, there are few new vehicle models entering the mass production stage and therefore few supply contracts are available to the UK supply base. Growth potential must therefore come from export contracts and the UK is not well placed to compete with mainland European sources as a result of the strength of Sterling relative to the Euro.

UK Car Output and Capacity Data

Manufacturer	Output	Capacity
MG Rover	392k ⁸	200k
Ford, Jaguar, Land Rover	439k	570k
General Motors	285k ⁹	200k
Peugeot	85k	180k
Nissan	272k	350k
Toyota	105k	250k
Honda	108k	250k
Mini (BMW)		125k
Others	12k	15k
TOTAL	1,689,000	2,140,000

Source: Rhys 2002 Welsh Automotive Conference

The British vehicle assembly sector is, on the whole, working at a level that is sub-capacity and this brings cost pressures as internal costs remain the same and the number of vehicle outputs are comparatively smaller (denominator). A variety of reasons explain the shortfall in capacity utilisation including production switching and new model and variant introductions. As British assemblers move closer to 'make to order' vehicle systems then this may also affect the capacity utilisation of the major assembly plants.

In terms of the world productivity ranking of vehicle assembly, European operations do not dominate yet the UK has one factory (Nissan UK) that ranks in the top 9 positions. Given the transferability of assembly systems throughout the globe these figures would suggest that vehicle assembly productivity is being affected by planned reductions to output but also suggest that the quality of supplied materials is also a factor that slows productivity. The latter issue was found to be true during this study and this result implies an imperative for supply chain improvement programmes (such as the formal training programmes operated by the SMMT Industry Forum).

⁸ Figure is based upon figures prior to change in ownership and current management predictions concerning vehicle build.

⁹ Figure cited is affected by plant closures.

World Productivity: Vehicle Assembly Rankings

Manufacturer	Vehicles per Employee
Daewoo (SK)	165
Mitsubishi (J)	163
Toyota (J)	107
Nissan (UK)	105
Toyota (J)	103
Honda (US)	88
Toyota (J)	84
Ford (USA)	84
VW (Sp)	76

Source: Rhys 2002

For a national perspective, the changes in assembler productivity has shown an increasingly productive trend despite the high level of new product introduction that tends to slow assembly productivity as a result of the 'learning curve' effect.

Changes in UK Assembly Productivity (Vehicles per Employee)

Manufacturer	Plant	1997	1998	1999	2000
Nissan	Sunderland	98	105	94	101
Honda	Swindon	62	64	83	55
Toyota	Burnaston	58	72	81	86
GM	Luton	39	43	47	49
Ford	Dagenham	62	61	46	62

Source: Rhys 2002

Recent new model and 'face lifts' of vehicles have been introduced to UK operations and these include:

Sector	Manufacturer
Passenger	BMW (mini), Jaguar, Land Rover, Honda, Nissan, Rolls Royce, Bentley, MG Rover, Toyota, and Vauxhall GM.
Heavy and non-car	Dennis, ERF, Foden, LDV, Leyland Trucks, Optare, and Seddon Atkinson.
Specialist	TVR, Lotus, and Caterham.

However, in parallel to these changes have been announcements to close UK assembly operations most notably by Ford and GM. The overall predictions for the total volume of vehicle output does reflect these losses but overall is set for a modest growth in production (July 2001 SMMT data).

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According to the SMMT prediction, 2005 vehicle output is set to rise to over 2 million vehicles. The trend, for total output, is shown in the table below:

Year	Total Output
1997	1,940,335
1998	1,981,051
1999	1,976,260
2000	1,817,125
2001	1,715,000
2002	1,815,000
2005	2,090,000

For volume passenger vehicle assemblers, Japanese inward investments and Jaguar vehicle production underlies this growth pattern.

	Toyota	Nissan	Honda	Jaguar
1997	104,615	271,666	108,097	43,551
1998	172,342	288,818	112,089	49,739
1999	178,660	271,157	114,479	86,387
2000	171,339	327,701	74,751	88,844
2001	180,000	310,000	127,500	140,000
2002	180,000	330,000	180,000	180,000
2005	200,000	400,000	200,000	260,000

Source: SMMT Database 2002

Some recent commentators have argued that the volume vehicle market is in decline and that the UK supply chain will no longer be dominated by volume vehicle assembly. This feature may well hold true in terms of recent plant closures of traditional mass production vehicle assemblers yet it is a distorted picture. Certainly, the government and UK supply chain must protect the Japanese and specialist sectors where the UK could gain a differential against other European sites. However, despite the closure of plants, many of these businesses either procured relatively little in the UK, as in the case of GM, or have retained engine manufacturing in the UK. The latter represents another major differential for the UK economy and a source of competitive advantage. Engines are important subsystems and require a good support infrastructure (Research, development and engineering) and, whilst engine manufacture is not typically co-located with vehicle assembly, there exist many opportunities to grow the 'wholly' and privately owned engine manufacturing sector. In parallel, the 'specialist' and 'non-passenger car' market also retains its importance and many of these businesses hold key market positions as manufacturing sites for vans and heavy applications. As the export market for these manufacturers is important, and so too is the contribution that these exports make to the UK economy, then the issue of how best to assist to support the industry is a matter of national importance.

A jewel in the crown for the British automotive supply chain is the continued growth and localisation of engine manufacturing in this country, many of which procure locally from domestic suppliers. Forecasts suggest that this sector is set for steady growth of products with long lifecycles and a good proportion of the engine that is sourced from within the UK and from the 'British made' primary metal industry.

UK Engine Manufacturing: Petrol and Diesel

Manufacturer	Output 1990	Forecast Output 2003	UK Content
Ford (inc. Jaguar)	650k	1,950k	Moderate
Land Rover	200k	250k	High
MG Rover	290k	200k	High
GM	120k	120k	Low
Nissan	280k	450k	High
Honda	80k	250k	Moderate
Toyota	120k	250k	High
Perkins	300k	300k	Moderate
Cummins	30k	30k	Low
BMW		400k	Low
Others (tractors etc.)	40k	55k	Moderate
Others (Car)	5k		
TOTAL	2,115,000	4,255,000	

Source: Rhys November 2001

Overall, investment plans in the automotive supply chain and the accuracy of forecast information is subject to errors as assemblers, the supply chain and raw materials providers wrestle with economic issues and engage in analyses of where best to locate production. At the heart of these debates is the long term stability of the British economy and the issue of currency integration. Whilst most major manufacturing businesses understand that 'Euro' issue is a government decision, it is true to say that the automotive industry is increasingly concerned about introducing new models/products to the UK. Most recently this has been demonstrated by the deliberations concerning the location of new products to Nissan UK (NMUK) - one of the world's most productive car assembly factories. In parallel, the recent Trade and Industry Select Committee heard evidence that over £100 million worth of new product introduction at a British engine plant was put 'at risk' due to perceived currency instability and risk associated with manufacturing in the UK.

To conclude this section, the UK automotive supply chain is important to the UK economy in terms of its worth, exports and employment levels. The latter includes the employment of British workers in regions that have seen a decline in traditional manufacturing sectors. In addition to the large inward investments are the SMEs who tend to locate in close proximity to their customer base and also employ, in aggregate terms, a significant number of regional workers (components, services and maintenance support). The presence of these manufacturers is, as a group, important for technology transfer including 'best practice' promotion to general industry. These businesses also contribute to their local communities, schools and practice good corporate citizenship.

The automotive supply chain landscape is changing and this report was commissioned to assess the form and extent of interaction needed between the major vehicle companies, their British supply chains, the government and other stakeholders of the industry. The remainder of this report will provide the key findings of the study and then present a series of recommendations for further action. Overall, the

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recommendations of this team concern the 'joined up thinking' necessary to benefit the automotive sector and wider manufacturing industry in the UK.

In Summary

The British automotive industry is a microcosm of wider manufacturing industry., The UK sector for assembly, supply and raw materials is undergoing vast changes and experiences many forms of uncertainty and instability in planning for the future.

Predictions concerning vehicle volumes reveal a mixed pattern of overall growth yet a number of businesses engaged in rationalisation programmes whilst others seek to expand their UK operations given that the UK location remains a favourable environment within which to invest.

The disadvantages and instability associated with the UK's decision not to join the Euro are a key factor in the investment plans and future volumes of vehicle to be assembled and manufactured in this country and exported. In the absence of a competitive British location, the manufacturers have sought to protect themselves from cost disadvantages by restructuring and trimming operations including re-sourcing supply contracts to sources outside of the UK.

The Field Research Findings

Issue 1: The Euro And A Level Playing Field For The Industry

The Automotive Supply Chain: Polite Yet Powerfully Positive towards Currency Integration

During our research, the vehicle assemblers paid courteous respect to the role of the government in deciding whether to join the Euro, the timing of any potential union and the rate at which such a union should be established. However, it is clear that the industry is suffering a significant loss of business. In the opinion of the industry this results from the high exchange rate and concerns about future instability.

Naturally, the most mobile of cost bases will be addressed first as the automotive industry adjusts to the competitive disadvantage perceived to result from a lack of currency integration with Europe. The most mobile costs are the costs of supply and therefore contracts are likely to be moved (changing the purchasing footprint¹⁰ of the assemblers) and renewed pressures will be placed on remaining sources for cost reduction. From a rough extrapolation of figures collected by this survey, the extent of movement could be up to 10% of the value of the supply chain and given the product movement abroad there is a secondary impact of 5% of the value of raw materials.

The sentiment of the vehicle assemblers is encapsulated in the following statements:

According to one Vehicle Manufacturer:

"...it is inappropriate to enter into the internal affairs of the UK domestic economy by having a public position on the issue ... The security of [our] investment would be strengthened if currency relationships with the EU were more stable and predictable. It is the job of Governments to set policy to create this more stable and predictable environment".

For another Vehicle Manufacturer, the message is the same:

"...a more favourable £:Euro exchange rate than currently exists is needed if the current trend of moving out of UK manufacture is to be halted/reversed"

According to another:

"The strong pound has brought about a fundamental revision in our supply base which is unlikely to be reversed"

¹⁰ The term 'footprint' is used to denote the spread of supply contracts across different locations and this spread of sourcing reflect the motivations of the customer. It is an important indicator when reviewing trends in the automotive industry. Movements abroad tend to reflect technological capabilities and a desire to reduce purchase costs even though the penalty of such action is an increased logistical, and problems often transaction cost, for the customer.

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For the automotive supply chain, the issue of currency integration is viewed, at all supply and assembly levels, in the same importance and the businesses investigated also called for a 'strong signal from the government concerning entry'. The businesses all believed that were the Government to take such a position it would greatly reduce concerns about future instability when future business investment plans are considered. Further questioning established that a firm decision not to join, or a continued position in the current vein, would continue the decline of the industry and the export of supply contracts abroad. A clear positive stance towards integration would slow the export and the determination of a timetable for entry would significantly enhance the chances of work being retained and investment growth in the UK. At the moment, these decisions are under review or in the process of movement to stable trading environments. Even where UK suppliers have retained work there remains a question mark concerning the future.

The Supply Chain Perspective:

"Entry into the Euro is relevant to future sourcing forecasts ... The currency rate is not competitive for UK based manufacturing competing in the Euro market and we believe that entry is only advisable at a competitive rate for sterling. Euro entry is entirely a matter for the UK government, but entry at a competitive rate would ensure future stability and create a more competitive sourcing environment for UK based manufacturers..".

For another:

"A further strengthening of the Pound against the Euro would lead to a further reduction in the volume of business placed in the UK".

According to others:

"A weaker pound would encourage greater UK content".

"Significant movements - either way - will have to be responded to by resourcing either into or out of the UK. This is unavoidable in order to safeguard our own UK production base"

"The key question of Euro membership is the entry rate"

"We will look to balance ourselves and source more into Eurozone"

"The strong sterling exchange rates impact us on two sides: less sales to overseas (due to a lack of competitiveness) and more purchases overseas. A more competitive exchange rate will help in both cases and will probably delay the transfer movement"

"The UK joining Eurozone will give better short and medium term visibility for currency stability and will consequently help decision-makers to keep businesses in the UK instead of expecting currency gains in imported materials"

Regional AIGT Dialogue Meetings: Exchange Rate Instability Findings

The regional dialogue events, organised as part of the AIGT research, explored the issue of *'the Euro'* and found that Eurozone locations have an advantage over their UK counterparts because of the exchange rate certainty provided by membership of the Euro. Attendees also expressed concern that plant investment decisions (based around Net Present Value assessments) take a long term (and risk-based) view of the exchange rate and attendees concluded that the instability of the Euro issue for Britain was putting at risk many investment projects. The lack of clear direction concerning currency integration, it was argued, was generating delays in such investment decisions at British factories.

Spending Review Analysis

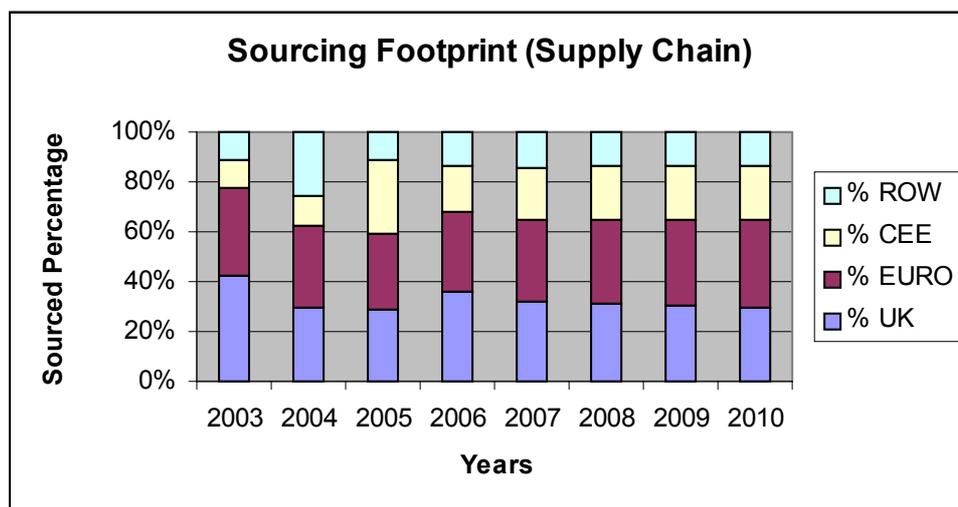
A review of spending patterns and future predicted movements in the purchasing budgets of British businesses was also undertaken using the interview evidence and questionnaires sent to selected businesses. The evidence of concern for stability in costs was reinforced by the trend in the footprint for these businesses and confirmed a drain from UK sources. Due to the high level of dependency relationships in the automotive industry, this poses very serious concerns. As the previous section highlighted, there is a high material flow (sales volume) dependency relationship throughout the UK automotive supply chain and therefore movements of supply contracts not only affect the direct suppliers but also the indirect supply chain. As such, losses of work at the higher levels of supply (close to the assembler) will lead to cancelled work for the lower supply tiers. In turn, factory overheads will be recovered across fewer products and margins will fall again or surplus labour will, in the absence of any other growth, be 'laid off'.

Overall supply contracts in the short and medium term are being placed in the Eurozone and not into Central Europe. The latter area remains a location of interest over the medium and longer terms whereas Western Europe is the main beneficiary of short-term adjustments to the UK procurement footprint¹¹. Given the constraints of this study, it is not possible to make a precise assessment of the worth of these contracts but in definite terms it is over £400 million. The ability to move supply contracts is a function of the level within the British supply chain. That is to say, that the tiers closer to the raw materials stage tend to buy in the UK and have decided to keep such buying practices in place. Those businesses at higher levels in the supply chain approach the subject with a greater interest in moving contracts 'off shore'. The following chart, showing movements in the percentages of purchases in each zone therefore understates (averages out) the high and continued dependencies at the lower tiers with larger movements at the higher tiers. Also the longer dated predictions tend to, because of forecasting vagaries, settle at a steady level of sourcing¹². It should also

¹¹ The term 'footprint' is used to denote the spread of supply contracts across different locations and this spread of sourcing reflects the motivations of the customer. It is an important indicator when reviewing trends in the automotive industry. Movements abroad tend to reflect technological capabilities and a desire to reduce purchase costs even though the penalty of such action is an increased logistical, and problems often transaction cost, for the customer.

¹² The 'levelling off' of predictions occurs because businesses cannot accurately predict beyond a certain point in time and therefore tend to forecast only minor adjustments after this point. In the case of this survey, this point occurred in 2006.

be noted that the presentation of this data expresses intentions and these are constrained by the lengths of awarded supply contracts and predictions, by suppliers of the future volumes and sourcing strategies of the vehicle assemblers. There is a common belief that the assemblers will increase the amount of contracts placed in emerging economies when these areas reach a common level of quality and delivery performance with established European manufacturers.



The modal form of attrition for higher tier suppliers is to reduce UK dependency by 5% of current trade in the period from 2004 -2006. The Eurozone will initially benefit from this movement and then the CEE countries as work is reallocated to that region. The question remains whether this movement to mainland Europe is merely a staging post as contracts migrate to the CEE countries over the longer term. Certainly this is a valid argument but there are several factors which act against such a wholesale move to long haul sourcing. These issues concern the technological sophistication of the region, the investment in new technology required, a lack of research and design support and the learning curve associated with the 'management' capability of these sources. These issues are significant in terms of efforts and the performance improvements required and this would inhibit the migration. If existing European manufacturers were to invest in the region this could increase the movement of certain products to the region. Again, many of the businesses that have established factories in the CEE are struggling to develop the necessary management practices with local managers who have been used to the traditional industrial policies of the former Soviet Bloc.

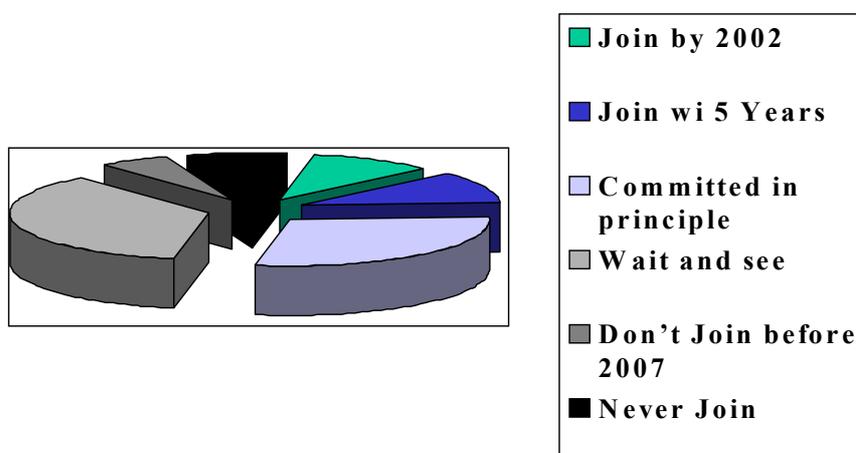
The assumption underpinning¹³ these movements is a strong sterling exchange rate and a continued absence from currency integration.

¹³ Therefore the data collected during this survey is subject to considerable positive benefits if broader economic conditions and support was provided to the industry.

Comparisons with UK General Manufacturing Position

According to the recent Mori poll survey of 500 Engineering Employers Federation members (2001¹⁴), 74% of businesses supported currency integration (the Euro) with 21% in favour of a timetabled entry in next parliament. The DDM study would confirm the broad support for early currency. The senior business managers all confirm a 'run down' decline in UK operations and sourcing patterns if this policy decision is not taken in the short term and a time table for entry is not established.

Mori/EEF Poll March 2001



The overwhelming perception held by the automotive and general-manufacturing sectors is that the UK would significantly improve its competitive position if Euro entry was progressed in the short term. This action would diminish and could halt the attrition to UK supply contracts

Summary

- The British automotive manufacturing supply chain is losing work as a result of exchange rate instability and the absence of clear timetable for entry. The general trend is to reduce UK content.
- The destination of these contracts, and the transfer of production (facility movement), is in the first instance, Eurozone but companies expected a growing interest in Central European locations.
- The work, most at risk of transfer, concerns items with high labour cost elements of production.
- The industry remains pessimistic that entry will be promoted in the short term and consequently remain committed to re-sourcing materials abroad. There are also a belief that in the short term, British manufacturers must enter the CEE region and invest, by acquisition and joint venture, businesses in these regions to support local UK operations. The Secretary of State for Trade and Industry made the latter

¹⁴ The summary results of the report can be found in 'The Engineer' March 2001.

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point during the Common's debate on 6th March 2002 in the context of support for Romania and emerging countries.

Issue 2: A Dependent Automotive Supply Chain System: The Implications

The argument so far is that the UK automotive industry and its associated supply chain is 'losing business' to the Eurozone. This finding dispels a common belief that British work is heading towards Central European Economies (CEE) in the short term. The movement of work from the UK poses many problems and these problems are most acute in the automotive industry for one central reason, there is a high level of dependency though all levels of the chain.

Here, two major problems exist:

- The first is a 'domino effect' as assembly sites are 'terminated' or 'run down' at the head of these chains. Those suppliers that survive will only remain viable if the overheads associated with these extinct customers are removed or companies will face a rising cost base as overheads are spread across fewer products. The reduction in the customer base will be identified by the DTI 'at risk' reports which focus on larger firms.
- The second, equally powerful means of disrupting the careful balance of supply concerns a 'reverse domino' as raw materials suppliers contract or leave markets. The results are clear, the viability of certain manufacturers in the supply chain are 'at risk' and many of these companies will not be 'flagged up' by the DTI 'at risk' reports.

The Levels of Customer Dependency Found during the Research (Automotive Suppliers)

Customer Dependency	Percentage of Sales Volume
Top Single Customer	35%
Top Three Customers	73%

The 'average customer dependencies' poses certain constraints in terms of how and where best to support the sector. Of significance is the fact that improvements at selected areas of the supply chain will lead to commercial exploitation as further benefits are passed onto direct customers in the chain. Obviously, any supply chain management initiative would add benefit to the sector. Important to the improvement of sector performance would be the development of the metals industry and a greater integration of the metal industry needs in designing an optimal supply chain¹⁵.

Summary

The dependency relationships throughout the automotive supply chain presents a major problem to the management of the sector. At present, information provided to the DTI is insufficient to meet the requirements of the department. Any recommendation of this report must therefore acknowledge that data about the industry and its supply and customer dependencies will be important data sets serving

¹⁵ It should be noted that, to improve national stock turn figures then the development of the metals sector is critical as this industry is the feeder for many of the UK's key supply chains and therefore positive benefits could be transferred to many sectors.

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to focus improvement efforts and identify the regional implications of growth/decline in key supply chain firms. It is important to note that the lack of effective resources at the disposal of the DTI is a 'total system' failing. An infrastructure of databases and continuous information feedback from industry/academia/trade associations or the RDAs would be ideal but would require a significant effort. During a study of Japanese automotive system design, it was discovered that MITI holds such informational databases and collects information that is offered on 'free supply' to business strategists in the automotive and general manufacturing sectors.

This 'information-based' programme, despite its apparent difficulty, is a worthwhile initiative that should commence with a government level review of data held by different departments and a listing of what can be shared. Secondly, departments should declare projects to a central 'clearing house' that allows access and understanding of programmes operated by different departments and finally a national system of key data supply should be created. At the moment such resources are not in place to support the development of key departments, such as the DTI, to engage in more value-adding and less routine-based activities.

Issue 3: The Future, Instability, Change and Government Assistance

The vehicle assemblers were asked to forecast the major changes in their environment. Many of these issues will feature in other sub-group analyses and a summary of the key changes and the government assistance required will now be presented.

2001 to 2005 Major Changes within the Industry (Assembler View).

Change	Business Outcome
Platform sharing and reductions in final product offerings. Modularity and standardisation.	Efficiency benefits and new product introduction efficiencies.
Integration of lean systems from design to distribution	Full compression of internal process times resulting in fewer unsold vehicles.
Component sourcing to distant markets	Relief of cost competition pressures by sourcing from inexpensive locations.
Block Exemption removal	Review of the market coverage and channels to market needed to effectively transfer vehicles to output markets.

2001 to 2005 Major Changes within the Industry (Supply Chain View).

Change	Business Outcome
Component Sourcing will move out of the UK	Restructuring of cost base and loss of local JIT supply capability
Euro issue will force increased supplier consolidation	Seek new ways of adding value and partnerships with specialist/premium customers
Increased ownership of product design	Introduce new capabilities to support near market and R&D aspects of supply contracts.
Further investment by assemblers in emerging economies	Displacement of UK businesses and re-sourcing of UK contracts
Increased vehicle features and electronics	Develop new product lines and modularity of products
Reduced pool of UK engineering talent	Source from abroad and/or subcontract services
CEE joins EU and new competition ensues	Focus internal improvement efforts and differentiate products from low cost segments.

Government Support Identified

The DDM study found the vehicle assemblers would propose government assistance in the form of:

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- A proactive approach to intervening in foreign exchange and currency issues (including currency integration) to prevent the erosion of British competitiveness.
- To support, through fiscal policy, the ability to ship products and components from other regions without undue penalties.
- The government should lobby to protect consumer choice and to ensure that consolidation of distribution channels does not work against market coverage and unfairly penalise UK businesses (Block exemption)¹⁶.
- To harmonise the treatment of national taxes on vehicle purchase such that tax is payable in the market of purchase to allow better price alignment and to maintain local market distribution networks.

From the supply chain perspective, and the feedback responses at the various dialogues, the perception was that government support was required in the form of:

- Promoting, for public acceptance, the benefits of Euro entry.
- Joining the Euro to protect and equalise the playing field for UK manufacturers.
- Developing high quality education and support for management.
- Establishing higher technical training facilities and regional support focus for training and development.
- Training for all levels of the business.
- The promotion of engineering graduates and modern apprenticeships.
- Providing investment grants and expert support.
- Tax incentives for R&D investments
- Removal of the climate change levy and high corporate taxation regimes.

Overall, the support from the industrialists for early entry into the Euro was clear. It is important to note though that no-one thought this was an alternative to enhancing the drive for productivity improvement in the sector, this needs to be a key priority whatever the decision on currency integration.

An interesting comment, provided by a major manufacturer stressed both the desirability and urgency of industry-government dialogue. The comment was as follows:

"The government in partnership with industry should establish a UK Manufacturing Plan that guides and prepares industry for the future. The plan must encompass schools, universities and companies to ensure that the correct levels of skills and expertise is available to make the required transition"

This sentiment was echoed throughout the industry and at all levels of the supply chain. It is important to note that the time is considered right for the development of such a partnership and all stakeholders see the need to pursue this line of action. In short, now is the time for plans of action involving the industry and any delay in acting to support the industry will probably mean that focus is redirected away from national issues towards immediate business pressures and the opportunity for meaningful dialogue will have been lost.

¹⁶ For further explanation of these issues please refer to the report from the AIGT's Distribution, Competition & Consumer team.

Medium Term Planning

Moving from the short term, the issues affecting the 2005 - 2010 planning horizon were reviewed. These included the following issues:

2005 to 2010 Major Changes within the Industry (Assembler View).

Change	Business Outcome
End of Life Vehicle Directive	New processes needed to cost effectively recover vehicles and major concern that such legislation will unfairly impact upon newly acquired businesses.
Environmental constraints	Greater attention to engineering management and supplier involvement.
UK suppliers seek cost advantages by producing in emerging countries	Change in the footprint of suppliers and the indirect supply base with the potential risk of a loss of expertise from the UK if current trends continue.
Strategic suppliers move to co-locate with customers	Integrated systems assembly from trusted and high performing integrated suppliers.

2005 to 2010 Major Changes within the Industry (Supply Chain View).

Change	Business Outcome
Development and mass production of alternative fuels	Development of new products and continued vehicle 'light weighting' ¹⁷ .
Increasing regulation	Additional administrative and compliance costs placing pressure on performance improvements for margin recovery.
Increased R&D responsibility	Find UK partners or global design engineering partners.
Increased outsourcing by assemblers	Increased cost pressure to meet assembler targets.
More joint ventures between manufacturers and suppliers	Selection of key partners and location of operation.

Government Support

The predicted government support required in the medium term time period includes:

- To ensure that the 'End of Life Vehicle Directive' does not unfairly penalise businesses in the UK.

¹⁷ 'Light weighting' is the design process of eliminating weight from the vehicle and is undertaken in response to cost and environmental pressures as well as the ability to exploit new material innovations.

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- To apply incentives and create conditions that support premium branded products and the drive to export production such as ensuring that exports are attractive to international customers and that penalties concerning large and premium vehicles do not restrict the demand for such products.

For the supply chain, government support should include:

- Greater grants for new product development and the exploitation of the UK 'design and engineering' infrastructure.
- Increased investment grants and subsidies

Longer Term Horizon

Over the longer term, the period 2010 to 2015, the automotive sector predicted even greater contraction in the UK supply base unless Euro entry had been achieved and the industry was fully supported by a national system of advanced engineering. These factors included:

2010 to 2015 Major Changes Within the Industry (Assembler View).

Change	Business Outcome
Alternative fuel introduction	Alternative materials and engineers leading to changes in manufacturing techniques and suppliers.
Traffic congestion	With an insufficient logistics system vehicle manufacturing and sales will be adversely affected.
New vehicle manufacturers formed from the major Tier 1 companies	Movement to brand management and distribution channel performance.
Skills shortages in the UK reach acute levels	The businesses will need to retain or sub-contract engineering support on a global basis.
Sourcing footprints move to India, China and CEE	To reduce the costs of supply and to buy more products from low wage economies.

2010 to 2015 Major Changes Within the Industry (Supply Chain View).

Change	Business Outcome
Emergence of new CEE and Chinese populations of suppliers	Threats to the viability of UK sources of supply.
Introduction of environmentally friendly products	Mass production of new designs created and tested in earlier planning period.
More complex components and materials	Develop next generation products including disassembly requirements. Increased joint ventures with businesses that are currently competitors.
Increased dependency with R&D activities.	Shared facilities and centres of excellence.

Government Support

The longer-term assistance involves an approach to corporation tax incentives that promote investment in new technologies to support the industry. These incentives will be required to develop and exploit new vehicle technologies especially those related to new body materials and new engine formats because these innovations have yet to reach a design/reliability stage at which mass production can take place.

Whilst it is difficult for many suppliers to forecast over this period, the main areas of support requested included assistance for the commercialisation of R&D and environmental processes, a continued incentive for exploitation of university research and help to further enhance productivity to face the continued threat of non-UK manufacturing bases.

Summary

The main themes identified by the industry experts are therefore the favourable adjustment of the exchange rate or harmonisation to give the UK a more competitive position in the short term. To generate an environment whereby the R&D base in the UK can contribute to the future market activities of assemblers and suppliers. Overwhelmingly, the issue of the Euro was seen as the critical item in establishing this new direction and challenge for the industry and without which many businesses forecasted contraction and potential exit from the UK automotive market.

The demands expressed by the automotive industry concern the stimulation of the business investment cycle and to engage in practices which will defend the UK market for vehicles. The challenges presented correlate well with the general trend information contained in the Foresight Vehicle Road Mapping Programme.

The challenges represent both positive and negative implications for British businesses. The changes in automotive technology could witness the end of supply sub-chains involved with traditional materials such as strip steel. On the other hand, the new technologies will require volume production and the organisations needed to do this have yet to be established. The new forms of technology are not associated with the skill capabilities of the emerging countries who trade on competitive costs and the exploitation of traditional technologies. There should therefore be an opportunity for the UK provided that the necessary support and infrastructure is developed. Many of these innovations will also serve the national interest in that they are also innovations that could be transferred to other sectors.

The issues presented in this section will be returned to many times during the remainder of this report. These key issues include the perception of British suppliers, education and research competencies, and critical skill shortages.

Issue 4: The Immediate Needs and Short-term Priorities of the Integrated Supply Chain (Assembler View)

When asked to conduct a review of the key areas of business improvement throughout the supply chain, the assemblers proposed the following activities as central to an overall improvement in the total supply chain for vehicle production.

1. Dealer-customer relationship development is considered highly important and the integration of e-business for vehicle sales (enabling 'build to order') were considered to be the main issues that could improve the performance of the vehicle assemblers from an operational perspective. The use of information technology within the vehicle is also an important issue, which has influence over vehicle diagnostic systems. These electronic systems also affect directly the quality of servicing and customer care offered by dealers.
2. At the interface between distribution and the vehicle dealer, the assemblers favoured the use of intelligent logistics and the introduction of telematics to control and monitor distribution channel activity. The major theme here is interactive and real time information exchange enabled by information technology.
3. For the interface between the assembly facility and distribution, the key operational improvement activity was considered to be the management of Just In Time distribution and the 'late configuration'¹⁸ of vehicles to meet customer orders.
4. The interface between assembly and engineering was dominated by introduction of digital systems for concurrent engineering. The new systems in the process of introduction include new approaches to design (assembly/dissassembly), the lowering of complexity and increasing use of virtual electronic integration of processes. The ultimate intention of the assemblers is to combine engineering capabilities to offer customers an almost limitless ability to configure vehicles in ever-shorter delivery times.
5. For the suppliers the main issue was the tightening of inbound requirements and performance levels needed to improve the total supply chain and its costs. The issue of quality management and investments in new supplier capabilities (design and supply chain management) were considered to be of highest priority. The latter also included the ability to compress time and complexity in the products supplied to the assembler including the use of techniques for late configuration of production needs.

A similar question was posed to the supply chain senior managers and this resulted in a common view that supplier integration, design engineering and quality improvements were required throughout the lower supply chain tiers in order to rise to the competitive challenge. In addition, of business leaders at the lower tiers the appropriate skill sets (commercial and engineering) to maintain the trading relationship with the supply chain as new targets were issued.

¹⁸ Late configuration involves the use of generic vehicle bodies and systems held as buffers within the manufacturing process or at the end of the process awaiting the exact customer requirement to be transmitted and for the vehicle to be fully customised to order. The benefits include a compression of time in the manufacturing system and a reduction of complexity.

The Area of the British Supply Chain in need of most Improvement

Without exception the area identified by all the vehicle assemblers during the questionnaire and interview stages was 'Supplier quality and management practices' at the first and second tiers. This findings confirm the opinions expressed in other studies such as the Deloitte and Touche review for Accelerate Midlands and recent KPMG reports¹⁹ which both identified problems with the quality of supply from the British supply chain manufacturers.

This issue directly affects the key changes within the vehicle assemblers over the past five years and a growing belief that the assembler must 'filter out' poor supplier quality which slows assembly productivity and inflate costs. The past five years has been spent with all assemblers renewing their focus on customer service and quality management. These processes of improvement have resulted in higher productivity levels and this is now expected of the British supply base - in effect poor supplier quality is now the bottleneck and barrier to further advances by the assemblers. This finding would suggest that additional assistance is needed to improve the performance of domestic suppliers through local initiatives and through assembler-focused programmes of improvement. To a certain extend the geographic dispersal of the British automotive supply chain implies that any 'Accelerate' or Industry Forum activity must allow for inter-regional trading to improve the aggregate performance of all suppliers in the UK. That is to say, a customer organisation with suppliers in Birmingham should expect that the Birmingham programme of development will work with their suppliers even though the customer is based in Wales²⁰.

Due to the high levels of material flow dependency within the automotive market, the first tier suppliers will inevitably point towards the improvement of quality performance by lower tier suppliers. Any improvement programme at the second and third tier levels (mainly SME organisations) will provide a direct impact on the productivity and material flow performance of the British supply chain. At the SME level the key issue is that of support and how best to meet the needs of the vehicle assemblers. It is also the case that these SME businesses should be encouraged to diversify their activities in order to lower the risks associated with dependency and also as a form of growth. It should be noted that this issue was also identified in the recent 2002 review of the 'Accelerate Programme'. These remarks also reinforce the need to work with the metals sector and to improve performance here such that a 'total' supply chain approach is implemented and that the benefits of metals industry improvement can impact positively upon the stock turns of customers in the automotive and other manufacturing sectors.

¹⁹ Both these reports can be downloaded from the Accelerate West Midlands web site.

²⁰ This process may or may not include cross charging between programmes and this activity would need careful consideration by the RDAs and organisations concerned.

Issue 5: R&D and Engineering Support

Most of the UK assemblers retained core R&D functions in the UK and design responsibility. However, most assemblers do procure basic R&D activities from other global sources especially from America, Germany and Japan.

Ownership	% Range of Design Effort
The Assembly facility	60 - 80%
Other Group Functions (non-UK)	10-12%
Suppliers	15 - 30%

When asked whether R&D should be located close to the assembly operations of the Vehicle Manufacturer, the answers were mixed with a general opinion that for 'near market' and introduction stages of new vehicle development then location is important. However for basic R&D activities, the existence of digital manufacturing engineering technologies means that location is not a key consideration. Instead specialism is more important given the ability to access the remote site.

Other key issues concerning R&D for automotive assemblers included the importance of an integrated logistics system and the working relationship with local authorities especially a flexible approach to planning and factory development.

The assemblers also predicted that advanced engineering systems will become increasingly more integrated (and virtual) and that this would necessitate the development of new engineering management competence in the UK (providers of specialist assistance) to assist the vehicle assembler. The development of local competence in the UK therefore offers opportunities for the University system to become involved in design engineering and management programmes of commercial importance to the assemblers.

The Supply Chain

The supply chain design effort shows, in general, a lower role for the UK facility in comparison to group functions. Despite the dependency relations in the supply chain, 2nd and lower tiers of supply account for very small amounts of design effort.

Ownership	% Range of Design Effort
The Customer	5 - 30%
The facility	10 - 30%
Other Group Functions (non-UK)	5 - 70%
Lower Suppliers	5 - 10%

The overall pattern of design responsibility is difficult to establish properly due to the vagaries of each product manufacturer but, in general terms, the UK manufacturing facilities were supported by group activities (wholly owned) and had responded to design devolution by the assemblers by centralising design activities. It is a recommendation of this report that the design dependency of UK manufacturers be examined in more detail in a small scale study commissioned by the DTI.

Integration with the British University Sector

Following the line of argument concerning integration with the University sector, the assemblers were asked whether they used such services now. All vehicle assemblers, to greater or lower extents, use the British University system and tend to acquire the following assistance:

Engineering	- including concurrent engineering,
Design	- rapid prototyping and tooling
Materials	- new manufacturing materials and processes

The experience of the vehicle assemblers, in terms of the quality of UK based research is unfortunately mixed and encapsulated in the statement "*...some very poor - others good*". This would suggest that the UK University system has many opportunities to improve its services (including commercial services) and to enhance its customer focus in a way that is more meaningful and exploitable by the vehicle assemblers. Given the importance attached to design and engineering issues that have been identified in the strategic intentions and issues between now and 2015, the university system could therefore play a much greater role in supporting the UK manufacturing base. Also, as the automotive industry is a microcosm of general manufacturing then these research programmes could have secondary benefits to the improvement of other supply chains (notably aerospace, construction etc.).

Summary

The study found support for an industry-government partnership and on-going dialogue at the strategic levels of the automotive sector to promote and assist in the development of the UK as an exemplary source of manufacturing/engineering expertise. The vehicle supply chain companies are however realistic and are operating plans to remain competitive in the absence of such a forum. These measures include the electronic integration of the entire supply chain and the entry of the industry into a new 'enabled-engineering' era of manufacturing that will bring a new business and supply chain model. An exploration of current UK University automotive research will be addressed in a later section.

Issue 6: The Shape and Future Shape of the British Supply Base: Purchasing Perceptions

The survey of the industry included various questionnaires and discussions concerning the future direction of change for the UK supply base relative to their international competition.

Assembly Organisations

The vehicle assemblers all forecasted changes to be made at the supply chain level and greater amounts of re-sourcing, as a direct consequence of Euro integration issues and the current perceived 'under-performance' of UK suppliers.

In terms of decision-making authority, the vehicle assemblers all operated with local policies (although some areas of decision-making discretion were centralised to global operations - these issues concerned 'input to' rather than 'dictation of' local policies). Every vehicle assembler also operated with a formal and written strategy covering the next five-year period. The typical performance measures applied to assembler purchasing professionals (an indicator of the priorities with the supply chain) included supplier cost reductions, quality and delivery performance, design capability and an increasing interest in the ISO14000 accreditation. These measures, in all cases, were not considered to promote or positively discriminate in favour of UK supply sources and all businesses operated with an 'open door' approach to new potential suppliers wishing to trade with the assembler.

The Assemblers' Supply Chain

The assemblers' approach to the management of the UK supply base reveals a bias towards single and dual sourcing away from the maintenance of vast numbers of alternative suppliers - suggesting that the market model of an oligopoly that supplies an oligopoly will continue. The second implication is that this form of dependency within the automotive supply chain will continue. The assemblers' interest in lowering transaction costs is confirmed when analysing the historic and predicted changes in the UK supply base (given no significant change to the market environment).

The general trend in the forecast reduction of UK sources shows the following pattern and implies that, in the absence of currency integration, the UK automotive supply chain will begin to 'hollow out' as supply contracts are placed with mainland European suppliers. It also implies that due to the industry's dependency relationships will threaten the viability of smaller suppliers unless they engage in diversification activity.

Supplier Category	1995 BASE	2000	2005
Productive Materials	100	75- 93%	50 - 70%
Raw Materials	100	80%	40%

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The predicted changes in the UK supplier population were explored by the DDM study and found these changes to be motivated by cost issues. The study found the following correlation between changes in sourcing policies and UK suppliers.

Assembler Motivation	Affected UK Suppliers
Rationalisation	approx. 60 UK suppliers per assembler
Re-tiering or the introduction of new firms to collect and configure supplies.	approx. 40 UK suppliers per assembler
Movement to low wage economies	approx. 10 - 50 suppliers per assembler

These motivations and directions of change suggest that rationalisation and overseas sourcing will, again in the absence of currency integration, remove UK suppliers from the supply chain with a near-permanent effect. The loss of volumes to these suppliers will inevitably lead to job losses and will further inflate unemployment figures (notably in the regions). The magnitude of this change is significant. The approach to re-tier suppliers implies that the current direct trading relationship with certain suppliers will be displaced to an indirect relationship and these firms will not necessarily be removed from the supply chain and UK value adding. There exists some ambiguity in the comments, quoted above by the vehicle manufacturers, concerning the possibility of reversing the sourcing trend. The rate and extent of contract movements, away from the UK, may be slowed and even reversed if improvements are made by automotive suppliers and more favourable trading conditions existed (which lower the advantage currently held by mainland European sources).

For the supply chain itself, the direction of change was less pronounced but also included the removal of weaker performing UK suppliers (as a result of poor operational performance or competence) and again for systems suppliers showed an increasing stress on re-tiering. However the rationalisation process was found to favour mainland European suppliers and the survey found relatively low levels support for the hypothesis that the CEE region was benefiting from the re-sourcing process. It should be noted that the CEE region, offering a 'low wage' advantage will become an increasing attractive source of supply when suppliers in this region begin to match the customer service levels of UK businesses. The CEE 'threat' is therefore a medium term issue and this will be explored in the next section of this report.

It should be noted that in both the analyses of the vehicle assemblers and supply chain, the issue of Central European countries as a destination for supply contracts was considered a medium term destination with Europe favoured as the first place to award new contracts. It should also be noted that the Japanese transplants and their UK supply bases remained 'committed in principle' to local supply but if currency issues worsened then new sources would be required especially if these sources offered high quality and delivery reliability to maintain a Just In Time supply system.

The Sourcing Footprint: The British Supply Chain

A finding of the DDM research is that the vehicle assemblers operate a much more integrated and demanding supply system than those developed between the tier 1 and the remainder of the supply chain. These performance differences covered all aspects

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of the trading relationship (quality, delivery and cost reduction pressures). The UK tier 1 are therefore filtering out the problems of the lower levels in the supply chain. In effect the Tier 1 suppliers face the acute customer service demands of the vehicle manufacturers but have to cope with much lower levels of performance provided by their own suppliers. The perceived 'under-performance' of the lower supply chain tiers would present many opportunities in terms of supply chain management development programmes and the future role of the SMMT Industry Forum. The current system of 'filtering out' problems before they reach the vehicle manufacturer is costly, depresses stock turns and lowers the returns that can be made by automotive suppliers - again reconfirming the need for an industry-wide supply chain improvement programme. The finding would suggest that it is the second tier of supply which needs operational help whilst the tier 1 require assistance to develop the capabilities needed to support the assemblers in the future.

The performance differential at the tier 1 to supply chain level exists despite a relatively stable trading relationship of some 7 years (average) with the indirect suppliers to the assembler. In addition, all tier 1 companies operated with formal sourcing strategies which covered a 3-year planning horizon and a small, yet dedicated, supplier development capability. The sourcing footprint for the tier 1 companies reveals the following dispersal of sources (taking out outlier companies):

Source	%of suppliers
Local (within 30 miles)	1 - 20%
Rest of UK	40 - 55%
Mainland Europe	30 - 60%
Central Europe	0- 2%
Rest of the World	0 - 10%

The pattern of sourcing shows that the regions beyond Europe remain relatively low in population terms for the typical UK supplier. However, mainland Europe and CEE sources were identified to grow and at the expense of UK sources.

It should be noted that the pattern is considerably distorted for lower tier businesses that are close to the raw material chain. These businesses tend to be dependent upon UK sales and dependent upon UK sources. These features make these smaller companies at greater risk to supply chain changes.

Perceptions of the UK Supply Base

The study directly addressed the perception of UK supply sources through the questionnaire and interview processes. The issue was also raised at each of the supplier seminar events.

Strengths

The strengths identified by the respondents all relate to 'basic' features of a stable supply system. Rarely did any respondents, at any level of the automotive supply chain, identify a technological or design superiority of UK suppliers.

Britain's Basic Offering

1. Long History and Experience (including multi-customer experience)
2. Language
3. Location and response time to change/developments (flexibility)
4. Exposure to industry-leading demands
5. Shorter lead times.
6. Reliability of supplier performance (Quality and Delivery)
7. Low cost and overhead structures (including Logistics and Inventory costs).

Weaknesses

The research programme found a common set of weaknesses expressed by respondents throughout the supply chain. These criticisms concern issues of financial stability and investment and secondly issues of management competence (design and supply chain issues).

Britain's Weaknesses

1. UK Price Competitiveness. Poor understanding of the threat posed by European suppliers - believing that UK location commands loyalty by purchasers. The UK sources are disadvantaged in cost relative to Eurozone.
2. Weak continuous improvement culture and poor retention of skilled personnel.
3. Poor control of suppliers (and development activities)
4. Financial stability of small businesses and inward looking attitude rather than a global perspective concerning trends and opportunities in the global automotive industry.
5. Focus on the short term not long terms combined with general under-investment
6. Lack of investment in R&D and technology.
7. Poor product planning processes and resolution techniques. UK suppliers are considered 'slow to market'.
8. Poor focus and lack of attention to customer requirements (forecasting of change in the industry).

Opportunities

The opportunities expressed by the respondents all feature themes of investment (technology, people and suppliers) and commercial exploitation. The opportunities also exist at the level of material supply and are paralleled with the need to engage in 'design' programme management capabilities to support the future trading position of the vehicle manufacturers²¹.

Britain's Opportunities

1. Opportunities only exist if there is a common currency with Europe.
2. Investments in employee skills to generate continuous improvements and problem resolution.
3. Design. Investments in product and process R&D. An associated opportunity concerns the development of better project management skills and competencies.
4. Investment in technological capability.
5. European expansion possibilities and the need to focus cost reductions to allow UK suppliers to compete and grow European customers.
6. Joint Ventures and the establishment of manufacturing facilities in low-cost labour markets or out-sourcing to these regions.
7. Improvements in supply chain management and planning of logistics leading to effective customer partnerships.
8. Greater application of lean manufacturing and six sigma approaches.
9. Exploitation of manufacturing advantages resulting from low UK interest rates.
10. Entering niche market segments

Threats

The respondents are unanimous in their response to the biggest threat to the UK supply base and cite the issue of currency integration with the Euro. The subject is topical but the interview process and works undertaken by this study reveals that the issue is the single greatest source of instability for the UK automotive industry. The Euro and the government's position are sources of planning instability that effectively delay, 'put on hold, or disadvantage the willingness of the UK supply base to invest. The second threat identified by the study was the associated issue of cost competitiveness and concerned the low cost labour economies.

²¹ The subjects of supply chain management and capabilities to design and programme manage new product introduction processes is a common criticism of British automotive suppliers. Programmes of assistance, to the industry, in these areas of management would therefore be warranted and represent good 'Value for Money' from the national perspective.

Threats to British Suppliers

1. Exchange Rate and No Entry to Euro leading to a lack of cost competitiveness.
2. A large number of imports reduce strength of UK suppliers combined with UK supplier apathy towards low labour cost regions (poor planning).
3. If low cost economies (Central Europe and Asia) manage to engage an improvement culture then this poses a significant threat. UK cannot be slow in reducing skills and skill training gaps.
4. Parent company decisions to withdraw a strategic presence in the UK especially if currency integration does not happen. Also movements of vehicle assemblers away from the UK.
5. Consolidation of suppliers and re-tiering to lower levels where influence is less.
6. Lack of technological investment and reliance on 'ageing' technology.
7. Inability to manage devolved design responsibility throughout the supply chain.
8. Attraction of good people to the industry and the loss of skills as the workforce ages.
9. General government stance that does not appreciate and promote manufacturing.

Immediate Needs

The study confirms that the immediate needs for British suppliers, based upon the Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis is one of improving basic business processes and step-changes to performance levels. These improvements require investments in people skills and innovations whilst senior business managers must extend and broaden their thinking to the European and global issues of the automotive industry. Again, a correlation is found with the government's position concerning currency integration, which with a positive stance, would create the planning stability needed to 'free up' the processes of investment.

Immediate Challenges to British Suppliers

1. Stability from government and positive position concerning Euro membership.
2. Short term survival as margins and volumes fall.
3. Dramatic improvement in cost position and supply chain performance measured in improvements to stock turn.
4. Generation of profit stream for re-investment and management of business growth possibilities.
5. Improvement in the quality of products and stock turns.
6. Improvement in Product Design Process and project management
7. Continuous improvement throughout the supplier business involving extensive training.
8. Development of global organisation and capability to supply. Importantly, UK companies must aggressively targeted centralised European VM purchasing divisions.
9. Understanding and anticipating government strategies and making sense of current economic instability.

Concerns about Direct Suppliers

The long-haul sourcing debate has another key dimension that was explored during the study. As the UK supply base struggles to compete with low labour cost countries and British customers (at each level of the supply chain) rely upon the management

capabilities of their direct suppliers - how concerned are UK purchasing executives about the capabilities of their direct suppliers to manage the indirect?

Every vehicle assembler expressed major concern about the ability of the first tier businesses to control their suppliers (the second tier). According to a vehicle assembler, the major concern involves the "*need for far greater responsibility for commercial and project management issues within 2nd and 3rd tiers*". The first tier of supply concerning their suppliers expressed the same concern. With current pressures to profit and survive, it was considered that the time, costs and supply chain management capabilities needed to fully exploit a 'devolved' system of responsibility was lacking. This deficiency poses many risks to the UK chain and, according to one Director of Purchasing, "*It is questionable as to whether the 2nd tier really has the skills to manage this process of supply chain integration let alone design responsibility*". A commonly cited fear was the devolution of purchasing discretion to lower tier firms and the procurement of cheap but poor quality raw materials. The concern expressed, is a fear that poor quality materials will pass through several manufacturing tiers in the supply chain before the defect is found. At this point, the supply of materials to the vehicle assemblers could be stopped with catastrophic consequences for the quality of vehicles produced and the productivity/costs of the vehicle assembler.

The interview responses identified the need for a greater understanding and promotion of supply chain management practices combined with the introduction of common standards, such as QAS 9000, to ensure procedures that set out basic systems are in place. The latter also raised issues concerning the effectiveness of these systems and that they can never be a substitute for good people in dealing with continuous improvement, supplier management and influencing the professionalism of purchasing/operations management at the lower tiers of supply.

Long Haul Sources

Long haul sources are a means of 'buying in' low technology and labour rich products by exploiting low wage economies at the borders to the EU (the Central European Economies). Both the questionnaire, groups seminars and individual interview process confirmed that long haul sources were 'on the strategic purchasing agenda' in the medium term. Many of the companies researched had already begun to source from these geographies although, relative to Eurozone sources, this practice is still small.

Attraction to Long Haul Sources

Unsurprisingly, the motivation to long haul source involved the issue of cost for customers and for suppliers the migration to such countries represented a response to the cost pressures of the vehicle assemblers and direct customers. The low cost CEE countries also attract high levels of grant aid and support which adds to the attractiveness of this region. In addition, senior purchasing executives highlighted the flexibility of labour in these countries and the potential alignment of the CEE region with investment plans of their own corporations.

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The migration of suppliers to CEE countries and the continuation of supply contracts means that the development of this region as an important supply source is likely and that new automotive dominated regions will emerge. A common view expressed by major manufacturing businesses was the availability of modern facilities, with expansion potential, access to modern technology and a common theme was the establishment of sites and supply sources to connect with existing/new customers as they migrate or 'sister' operations. The latter process of 'corporate supply chain integration' poses a major issue to the UK supply base. Those pan-European and global automotive suppliers, operate with 'sister facilities' in Europe and these facilities often inter-trade materials, components and services. As such it would be possible to move current UK production to areas closer to other company facilities or establish new plants in mainland and central Europe that were closer to other corporate sites. Additional information gathered during the interview process does suggest that the larger 'corporate' groups have not finally decided where products should be made and these businesses are constantly reviewing products and their migration between 'sister factories'. One of the problems of this perpetual review activity is the impact of factory overhead recovery as volumes of work move to low cost facilities.

Another view, expressed during the interviews, was that the 'distanced' CEE manufacturing facilities are likely to be supported by centralised purchasing and technology centres but the deployment of engineering and product development processes lack a sufficient infrastructure to support manufacturing in the short term.

The countries most favoured by British suppliers as sources of materials and components.

<p>Country of Destination (Rank Order)</p> <p>Top Single Destination: Czech Republic</p> <p>Popular Sources : Hungary Poland</p> <p>Product Dependent Sources: Romania, Turkey, Ukraine and Lithuania</p>

The products, that were cited as 'migrating' to the CEE region, included electrical wiring systems, fabricated parts and specialist requirements (mainly specialist metal derivative products). The movement, out of the UK, of products such as wiring harnesses follows a trend to out-source this product grouping by the vehicle manufacturers themselves and is therefore being repeated throughout the supply chain. The driver for this trend is the labour cost disadvantage of the UK. The product is labour intensive and other mature economies, such as Japan, do not use the factory system to produce such products (outwork is the preferred option). Other products migrating to the CEE region include alloy wheels, a product that is heavily influenced by raw material prices and a product that has, in recent years, been a constraint supply item for UK vehicle manufacturers²². More generally, light assemblies, fabrications,

²² The production of alloy wheels in the UK was a constraint item when demand exceeded capacity as a result of vehicles entering the 'phase out' stage of the lifecycle. At this point, additional vehicle features are added, without consumer price increases, to stimulate the 'phase out' process. Traditionally, such items included alloy wheels, air conditioning, sun roofs and electric windows.

forging and steel components were all target products for transfer to the low cost CEE countries.

The Rate of Migration: Future Sourcing Pattern

An important dimension of the long haul sourcing debate is the rate at which this migration, and the 'hollowing out' of the British supply chain, is occurring. To assess the rate of transfer, the survey asked for changes in the purchasing profile (the 'foot print') in terms of the number of suppliers in the CEE region in 1995, 2000 and 2005 (prediction). In 1995, most companies in the British automotive supply chain operated with typically no suppliers in the CEE region, by year 2000 this had risen to figures of almost 10 sources and the prediction was that sources would treble by 2005. This figure may be due to the exploitation of these sources at lower tiers of supply and the belief that the CEE region will not manufacture systems but remain focused on components. The rate of substitution affecting British suppliers is however significant and the CEE region is the second threat to UK supply after short-term movements to Eurozone nations. When the CEE integration to the EU occurs in 2004, combined overseas re-sourcing activities pose a significant threat to the UK supply base. In addition to the CEE countries, many respondents highlighted China as a source of cost-effective supply that offers good management commitment, high technology and good levels of quality. In parallel, South Africa and Brazil were also identified as sources with good piece part prices and a relatively sophisticated approach to R&D and technology. These regions must therefore be a source of concern for the UK supply chain and it is remarkable that such long haul sources, given logistics costs, can maintain an advantage over domestic sources of supply. The means of defending this substitution process is therefore to improve UK levels of productivity and quality (resulting in lower total costs of supply) and national changes which would favour the UK.

Issue 7: The Central European Threat

For many of the interviewees and respondents to this study, Central Europe poses a small yet rapidly growing threat to the UK manufacturing base. In essence, many former Soviet bloc facilities are 'offered for sale' through the various Ministries of Finance in Regions such as Romania, Hungary, Poland, etc. The price of these factories is modest and well below that sought by the governments concerned. To date, American industry (especially in Romania) has been quick to invest in this region yet British interests remain low (preferring instead to buy from rather than own such manufacturing sites). Currently these countries are keenly interested in selling to the EU and Britain. At present up to 70% of Hungary and Czech Republic's exports go to the EU and the destination of much of this volume is Germany (growth is forecasted to be sluggish and therefore other destinations will become desirable).

The process of EU membership by Central European economies (CEE) will increase from 2004 and many of these economies are focused on developing competitiveness equivalent to European levels and with meeting European regulation. Should these countries improve and sustain their competitive potential then, combined with a low paid and highly skilled engineering labour base²³, they pose a major threat to British manufacturers. In parallel, vehicle manufacturers in these regions have shown interest in developing these sources of supply. Manufacturers in this region have been engaging European consultants to raise productivity, target European markets²⁴, and transfer knowledge concerning tooling and best practice²⁵.

Of key concern to CEE countries is to improve the 'productivity' and 'quality' performance of businesses. These manufacturers average a turnover per employee of 61,000 Euros (2000 figures) which is well below the global average of 180,000 Euros and 'best' levels set at 222,000 Euros per employee. The automotive industry in the region ranks highest in this analysis of turnover per employee and has an average figure of 115,000 Euros per year²⁶.

These accession countries have levels of GNP per capita four times smaller than that of the 15 current EU members (The World Bank Group World Development Report 2000/2001). In parallel, accession will however reduce the labour cost advantage against the UK. A recent EU study, The Free Movement of Workers in the Context of Enlargement, March 2001, suggests 70,000-150,000 workers per year will migrate from the 8 Central European candidate countries, commencing in 2003 and continuing for a decade. The long-term prediction is that 3.9 million people from the region will migrate to the current EU (accounting for 1.1% of EU population in 2030).

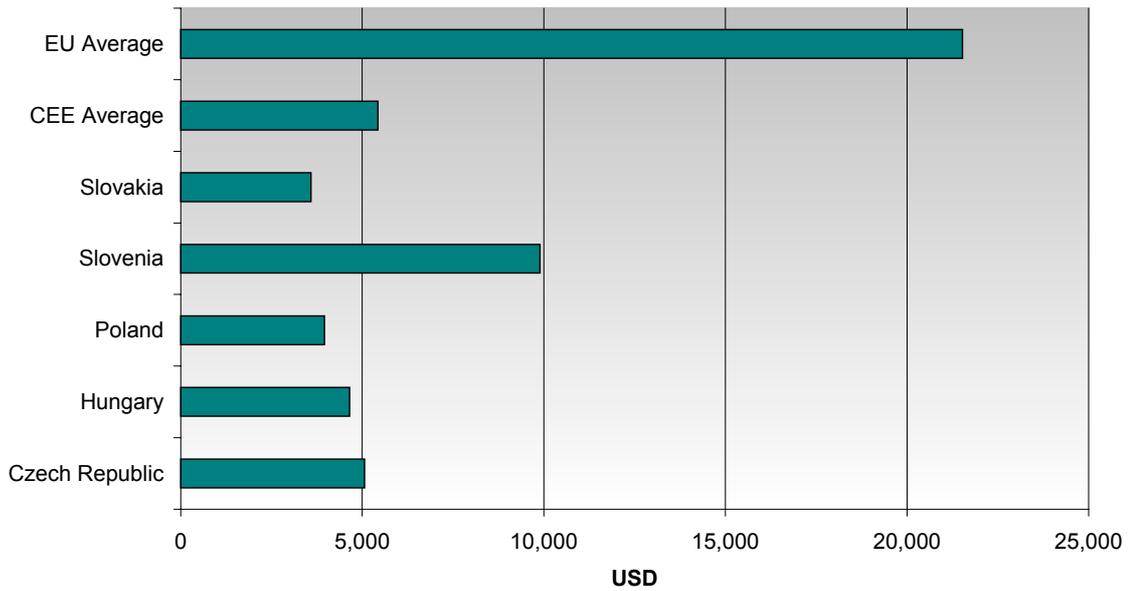
²³ In a recent study of Romanian and Hungarian manufacturing businesses, the average pay of a skilled Romanian technician (operator/setter/maintainer) was seen to be just \$75 per month (Rich 2001).

²⁴ During the study tour of Romania many businesses, especially in Engine Component and Power Train applications had targeted Britain.

²⁵ The Slovenian Government is funding a programme of best practice based upon Japanese management techniques (The Kobayashi 20 Keys Programme).

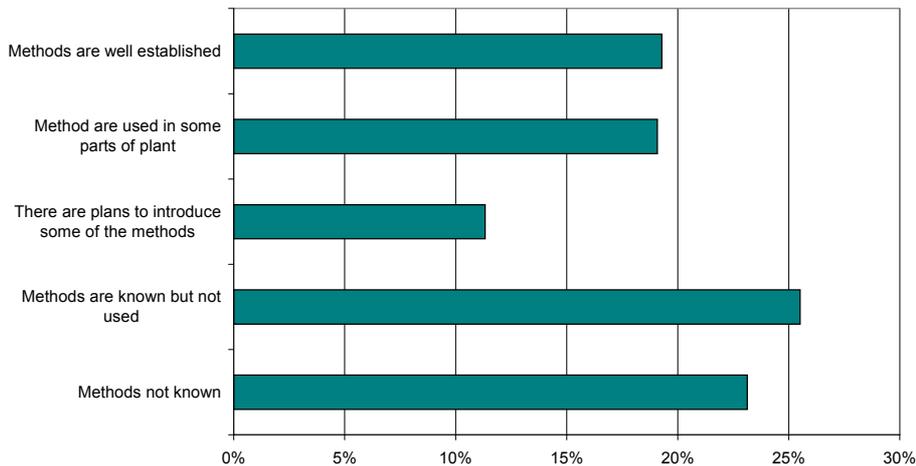
²⁶ Deloitte and Touche Central European Review Document.

GNP Per Capita (1999)



Moving beyond national performances, a recent Deloitte and Touche (2001) study confirms that the region is beginning to engage in lean production (but not yet lean supply chain) practices. Following in the wake of asset sales and downsizing of workforces, businesses are engaging new processes for product design and development, new technology exploitation and the establishment of better relationships with suppliers and customers.

Lean Manufacturing Methods



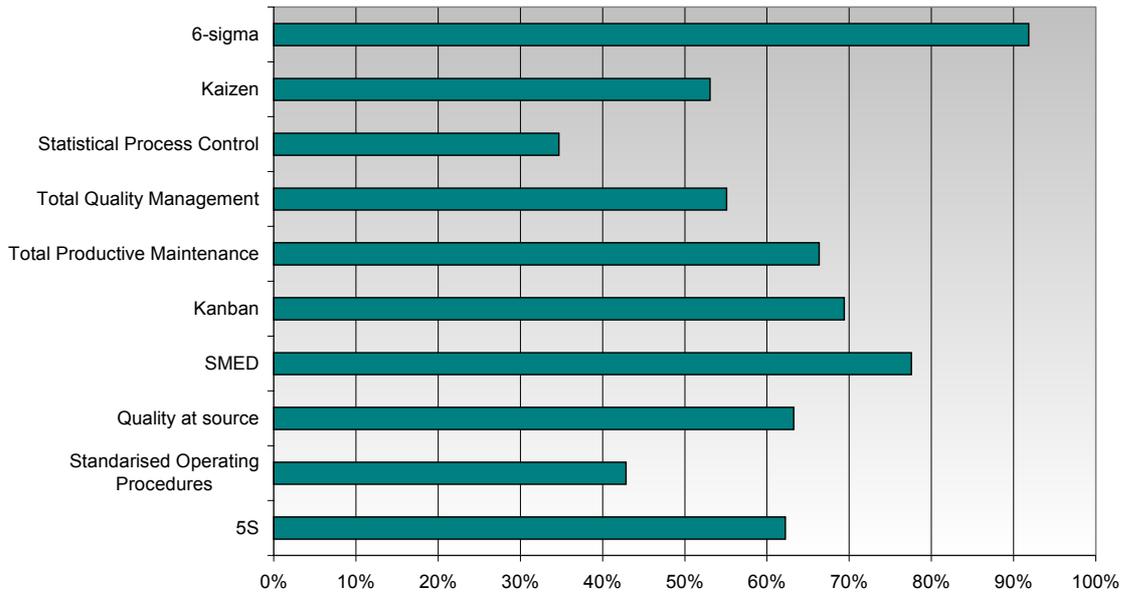
The results of the survey indicate that the defective inbound materials are on average 30,000 PPM, with a range from 1000 to 100,000 PPM putting the CEE region at a considerable disadvantage and implying many years of national change before harmonising performances with Europe and the UK²⁷. Again, acting against

²⁷ The quality performance of UK and European manufacturers varies widely would be in the order of 100:1 advantage over the CEE regional averages. However, it should also be noted that quality

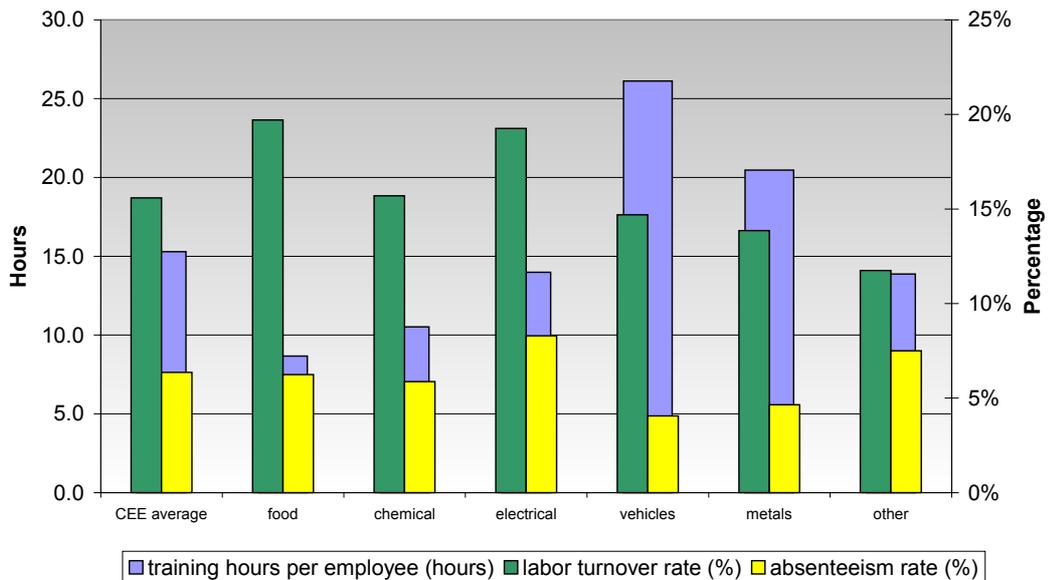
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improvement is the high levels of labour instability (strikes, labour attrition) despite increasing levels of training to redress 'labour problems' in the region. However, the threat from this region cannot be underestimated as British firms seek to trade with this geography in order to combat pressures by vehicle assemblers to lower costs. The following charts present, from the CEE region perspective, performance figures and the extent of 'world class' manufacturing practices engaged by the firms.

Management Methods not used by Participating Companies

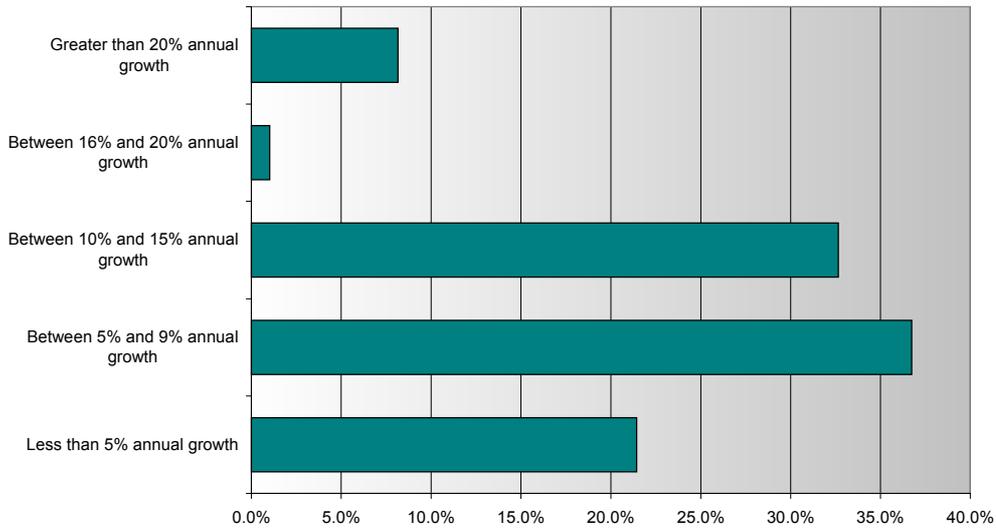


HR Indicators



improvements are the source of productivity improvements and programmes of 'quality' improvement have already been introduced to the CEE manufacturing region by local governments.

The expected annual growth rate over the next 3 to 5 years



CEE Report Summary.

The CEE countries pose a medium term threat to the current UK automotive supply chain. To date, British investment in CEE economies is low and vastly outweighed by US\$ investments and a US government promotion of this region (especially Romania). At the current time, inward investment by British manufacturers is insufficient to create the logistics infrastructure needed to exploit the resources of these countries. In this respect, UK businesses investing in the CEE are likely to benefit only when American investments have reached a critical mass.

The ability to buy well equipped yet poorly managed facilities from CEE governments is a possible route for British manufacturers and would suit the UK economy if profits were repatriated to the UK. The long distance associated with CEE countries is deemed irrelevant by US manufacturers resident in the CEE who perceive the internet as a means of integrating their manufacturing concerns²⁸.

Supplier Perceptions: Summary

The motivation to move sources concerns the issue of costs alone. The view that *“Costs will be a factor to move in this direction in the future”* suggests that the UK supply base, and importantly sections of this supply base, lacks the means of differentiation against these 'cheaper' sources of supply. Such differentiation would benefit the UK and the vehicle assemblers. The UK assemblers prefer local supply and Just In Time material flow systems in order to maximise the productivity of the assembly sites and to avoid the costs of warehousing materials. The issue of currency integration is again a relevant factor here and, the research process found that a positive stance on British membership of the Euro would slow down but not

²⁸ Those US owned facilities visited by a recent study tour (Lean Enterprise Research Centre) included Wisconsin Machine Tool company (acquiring lathe interests) and Timken Bearings (acquiring capital intensive machine shops and Design training centres). A mix of American and European ex-patriots managed these facilities - many of whom were well versed in lean manufacturing techniques.

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necessarily halt the migration of products to these 'cheaper' sources of supply. Overall, the fear of the respondents was that UK supply operations were not actively building the capabilities required to compete with or exploit these CEE sources.

The migration process is affected by a 'push' from UK businesses to outsource to the region in response to assemblers and major first tier pressure for cost reduction as well as a 'pull' from the exploitable advantages of operating in the CEE. These latter advantages will increase as an extended pan-European logistics system improves delivery reliability and the flow of materials through member states.

Joint ventures and other agreements with companies in the CEE region represent possibilities to own assets abroad whilst repatriating profits to the UK. However the ability to engage in such a process would depend heavily upon government support and the encouragement given to current UK supply sources as well as expansion opportunities in terms of supplying from the former CEE to nations such as Germany. In the context of an industry that is not making high profit returns, the overseas investment option is difficult but would serve the national interest well especially, if vehicle assembly sites expand in the CEE region and new opportunities exist to attract British investment abroad.

Issue 8: Lean Manufacturing Knowledge & Lean Production Dissemination in the UK

After a decade after the evidence of lean versus mass production automotive assembler systems was presented in "The Machine That Changed The World" (Womack, Jones and Roos 1990), the extent and quality of dissemination of lean production practices remains limited. This issue has been most recently the subject of questions at meetings of the Commons Trade and Industry Select Committee. This knowledge base and its practical implementation is important if the UK supply chain is to make improvements in performance. This priority has already been identified at the assembler level in previous sections.

A recent doctoral study²⁹ looked afresh at the question of differences in productivity between lean production firms and those which have chosen to stick to traditional mass production.

The Comparative Cases

In 1997-1998, three companies were selected to compare lean manufacturing performance with traditional business models. In 1997, similar businesses from the Japanese supply base to Toyota Motor Corporation were researched to establish the practices and performance of these 'lean' businesses.

Selection Criteria of the Case Companies:

1. The case companies employed similar levels of employment (each company employed between 620 - 640 persons)
2. The case companies would all operate at the first tier of supply in the UK automotive supply chain.
3. Each company manufactured products with similar application but to different customers. The products were all pressed metal parts.
4. The weight of the product and number of process steps were identical and used identical technology.
5. The average age of workers was 36 years old.

The research found that Case A had all the features of the lean production model albeit the human resources policies were not at the levels of Japanese lean organisations. Cases B and C were deemed to be mass producers and compared well against the traditional 'push' system of forecasted manufacturing. The superiority of Case A was demonstrated in all operational performance measures including a significant stock turn advantage and, if all companies were profit centres would have a greater profit stream and also a more stable level of profit rather than swings in profitability.

²⁹ Rich (2002) who is a member of the DDM team conducted the study.

The Lean Advantage

Case A was found to have superiority in the following areas of management:

Outbound Logistics

Case A shipped more regularly to its customers and operated with finished buffer stocks (measured in a few hours). Cases B and C shipped less often and operated with many days of inventory.

Operational Control

The production system of Case A was levelled to create a schedule for the average number of daily products required. In process and between process buffers were held with small safety stocks that allowed continued production whilst detected problems were corrected quickly by the team and specialists.

The Overall Equipment Effectiveness (OEE) at the bottleneck operation of Case A was over 20 points higher than Cases B and C. OEE measures at other stations, except painting, were also considerably better. Case A operated at World class (TPM level 1) measures in 3 of its 4 key processes. Cases B and C managed level 1 TPM performance in only 1 automated process each. Asset breakdowns were minimal at Case A whereas Cases B and C suffered constant interruptions to schedules as a result of poor asset management and held significantly higher buffers to compensate for these interruptions.

The quality assurance regime at Case A meant that the entire manufacturing system was exposed for no more than 20 minutes before defects could be detected (formal systems of measurement) and all operators inspected products within cycle times.

Case A held a superior safety record in terms of the number of days between accidents. Cases B and C operated with over twice the number of accidents.

Inbound Materials

Case A operated a supplier association of materials and component purchases. This club addressed issues of quality, cost, delivery, design and environment. Case A also had a longer trading history with its supply base and did not engage in changes in sourcing. Cases B and C operated with annual contracts and constant switching of supply.

The deliveries to Cases B and C contained high levels of quality defects (up to 2.8% defects) and were subject to delays (73% on time delivery). Case A held no more than 2 days of in-bound materials, had variances in schedules of less than 5% (Cases B and C were at the 25% levels), recorded much lower levels of supplier quality defects and operated with on-time delivery performance of 93%.

The in-bound materials requirements were controlled with both kanban systems and also a 'headline' and levelled forecast to assist suppliers in managing their medium term capacity.

This secondary review demonstrated the superior performance that results from the implementation of a lean production system that controls all aspects of the factory

supply chain. Case A is recognised by its Japanese companies as an exemplar British company.

Lean Dissemination in the UK

Various organisations, in the UK, have been involved with the dissemination of lean production techniques. These institutions include a select few universities³⁰, the Automotive College, the SMMT Industry Forum, and a few private consulting firms.

SMMT Industry Forum

For the automotive industry, the SMMT Industry Forum spearheads the promotion of lean manufacturing practices working with Japanese Master Engineers to improve the performance of British supplier firms. The initiative has provided immense benefit to the industry and more recently it has extended its remit to support improvement campaigns in other economically important sectors (notably aerospace). Those companies, involved with this research, which had used the service, had used the IF for senior management networking and also for operational improvement programmes. The quality of the service provided was rated as 'Very Good' by these companies. The IF model has proven beneficial to industry, since its launch in 1996. The industry would benefit from an extension of these activities and greater numbers of companies being involved in Master Classes, team leader development and supply chain groups. The IF is also capable of extending its product range and services to the great benefit to the component sector.

"The industry Forum has worked with more than 450 companies over the last 5 years with considerable success. We need this to be replicated throughout the UK".

Graham Broome, SMMT IF, The Manufacturer Jan 2002

It is the view of the DDM team that the role and financing of the IF should be reviewed with the intention of increasing the services and employees engaged in the automotive and other sectors. The IF has high brand awareness and a good reputation that deserves to be extended and enlarged.

Given the preceding analysis, an obvious extension of the IF activities include an enlarged role in supply chain management programmes and activities involving larger as well as SME automotive businesses. Additional activities would also include programmes for the development of 'best practice' in design and programme management to close the gap in the capabilities of British firms. Increasing levels of design devolution from the assemblers to the supply chain mean that, the ability to design new products is of growing importance. Increasing the dependency between assemblers and 'design capable' suppliers would therefore generate a reluctance to 'switch sources' of supply as a result of these 'added UK capabilities' which do not yet exist in the form of a critical mass.

³⁰ Cardiff Business School is one of the few universities to offer a Masters Degree qualification in the subject area.

The Automotive College

The automotive college was created as a result of the earlier Andersen Report on the development of the automotive industry. The college is a virtual network of colleges and universities with an interest in the automotive sector and has reported some good results from companies with which it has worked. There are two issues that affect the college:

1. The future role of the college and its relationship with SMMT IF activities.
Relations between the two organisations are good and best practice information is formally exchanged. This mechanism could be improved to allow the universities involved to increase their activities with automotive companies.
2. The extension in terms of the number of universities involved in the network, especially colleges with established records in the automotive sector, should be investigated to increase the profile, regional coverage and resources of the Automotive College. This approach would have a greater probability of success if other universities with a strong reputation for their work in the sector were encouraged by the DTI to join the network and to extend its geographical coverage. An important addition would be to target universities with a technological asset base that could be exploited by SME firms and to engage in design issues with the automotive sector.

These issues should be investigated by the organisations concerned and a business case presented to the DTI covering ways of extending operations and potential funding opportunities. Another worthy extension of this initiative would be to use the forum as a means of co-ordinating an extended network of Teaching Company Scheme students.

The Teaching Company Scheme

The TCS system is an under-utilised programme, with many universities deciding that the 'return on investment' of the scheme is low. TCS students gain from supervisory support from the host university and provide a source of trained workers able to move between industries at the end of the scheme. Other sections of this report have acknowledged the role of this programme and the benefits for individuals, their sponsor companies and the universities involved. As recent changes have shifted the focus of the scheme to management and engineering issues, this system, operated by local universities should be encouraged. The recommendation is that the TCS council that governs the programme should identify key universities which could support the development and dissemination of the programme's benefits. This scheme is very attractive at the SME level and a possible extension of the programme might include a TCS student working for a number of industrial sponsors in a geographic region to the commercial benefit of each company.

Accelerate Programmes

The UK has benefited from recent 'Accelerate' improvement programmes operated in its regions (namely the Midlands and Wales). This programme is inextricably linked

to the institutions mentioned above and unites improvement activities through the administration of such programmes by RDAs.

The Accelerate programmes have been proven to generate business results in the regions and offer an ideal platform upon which to disseminate 'best practice'. The ability to extend these operations depends securing funding for different sectors and regions. Our recommendation is that the DTI should broker an arrangement with the RDAs whereby a central fund is available to support Supply Chain Groups across regional boundaries. The other activity required is that the DTI work with regional partners on the formal review and evaluation of these schemes to ensue that they are continuously improved. In effect, the DTI should lead with other interested parties the national quality assurance routines that surround these schemes³¹.

Other Regional Activities

There are many regional centres that promote lean production techniques, most notably that operated at Trafford Park (Manchester). These activities offer many benefits to the local community and businesses prepared to send employees to these inexpensive public courses. Many of the seminars that are offered by these firms include leading professional managers, academics and consultants in the delivery processes. These activities should be extended on a regional scale in terms of establishing a network of 'centres of excellence'. The general infrastructure required to close this gap and shortfall in skills/improvement programmes would include:

1. An expansion of Industry Forum activities to include those identified earlier in this report.
2. To develop a central body concerned with the development of training materials for industry which are delivered locally in the regions.
3. The development of a centre for supply chain management 'best practice' and support to industry.
4. A product development and programme management support system.
5. A senior-management level 'finishing school' for future generations of business leaders (a central Automotive Academy concept). The academy would therefore support the technology centres proposed in other AIGT reports (Low Carbon and Telematics centres) and would complete the system in providing better management, better supply chain control and the development of a 'design led' capability for the automotive sector to exploit commercially.
6. Greater levels of integration with the RDA activities and support/quality assurance processes to ensure all RDAs access the latest thinking and intelligence.

³¹ These interested parties should include the SMMT IF, the automotive college, other universities and RDAs.

Life Long Learning

Finally, with regard to the policy of life-long learning, the lean dissemination system lacks one important ingredient, that of formal qualifications. As such, a working group should be established to discuss how the training, offered by these institutions³², could be used to gain credits with professional bodies. For the level of training conducted it is expected that the Institute of Supervision and Management (ISM) could be used to ensure that training is converted into factory projects and that these go, in some way, to the personal qualifications of the individual. This latter activity is best facilitated by the DTI offices located in the regions, LSCs and RDAs.

Summary

The extent of lean dissemination in the UK is low, with the notable exception of the SMMT IF contribution, and lacks a critical mass of support to the needs of the industry. The larger scale lean implementation programmes lie in the hands of private consulting firms whose professional fees are prohibitive for smaller businesses. Extensions and synergies with the providers listed in this section would be of benefit to the industry and would appeal to the vehicle assemblers preference for 'high quality and local' assistance. Given the geographic density of the automotive supply chain there exist many opportunities to enhance the services to the automotive and other industries.

The future activities of the institutions must be biased towards action at the operational level of the business and also serve to promote the wider management agenda and to 'raise awareness' of business issues. The implementation of lean manufacturing and more importantly a lean supply chain (which favours local Just In Time supply and an integrated network) is high on the 'shopping list' of most Regional Development Agencies, Trade Associations and other bodies. It is clear from the preceding sections, the integration and development of the supply chain is critical if business is to be secured in the UK and the necessary step change in performance is to be achieved.

Despite the need for sustained action and improvement, recent studies have shown that the lean approach has a short 'pay back' time between implementation and commercial results. According to Dr. Andrew Cave (Smallpiece Enterprises) Five UK companies³³ involved in a 16 day lean training programme have announced savings and improvements showing "threads of success"³⁴ (The Manufacturer August 2001) reconfirming the process improvement approach and results similar to that of the SMMT IF. In the UK, sources of 'lean knowledge' are generally expensive and to make the most of the future development of this 'support system', HM Government

³² These institutions would include the Industry Forum and the Automotive College as well as other 'technology transfer' facilities such as the Trafford Park Centre in Manchester.

³³ The five named UK companies include Aga Foodservice Group, Dunlop, Golden West Foods, Chapmans Agricultural and Pall Infracombe.

³⁴ The 'threads of success' quotation was used to present findings that the businesses had made significant improvements and that the firms involved were developing the business support systems needed to sustain and grow these benefits.

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should explore alternative options. These include the establishment of the Automotive Academy to develop the future generations of senior managers in the automotive industry, the development of supply chain and programme management capabilities and finally the establishment of the regional technology/management centres in the regions. To make the most of the approach for the UK economy though, where demand for lean assistance vastly outweighs the supply of 'quality' solutions and where current supply is too expensive for the SME group (unless subsidised) an extension of the current system is required. These infrastructure investments are essential to promote the process improvements and supply chain management techniques so desperately needed by the middle and lower tiers in the automotive and general manufacturing supply chains. This latter comment cannot be overstated because it concerns the professionalism of UK management and those individuals, upon whose decisions, the future of the industry will rest. A central Automotive Academy, similar to those operated in other countries would serve this interest well.

Issue 9: The Synchronised and 'E'nabled Supply Chain

A popular position promoted by the British media is that the Internet will revolutionize the current manufacturing business model. This issue is closely linked with the subject of lean supply chain practice and the logistics of supply components and systems for vehicle assembly. The high levels of expectation concerning the internet revolution have not gone far beyond the citing of individual case studies and the term revolution, in business models in the automotive industry, may be overstated. It is true that the Internet opens many opportunities and for the automotive industry it has specific implications. Recently, the mass production vehicle assemblers have engaged in open auctioning of contracts using the Internet and have extended their purchasing reach to any firm in any location. The treatment of the supply base as an open auction is not new but it does contravene the 'close working relationships' between customers and suppliers that underpins the lean supply and Japanese transplant approaches to supplier integration/collaboration. Two recent studies have been conducted of this subject within the automotive sector. The first involved Deloitte and Touche in collaboration with Cardiff Business School (2000). The second study was conducted in April-June (2001) by the DTI and ANISA Consulting. A summary of the surveys will now be presented.

The D&T Cardiff Business School 'Manufacturing with a small e' Report

The research for this report was conducted in the final quarter of year 2000 and included 300 interviews with senior managers from British and American manufacturing businesses with in-depth interviews involving leading management experts in the UK³⁵. The study looked at a cross-section of industrial segments including the automotive, engineering, chemicals and household goods sectors. The findings suggest that currently, less than 10% of the supply side and less than 10% of the sales side of the survey was conducted using e-trading. The firms involved also predicted that the volume of e-business bought and sold would rise dramatically from year 2001 and, extrapolating from the data, 38% of the sample would be conducting small amounts of buying and selling materials in this way. The importance of an e-enabled supply chain was therefore reinforced by the anticipated growth by the UK firms involved.

The survey also found that over 63% of the British firms sampled believed that e-business would result in either a radical transformation of the supply chain or deliver benefits to both trading partners. A further 21% believed that these electronic systems would benefit the 'powerful' trading partner (typically the customer) and only 16% of British firms believed it would have little impact on their business. Within the firm, 81% of British and 70% of American manufacturers sampled perceived e-business as having an impact on its key business processes or providing a new business model that would transform the firm on a company-wide scale.

³⁵ The experts included Professor Garel Rhys CBE (Professor of Automotive Economics, Cardiff Business School), Professor John Kay (Professor of Economics, London School of Economics), Professor Patrick Barwise (London Business School) and Professor Jim Norton (Institute of Directors).

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The transforming power of e-business is also reflected in the development of a formal e-business strategy to support the corporate objectives of the firm. 28% of UK manufacturers had already launched implementation programmes that were endorsed by senior management and a further 48% had engaged in a process of middle management investigation prior to determining the firm's position.

The survey found that technological barriers would not inhibit the implementation of e-business solutions with the supply chain but concerns were expressed in terms of the costs of investment, the general business culture and people skills.

In general, the firms involved found the measurement and financial justification of e-business systems difficult and that no true 'costing' approach was being used. Instead the firms were relying on a 'leap of faith' and the belief that e-trading was a mandatory requirement for the industries concerned.

Most British manufacturers were at the beginning of the e-Business implementation process and the senior managers of these manufacturing businesses have only just awoken to the changes and trends in the market. Often the CEO is in a process of denial, rejecting the hype that surrounds the industry, and attempting to 'make sense' of what is going on around the business. (From the interviews, these businesses have an introverted view and also operate manufacturing systems and supply chains that are not well controlled and cause operational problems in meeting the levels of customer service demanded by existing clients). For these businesses, the immediate requirements are to stabilise and control the flow of materials before implementing e-Business solutions to attract more customers and secure the future of the business. The attitude to e-Business, with low levels of senior management support is therefore 'minimalist' and would involve the ineffective use of a web-site as an electronic billboard for potential customers.

However, the survey also identified a number of British companies with e-business systems operating at the 'cutting edge' of the technology and with major plans to extend these systems. These businesses, few in number, offered customers catalogue links to products, diagrams and after-market replacement parts together with access to technical maintenance manuals. The systems also monitored performance and issues in the trading relationship (demand amplification and noise in sales). For the internal manufacturing process, the E-Systems were employed to allow the integration of production planning, treasury functions (low cash balances), purchasing of non-strategic supplies, direct customer interface with inventory holdings and the elimination of minimum order rules. At the supply side, the E-Systems were extended to include level demand information, transparency of production programmes and stock holdings. The systems were integrated with communal logistics providers, invoicing routines, and replenishment orders.

The E-Systems were also used to develop in-house capabilities and new customer offerings including connecting global design systems for Simultaneous Engineering and on-line design. The systems were also designed for on-line employee learning and work scheduling (including the rapid formation of project and creativity teams). Overall though, the UK automotive industry was at the beginning of the e-business

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journey and awaiting a direct lead by the vehicle manufacturers in terms of the chosen systems and the information that would be traded with suppliers.

DTI - ANISA Consulting Study Findings

The study, drawing from evidence collected from 150 automotive firms (average turnover GB£5-10 Million), found:

59% of firms have no 'e-business' strategy a further 4% did not know.
23% of tier 1 companies had a strategy and 14% tier 2 companies.
48% of companies operated Electronic Data Interchange (EDI)
23% Operated fully integrated Enterprise Resource Planning systems (ERP)
29% employed electronic Advanced Planning and Scheduling (APS) systems
42% of companies operated Manufacturing Resource Planning (MRP)

The firms were found to use new information technology in the following ways:

Tactical Usage
87% had a web-site and 37% provided on-line catalogues.
30% offered customers the ability to track orders
27% used such systems to procure materials from suppliers.
Capability Management
31% operated electronic systems to enhance collaborative product development processes and 24% engaged electronic systems for Knowledge Management.

Just like the previous D&T study, the firms had no formal measurement system concerning the benefits associated with such automation. However, the researched firms acknowledged a number of derived benefits.

Benefits of 'E'	
Improvements in information exchange 77%	Winning new orders 30%
Improved Customer Service levels 60%	Reduce purchase costs 24%
Improved efficiency 38%	Reduced inventory 18%

Overall, a staggering 17% of companies had no experience of 'e-business' and the report presents a number of reasons why such a high proportion of supplier companies lack such a key part of modern trading and 'order qualification' offerings. The authors contend that automotive customers are holding the supply chain back in terms of exploiting the new technology by a lack of customer endorsement for certain systems. More generally, manufacturing businesses were concerned about technical training, a lack of expertise, an additional lack of case study information of successful applications and finally the absence of grant funding with which to capitalize these projects.

Summary

E-Business activity is low in the UK and many companies have not yet grasped the significance of the new opportunities available. Neither of the recent surveys found evidence of e-business strategies to support the overall goals of the firm and therefore there remains an opportunity to promote 'e-business' for the automotive and general manufacturing sectors.

Opening up the 'display window' for British firms and British products is an opportunity that would enhance the position of firms in the lower reaches of the automotive supply chain. Such an approach might also foster diversification of products for these businesses, as many are not wholly dependent suppliers to the automotive industry. Current nationwide initiatives in the area of e-business are fragmented and relatively uncoordinated with different regions adopting different promotional programmes. A better approach might well be to target the automotive sector as an exemplar and gain a critical mass of connectivity. At the heart of this initiative would be a broad agreement, involving the automotive assemblers and the government, in order to promote a harmonized and integrated system. This aspect of the research warrants a recommendation to assist British manufacturing firms in identifying the opportunities available as a result of e-business and the search for new customers with which to trade. Such a project should be conducted by the university system and the specialist research centres in this field.

The integrated and national approach which has been achieved in the Japanese Steel industry has brought significant benefits from e-trading. The focus of the "Kozai Club" was to reduce information costs, moving from push type data transfer to pull type systems and to facilitate information sharing on a supply chain scale. The standard has been established in over 100 larger companies and now the promotion of the system is for the small and medium sized supply chain firms. The new systems have been designed to replace the traditional Japanese approach that was, similar to the British context, based on one-to-one relationships between the steel manufacturer, service centre, component maker and the trading company. This traditional Japanese metals system was inefficient and a high cost solution that was prone to errors at each firm and the new system promotes information sharing for mutual gain. The pilot programme was concluded in 1996, it was put 'on the web' and has been continuously enhanced (inter-linked databases). The new system allows a 'Total inventory' approach involving master (parent) coil inventory which can be managed across the supply chain as well as interrogation of the system for specific material. It has resulted in significant benefits to all parties. This form of system and transparent understanding would greatly benefit the British system and help to raise supply chain performance for this sector if UK manufacturing within which, as we have previously identified in this report, there are significant benefits to be exploited for the metals and automotive chains.

Issue 10: Skills and Training in the Automotive Industry³⁶

Long-term productivity remains a core objective of the government (DTI/DfEE White Paper 'Opportunity for all in a world of change' / DTI/HMT 'Enterprise and Productivity Challenge'). Improving workforce skills is a key task as a route to greater productivity and economic growth. The key requirements for the automotive industry are for greater variety of products to be supplied by fewer organisations that interface directly with the assembler, greater use of new technology, and new skill sets for employees to manage these emerging automotive systems (design, supply chain, continuous improvement etc.). The issue of skills and training within the automotive industry is a long-standing debate and this subject was addressed as part of this study. Various features of the UK system of skills provision were tested to find opportunities for meaningful progression in terms of employee skills led productivity improvement.

Human Resources Policy and Local Management

The survey has found that British assemblers and manufacturers retain responsibility over the key human resources policies that they operate and that these are established and implemented locally at the site concerned. This finding confirms an earlier study conducted by North East Economic Research Unit (NERU) that focused on employment issues in automotive industry, in the North and Midlands. The AIGT survey also found that the personnel HR departments also operated the formal systems and policies concerning the development of employees.

Human Resources: Formalisation of Plans

The study tested the formalisation of planning and support structures at the assembler, engine manufacturing and supply chain levels and found high levels of evidence that assembler systems are formalized, structured, documented and resourced with specialists.

³⁶ The author of this report would like to acknowledge the long standing and active involvement of Mr Francis Evans (DTI) in the education and skills debates in the UK.

Employee Statistics: Assembler Level

- All companies operated formal HR strategies, policies and have dedicated training teams. The policies cover skill needs, training programme development, delivery and post-training evaluation at all employee grade levels.
- All companies operate with employees who are qualified training auditors and assessors.
- The average employee job tenure is well in excess of a decade with the firm and the average age of employees is in the 40-year-old bracket.
- Attrition rates vary between 3 and 5%

Employee Statistics: Supply Chain

- A dedicated training and development team was uncommon at the supply chain level and instead businesses were reliant upon external providers.
- Average employee age was 37 years with a average job tenure of 5 years.
- Absenteeism varied enormously throughout the industry with an average of 5% and extremes in excess of 20%.

Accessibility to New Recruits

A common perception in manufacturing industry is that there exists a vacuum in certain management and specialist skill sets. This was tested and the findings of this survey indicate that the problem is not one of quantity but of quality of applications to meet the job criteria of the organisation concerned.

Applications per Job Grade: Assembler Level		Applications per Job: Supply Chain Level	
Front line management position	20:1	Front line management position	10:1
Qualified Engineers	15:1	Qualified Engineers	10:1
Newly Graduated Engineers	20:1	Newly Graduated Engineers	40:1
Maintenance Technicians	15:1	Maintenance Technicians	25:1

It is noted that these application figures vary widely between individual companies with some businesses facing almost a 1:1 rate of applications for engineering and maintenance jobs. To test further the perceived issues concerning skill shortages in the UK the generic and specific company shortages were reviewed. All assemblers did acknowledge skills gaps and problems with recruitment of quality workers and these were deemed to result from a national problem with quality of these staff grades.

Skills Shortages by Grade of Employee (Assembler Level)

The shortage of Engineering Staff involved in product engineering, manufacturing, computer-based engineering and specialist automotive engineering applications is a significant problem. The countermeasures employed by the vehicle assemblers to reduce these skill shortages have included a mix of training, enhanced personal development packages, a tightening of recruitment processes and selective links with universities and FE colleges.

A Front Line Managers and Team Leader skill shortage was also acknowledged to include the quality of production-oriented team leaders. These individuals fall outside of modern apprenticeships and other forms of nationwide support. The countermeasures employed by the businesses included additional training and 'on the job' development activity. However, in the majority of cases, this development activity was fragmented, piecemeal and operated at the level of the individual rather than general re-training and development.

Operational Staff skills shortages included all forms of maintenance technician (especially electrical and automation skills). Countermeasures include links and promotional activities with local schools, apprenticeships and increased training.

For the supply chain, a different picture emerges and a shortage in purchasing professionals is acknowledged as a major concern as well as a national shortage in multi-skilled technicians (a lack of electrical skills was a common concern). The problem with the supply of engineers is also confirmed to include management levels, quality engineers and manufacturing engineers. These shortages were thought to reflect both national and regional skill shortages.

Differentiating between generic and specific skills gaps, for the entire supply chain, the results of the survey are consistent and include generic issues concerning problem solving, IT usage, and basic numeracy/literacy of operators. Specific issues concern electrical and electronics skills sets, manufacturing engineering and control engineering. The difficulty associated with these specific skills includes the length of training time required for specialist assembler assets and also relevant experience/training by educational providers.

Human Resources: The Quality of Training Provision

The vehicle assemblers and supply chain firms tend to formally appraise the quality of service and value of the training programmes and providers that they retain. On the whole, the assemblers opt for local support³⁷ and would welcome improvements in the quality of local provision in their regions. In general terms the assembler organisations regarded local providers as good in terms of variety but were highly

³⁷ The local network of organisations supplying support to the vehicle assemblers and local automotive supply chains represents an efficient means of delivering training. This would imply that an improvement to the national support for the automotive industry needs to have a dimension of local 'delivery' by providers of 'high quality' training programmes.

critical of the quality of the deliverers themselves and their knowledge of the automotive sector. These criticisms would suggest that there is some scope to change and improve the quality of training at the local level. The approach most likely to succeed would be for a national centre or responsible body to develop basic training materials and disseminate them to local organisations and maintain these materials (including incorporating latest management though and 'best practice')³⁸.

Local & National Universities

Local universities were used by all assemblers and at all levels of the organisation including the shop floor, administrative and specialist staff, and senior management. The general criticisms of the local academic providers involved the responsiveness of the system and the variability in the quality of the staff. Universities elsewhere in the UK and in Europe were rarely used and this would reinforce the assemblers preference for local delivery of training at all levels in the firm.

Colleges of Higher Education

HE colleges were used some of the time and were employed to provide technical and professional training. These institutions suffered from variability in teaching standards and rated 'average' in terms of the overall quality of service provided.

Local and Technical Colleges

The local and technical colleges provide shop floor, clerical and junior management training and again meet only the 'average' quality rating by the assemblers.

Local Independent Consultants

Local consultancy companies were rated as good and responsive providers of educational services to a mainly management audience. These businesses provided specialist-training services often in well-defined areas of skills shortage.

Professional Bodies

Professional bodies ranked 'very good' by those assemblers who engaged their services for engineering grades of employee but the services procured were restricted to specialist areas (mainly in the areas of engineering, robots, logistics and purchasing).

³⁸ It should be noted that the DTI M90s programme did provide some of this material for industry and certainly provided access to documents that increased management awareness of key processes (quality, just in time, purchasing etc.) but this series has been stopped. It would be timely to review this decision and to evaluate the merits of reinstating these booklets CF P81

The use of different training formats by the supply chain varies greatly as a function of company size. In most cases, senior and middle management training was conducted at local universities with a distinct bias towards MBA qualifications. These institutions were rated good but suffered criticisms in terms of the theoretical rather than applied content of the courses. Professional managers and some senior managers were trained at national universities with a quality of service rated as 'Good'. No company sent personnel to European universities for training. The greater use of training providers was recorded at the HE (HNDs), technical college (B\TEC), and professional Body levels. Again these institutions were all rated between 'Good' and 'Very Good'. Local consultants were also retained but the quality of service provided was variable. The SMMT Industry Forum, was rated uniformly highly by employing companies.

In summary, the skills provision is considered to be good in terms of the improvement of employees' skills as far as it went. Courses covered functional and job skills which will serve to improve industry only so far and misses the vital cross-functional management processes needed to exploit 'best practice' design, supply chain management, operations and engineering within the firm. As such, the national education system would be improved by the provision of high quality and local supplementary training in lean management techniques. A common criticism of the companies surveyed included the provision of leadership and management skills as an integral part of the formal training received and that the current training and education system lacks an attention on the life skills of management and individual self-development.

The UK System of Skills Provision: Advantages and Disadvantages

In general terms the vehicle assemblers rated the strengths of the total UK system of skills provision as the established and broad nature of what is available and that the institutions concerned were well meaning and interested in supporting the assembler. However, the perceived disadvantages of the current system include a general lack of focus in product specification, the self justifying nature of standard training packages, a lack of 'cutting edge' products, excessive bureaucracy and a generally low calibre of staff that deliver the training³⁹. These criticisms represent some cause for concern in terms of the national skills system and would suggest that these providers are not disseminating best practice to the industry and go no further than the delivery of standard training packages.

For supply chain companies, the strengths of the system were considered to be in the expertise of providers. The NVQ system was regarded as having gained credibility as a result of quality improvements. The weaknesses of the system concerned issues of publicity and promotion of courses and too much time involved with the bureaucracy of courses. In addition, companies perceived that there was an insufficient range of courses that assisted the development of technician skills.

³⁹ The specific criticism here is the deliverers lack automotive experience and an understanding of the pressures and practices of the industry. Instead, deliverers take a text-book approach to best practice without explaining how or why such systems are operated.

Britain Vs. Other Countries

When asked to compare the UK system with other countries, the vehicle assemblers highlighted the German system as the benchmark and, in particular, the much stronger emphasis on vocational training and that German students in particular qualify to higher technical standards with rounded knowledge bases and often in a particular specialism. The responses of the study concerning the skills and training provided to senior management of British firms found a significant agreement that the industry lacks a 'Centre of Excellence' in the training of 'senior managers' for industry and the automotive sector in particular. A number of key industry 'thought leaders' have proposed that there is an opportunity to increase the interaction, training and access to basic R&D information concerning the automotive industries and have promoted the establishment of a senior management automotive college similar to the German system of senior management education. The system in Germany (Aachen and Fraunhofer Institutes) produces and has produced, almost every senior manager in Germany and fulfils the role of uniting the strategic direction of the German automotive sector and focusing of efforts across all the major stakeholders in the sector.

Improvements to the UK System

There were many improvements that the assemblers would recommend to improve the service they receive. In general, the businesses preferred a more in-depth approach to vocational training and training to promote the attractiveness of manufacturing. At the practical level, many complained about the constraints and bureaucracy of the interactions with LSCs and government departments (DTI and DFES) in particular the time delays and amount of paperwork that must be completed for simple training requirements. The improvements suggested by all supply chain companies included the promotion of courses and *"the marketing of non-degree careers and associated vocational training"*. These issues, once again, confirm the need for the development of a central Automotive Academy that is supported by regional centres of technology and management excellence that has been identified in earlier sections of this report.

Flexibility and Mobility of Human Resources

In parallel to the issue of attracting quality labour and training employees, the AIGT survey assessed the firm's ability to retain trained workers. Generally, most assemblers reported problems with retention and highlighted the engineering, maintenance and supply chain management grades of employees as those most difficult to retain. The countermeasures to stop this problem included changes to remuneration packages, greater training and project work to improve the individual and provide intellectual challenges.

All supply chain companies reported significant difficulties in retaining key skills especially concerning qualified engineering and management personnel. The countermeasures have included additional features to basic remuneration packages. Graduate retention was a particular issue of concern to the businesses.

Overall the issues facing automotive firms concern the retention of personnel charged with the development of core business systems and engineering/purchasing capabilities which confirms significant shortfalls in the automotive supply chain. We recommend that a meeting of industry stakeholders, by region, should be held to air such issues and to establish working groups to address these issues. It is considered important that the vehicle assemblers are present at these meetings and representatives of the RDAs and the DTI should provide facilitation for these discussions.

Newly Recruited Workers

The major issues faced by all assemblers were the adjustment of the worker to the unique requirements of vehicle manufacturing, adjusting to the discipline of the workplace and also in transferring theory into practice (for specialist grades). For newly recruited graduate engineers, the assemblers contended that the UK standards varied sharply between excellent universities from which they would recruit and the remainder of the university Engineering Schools. Generally, the concern was that, even the good universities do not equip their students with appropriate project management and interpersonal skills. The supply chain firms echoed these issues and that it should form part of the regional dialogue agenda and should be a 'design criterion' for the proposed new system of centres of excellence and the national 'Automotive Academy'.

Labour Market Laws and Britain

A review of British labour laws was not a primary concern of this study, however, the questionnaires and interviews did address this issue following several anecdotal accounts, by senior manufacturing managers of multi-divisional companies that the flexibility of UK labour laws allows for an easier process of factory closure. The vehicle assemblers forcibly reject this contention and defend the moral and legal basis of their processes of consultation. Each business also argued that it had a right to adjust the workforce in line with business conditions and to use existing policies and procedures, that were considered fair, for such adjustments to meet economic demands and production/cost pressures.

The AIGT Findings: Regional Dialogue Seminars

The network meeting process yielded many points from the automotive suppliers in the audiences⁴⁰. These issues included a vibrant debate covering the skills level in the sector and two main areas of shortage were identified that confirm the issues that were noted in previous sections:

- 1) Engineering, and,
- 2) General management

The meetings also discussed the issue of comparatively low salaries in this sector but this was not seen to be exclusively the reason for skill shortages. It was believed that there is insufficient effort directed towards promoting engineering within the compulsory education system. The contention was that an industry/government

⁴⁰ Approximately 200 business leaders were involved in the 'round table' AIGT discussion panels.

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partnership should be established to attract school leavers into engineering apprenticeships and to attract women to engineering. Schools targets should be broadened not just to encourage them to push school leavers through the higher education system, but also to incentivise engineering apprenticeships. The latter would support the EEF report (2001) which suggests that National Insurance rebates should be used to provide incentives for manufacturers who suffer as a result of off-site training for engineers. We would support this recommendation and would propose the relevant government departments should conduct an investigation of this area.

In parallel, the seminars also identified the declining interest in maths, physics and engineering amongst children as a factor reducing the number of potential recruits to the workforce and more importantly the children who could potentially become engineering graduates. This is an important feature and a skills vacuum that, if addressed now, provides results only in five years time as new engineering graduates enter employment. It was also considered that the value system in the UK makes it hard to persuade students to take up subjects like engineering due to the comparatively poor image of the career path which itself is not a true reflection of engineering within the automotive sector. The government promotion of manufacturing is not as proactive as it should be which leaves room for criticisms that the government is not concerned about the manufacturing economy.

Many attendees argued that a lot of the UK's training infrastructure was lost in the early 1980s and has not been replaced nor upgraded. The attendees also said that the larger British firms are no longer training more staff than they need thus providing potential recruits for their suppliers and instead have begun to pay relatively high wages to poach staff from their suppliers.

Attendees also identified regional and local issues that affect the availability of engineering resources and recommended that firms should an effort in things such as providing work experience and allowing staff time to serve as communal 'Neighbourhood Engineers' if they are to counteract negative images of engineering. This approach is similar to an 'out reach' programme and would benefit the SME sector as well as serving to integrate automotive manufacturers with the schools and colleges as part of the overall supply chain. This issue includes the provision of finances to pay for equipment such as CAD-CAM systems that might attract pupils and the lower the poor image of the industry as not at the cutting edge.

Generally, the attendees considered the standard of training to be weaker in the UK than our European counterparts especially Germany where engineers train for longer and develop broader business awareness before entering their careers. In the UK, the senior manufacturing representatives considered the skills base of lower supply chain tiers to be 'amateurish' and this poses a problem in the UK automotive context where the future of the industry depends largely upon professionalism and the integration of management in the design of efficient and cost-effective processes (from design to lean manufacturing and from the facility to its dependent supply chain). Particular skill problem areas included "lean skills" (where the talent pool is larger but still lacking in depth of understanding) at the management level and a lack of technician and diagnostic skills within most workplaces.

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It was noted that any increase in the number of people going to university reduces the number of potential technicians available in the short term. The approach to the demand and supply of qualified personnel was considered to require careful planning at the national level to avoid starving the industry of graduates yet also promoting graduate engineering as a rewarding career. Overall the regional seminars confirmed that management and engineering skills require significant attention and a coalition response by key industry stakeholders. Without good factory managers then little 'systems change' within and between companies in the supply chain will take place. Also with low levels of innovation and training investment in management the result is that good managers are lost to other sectors or to other countries. Losses at the management and engineering levels of the business were considered the most severe and damaging, of all threats over which the industry had direct influence, to the long term competitive position of the UK.

Issue 11: The Engineer - Image & The Skills Debate

Many of the points raised during the research programme concern the image of engineering and the process of developing good engineers..These findings confirm much earlier research in this area conducted with general manufacturing businesses. The skills debate pervades industry with, the competitiveness of UK manufacturers high on the agenda at management and trade union conferences (e.g. the recent AEEU (now Amicus) conference was dominated by references and direct exploration of this issue). This issue will now be explored and it will be argued that the automotive industry is barometer of the general concern for the diagnostic capabilities of the British knowledge base. To take one example of many Bentley Motor cars have acknowledged that they face difficulties in recruiting graduate engineers due to a shortage of UK talent at a recent recruitment show in Birmingham (2001). They proposed *“At an operational level we compete for the same people – virtually all vehicle manufacturers are chasing a disproportionate number of engineers”*

This argument is further reinforced by the professional recruitment consultancy sector who have also complained that “There is a massive lack of qualified engineers with the right experience ... The engineering industry is just not sexy enough to attract the number of graduates it needs” Simon Young (Michael Page Recruitment).

The AIGT survey provides a strong base of evidence to suggest that the quantity of engineers with appropriate skills falls short of automotive and general industry needs. Given the high levels of applicants per available position at automotive assemblers and supply companies it would appear that there is a main problem in terms of engineers with suitable experience and skills.

The recent EMTA Mori poll highlights that, at the beginning of the process of graduate engineering as a career, there are difficulties. Whilst comparative data is not easy to assimilate, it is suspected that this is not a uniquely British phenomenon but anecdotal evidence, from the research suggests that other European countries do not suffer shortage to the same extent.

The EMTA MORI (2001) poll on School Leaver attitudes and skills:

- 7 out of 10 secondary school age students say they know not very much or nothing about engineering as a career route.
- 13% of boys put engineering in their top quartile of attractive careers.
- 8 out of 10 girls said they knew little about engineering. Only 4% of girls surveyed said that they would consider a career in engineering.

What Will Attract Youth to Engineering?

- Top three drivers for school age students:
1. Good pay
 2. Interesting work
 3. Responsibility

According to the recent opinion polls, the motivational factors that attract school leavers into certain professions and career routes concern basic issues of working lifestyle and progression. This issue is one of national importance and requires co-ordination at the UK level, involving professional bodies and trade associations. These dialogues should focus on how to resolve the gap and the duration of the engineering skills vacuum (which is predicted to last, at minimum, for 7-8 years as school students change their subject selection patterns). Engineering degree courses require science GCSEs to be taken and these choices, in the UK education system, are taken at a very early stage. GNVQs and modern apprenticeships are not taken in sufficient numbers to redress the vacuum⁴¹. A depressing scenario is faced if simple laws of probability are applied at each stage of the British education process then the UK will produce, at the end of the university pipeline, fewer and fewer qualified graduates of suitable calibre for the automotive industry. These issues are important if the UK automotive industry is to have access to suitably qualified individuals for available positions. It is the case that the high levels of applicants per available position contains a high level of speculative applications whereby the individual is not suitable for the job specification offered.

UK Training Routes for Industry

Starting Qualifications	Learning	Training	NVQ	Status
A Levels, A/S Levels & Vocational A Levels (critical decision age 16 - with qualification age 18 years)	Degree	Professional Development	4/5	Chartered Engineer
	Higher National Certificate or Diploma		4/5	Incorporated Engineer
Intermediate GNVQ, 4 GCSEs Graded A-C (critical decision age 14 - with qualification age 16 years)	National Certificate	Advanced Modern Apprenticeship	3/4	Engineering Technician
	Vocational A Levels		3	Craftsperson
BTEC First Foundation, GNVQ, GCSEs	City & Guilds Certificate	Foundation Modern Apprenticeship	1/2	Operator

Source: EMTA Engineering Training Routes.

The age banding of the modern apprenticeship programme is also of concern to industry given the upper age ceiling for potential applicants. This survey has found that the average age of employees is, for supply chain companies in the mid thirties

⁴¹ At the time of this report over 36,000 modern apprenticeships were available in the UK with only 24,000 actively in operation.

and this age group is not eligible for such support. From the study it was not possible to assess in detail the relationship between the team leader grade and age. However, the average age and average tenure of the employees at the assemblers and the manufacturers would suggest that this grade of management is not in the age profile covering modern apprenticeships etc. New means of on-line training materials for remote access and self study would therefore seem appropriate given the survey finding that the education system is variable and that employees lack lean and problem-solving skills. These individuals, who control business processes throughout the supply chain, must therefore be the focus of sector and national initiatives to improve the skill base. At the moment, these people 'fall outside' of national skills programmes and have insufficient technical skills to engage in professional development activities as qualified engineers.

Don't De-skill Engineers: Up-skill the Team Leaders

The engineering debate in the UK has focused squarely on the issue of the graduate engineer in a belief that this single point of improvement will influence the future performance of the British automotive and general manufacturing sectors. This hypothesis, whilst correct as far as it goes, is insufficient to truly address the manufacturing and engineering problem. Instead there is evidence to suggest that the routine aspects of the engineering role should be deployed to the front line supervision (team leader) and team levels. This process is integral to the Japanese approach known as Total Productive Maintenance. The TPM approach seeks to deploy routine maintenance and technical problem-solving to line teams and thereby to release the time from engineers to engage in project activities. This approach would seem to offer many advantages to the UK economy, not least in slowing the attrition of the engineering skill set and enhancing the diagnostic capabilities of the team leader (there are many more team leaders in the UK automotive supply chains than engineers). This process would also increase the attractiveness of engineering as a profession.

Little can be done to sway the belief of graduates that the individual will not serve an entire career at one company but instead will engage in a series of contracts (effectively making the engineer a career 'journey person'). The latter would suggest that British automotive manufacturers are not doing enough to change the self-perception of the engineer and that not enough 'attractors' exist to retain the engineer at the place of work. Again this would involve significant national promotion of engineering as an interesting career in association with professional and trade associations. To satisfy the problems associated with under-performance from lower tiers in the automotive supply chain, we would recommend a dialogue between the Chartered Engineering professional bodies and the Chartered Institute of Purchasing and Supply to be facilitated by the industry and DTI. The agenda would be to explore ways of combining careers to allow engineers to work as supplier development specialists (a quasi neighbourhood engineer but for the supply chain to the employing company). The latter should result in new qualifications for engineers and new career routes that do not disrupt the professional allegiance of the engineer but offer benefits to companies that cannot secure high quality and quantity of engineering staff.

The latter solution fits with the prescriptions of Bullen, Taylor and Mughal (1999), who suggest that the automotive industry needs to equip new graduates with the technical skills of engineering whilst also developing the managerial and inter-personal skills sets needed to lead numbers of employees. They state *“The importance of ‘business engineers’ to the future success of the automotive industry is established. These ‘business engineers’ require continuing professional development to enable them to take a systems view of the industry and its processes, whilst developing their technical and managerial capabilities”*.

From “Developing Engineering in the Automotive Industry”⁴²

The issue identified by Bullen et al (1999) is important and suggests that the on-going development and commercial training of the engineer is a process that will provide business benefits. In the context of the automotive sector, the preference is to source from local trainers and this would imply that the current training system, with sufficient endorsement from the relevant institutions⁴³ should investigate the most effective and efficient means of supporting a lifetime of engineering contribution to the firm. This activity would help to reduce the mobility of engineers and would appeal to the continuous post-qualification development of the individual. Again, a key design criteria concerning this issue is the maintenance of a high standard of quality training materials that are delivered locally to the firm.

According to the McKinsey Global Institute Report it is argued that the *“development of employer-led training and design of processes to suit certain levels of skill”* are key to improving national competitiveness. At one extreme position this could imply the establishment of company-based university systems. Few automotive companies have previously engaged in Company University systems, the highest profile of which is the Unipart U which is based upon developments made by Motorola in the US. The model has been transferred to other sectors such as the British Aerospace Virtual University (established May 1997) to train 'systems engineers' in collaboration with Loughborough University. However, this form of education is expensive and beyond the financial resources of most automotive firms. The desirability and extension of such a 'corporate' system is unlikely in an industry that does not make large profits and in a climate whereby other resources are competing for funding.

Finally, there exist many opportunities to change the role of the engineer and to appeal to the true value of engineering, that of engaging in projects that demand diagnostic problem-solving based upon qualified engineering skills. The key to freeing up, engineers time to allow them to engage in these roles is the effective use of the team leader in industry. This important organisational position was identified by a number of benchmarking studies (Andersen 1993, 1994) which addressed the comparative performance of British firms. Team leader development is also a key focus for the SMMT IF. To enhance the role of the engineer there is potential to up-skill team leaders to take on routine engineering activities (such as those required by TPM). These skills would allow team leaders to control, at the front line, the assets that are employed by the firm and also to engage in more appropriate problem-solving

⁴² Paper number C574/019/99 in International Conference on Education in Automotive Engineering (ImechE November 1999)

⁴³ These being the professional bodies, DTI, SMMT IF, Automotive College, RDAs, LSCs, EMTA, EEF and a central 'Academy'.

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activities. This issue is one worthy of future exploration and development. To put it bluntly, this report has identified a problem with training good team leaders from individuals who are already employed by the firm. The report has also found a problem with a skills shortage (quantity) and a skills gap (commercial skills) with engineering grades. As there are more team leaders in industry than engineers, it would seem appropriate to promote and develop the team leader grade and to develop some basic engineering skills at the team leader level. Many British institutions, and especially the Trade Union Amicus have been promoting this agenda for many years and have proven 'exemplar' businesses with whom they have worked. Given the availability of 'Partnership' funding for such management-union collaboration, this would appear to offer many benefits to UK manufacturing and for the automotive industry in particular. The recommendation is that this issue should be explored, at the highest level of government with the leaders of the Trade Union movement, as the process and funding is already in place to move this agenda forward. To date, the UK has been subject to surveys and continual complaints, from industry and education, that engineering skills are insufficient but little has, in reality changed to close these shortages and gaps.

Issue 12: The British University Research System & The Automotive Industry

The research skills of the British University system are held in high regard by the automotive industry and findings from the survey reflect well upon the provision of **research based** initiatives for the automotive sector. To date though, too few automotive firms have fully understood the commercial benefit of working with the university system. In parallel, the university system itself has certain features that are not conducive to industrial collaboration and the way in which universities are measured does not necessarily support such collaborations. The university sector has a vital and important role to play alongside the national government and DTI in assisting industry to develop and grow and to support the challenges presented to the UK automotive businesses.

The DTI Competitiveness White Paper states that *"The most dynamic economies have strong universities ... the UK has a world-class science, engineering and design base which provides a pool of talented people to work in and with business"*.

The report so far has identified that the automotive industry has reservations concerning the uniform quality of **education** provision provided by the University sector. The 'buying criteria' of the automotive industry, expressed earlier in this report, included that educational services should be provided locally and include latest thinking delivered by high calibre individuals. The priorities for research included design engineering processes and 'near market' technology (see 'Issue 3' of this report). The university research sector was considered by the vehicle assemblers to be 'good' but on occasions was described as 'poor' in terms of the ability to commercialise the work. This suggests that the university system has some way to go in improving its services, potentially more to offer the industry and dissemination activities are not sufficiently effective for the industry to understand the availability of high quality research. From our research, it would appear that the issue is one of the communication of research and, for the vehicle assemblers, the issue is one of understanding the process of commissioning such research. It is noted that key assemblers including Nissan UK, Ford and others are active sponsors of UK research. Beyond these assemblers, few first tier companies are engaged in research activities in the UK.

EUCAR Research Priorities

British automotive industry research is inextricably linked to the broad issues related to vehicles and society at the European level. At the centre of 'thought leadership', at the European level, is the European Committee for Automotive R&D) or EUCAR initiative that comprises of the research directors from the major European vehicle assemblers. EUCAR serves as the main intermediary body between the automotive industry and the Research Directorate of the European Commission. The body is powerful and linked to other trade groups (such as the Association of European Car Constructors) and the organisation is currently focused upon traffic management including environmental emissions controls.

EUCAR Research Priorities

1. Vehicle electronics
2. Mobility and multi-mobility options
3. The future of the internal combustion engine
4. Active and Passive Safety management
5. Telematics
6. Low Weight Ratio Vehicles and construction materials
7. Alternative Drive Sources
8. Driver Vehicle interfacing
9. Hydrogen as a fuel
10. Product and manufacturing process design

The Foresight Vehicle Initiative

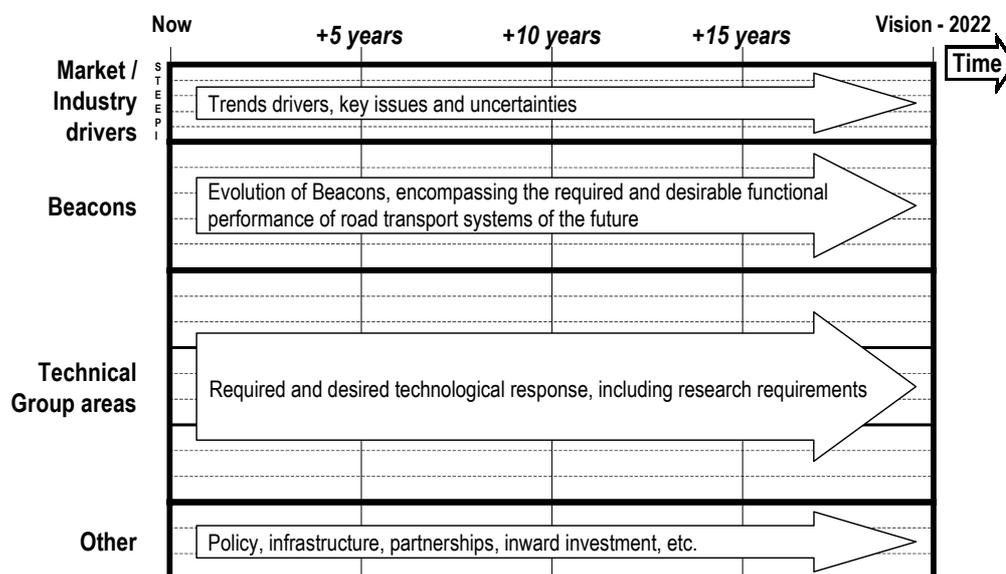
Foresight Vehicle is the UK's national automotive R&D programme, aiming to promote technology and to stimulate suppliers to develop and demonstrate market-driven enabling technologies for future motor vehicles which must satisfy stringent environmental requirements as well as meeting expectations for safety, cost, performance and desirability. To date the Foresight Vehicle research portfolio is worth over £80 million and involves over 400 organisations (industry and academia). Government has committed a further £17million to the programme over the next 3 years.

The FV technology 'road mapping' exercise is an important activity for the UK and involves all major stakeholders in the process of planning the medium and long term timing plan for the UK position within the global industry. The FV mapping process is however long and, occasionally, in its current state the road maps are questioned (though doubts usually concern timing rather than content of innovations). Technology road mapping is a technique that is used widely in industry to support strategic planning. Roadmaps generally take the form of multi-layered time-based charts, linking technology developments to future product and market requirements. Companies such as Motorola, Philips and ABB pioneered the approach and have used it for many years and with commercial success. More recently roadmaps have been used for supporting industry foresight initiatives, such as the Semiconductor Industry Association and Aluminium Industry technology roadmaps. Foresight Vehicle is using the road mapping technique to identify future priorities for the UK Foresight Vehicle Programme, supported by the University of Cambridge Institute for Manufacturing.

Overall, the UK University sector carries out engineering-related research of high significance to the automotive industry sponsored through the Foresight Vehicle initiative and also by private agreements between automotive manufacturers and their selected university partners. The question is therefore, if the research is aligned with the interests of the European agenda is there a problem with the commercialisation and dissemination of such publicly-funded works? The latter would include the quality of the work and also the incentives of the University sector to commercialise its activities. For the latter issue there exists some available literature and positions volunteered by the University sector. The first issue concerns the commercialisation and Intellectual Property Rights (IPR) of research and the second concerns the

measurement/incentivisation of the University system (effectively the Research Assessment Exercise).

The Automotive Industry (STEEPI) Road Mapping



The opportunities offered by the university sector involve offering services and sponsored (funding council supported) research involving the automotive supply chain. Of the firms interviewed only a handful of companies in the supply chain had an experience of working with the HE and FE sectors on research issues. These companies (6 in total) had worked on supply chain research initiatives as part of previous EPSRC initiatives.

It would appear that this aspect of the wider automotive supply chain could offer tremendous benefits to the UK automotive supply chain and the calibre of researchers at the Universities could well help to address the engineering shortages at the automotive manufacturing businesses. From the previous issues explored, the programmes that should be funded by the EPSRC Foresight Vehicle and other programmes would include the following extensions to the current valuable portfolio:

1. The development of a collective network of automotive suppliers to work on supply chain management techniques and to develop good practices through case materials. This would compliment the work of Prof. Kehoe (Liverpool), Prof. Evans (Cranfield) and Prof. Hines (Cardiff) to name just a few of the major figures in this area. If a situation could be established within which different regional networks of automotive manufacturers were combined to share experiences then this would be a powerful and rewarding programme of work.
2. The second area of attack would include and extension of the current design-related initiatives to include 'best practice' for near market technologies and would exploit the physical assets owned by the university system.
3. The management of SME organisations for sustainable improvement as a result of supplier development activity. This programme would provide direct advice to this

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important sector and how it can incrementally master the quality, delivery, cost, design and supply chain capabilities needed to survive and grow in the automotive industry.

4. With the run down of the M90s programme and range of high quality booklets, it is important that this gap is filled with practical work books that allow managers to profile their operations, identify weaknesses and understand the methodologies of 'best practice'. This material is all known to the University system and the researchers could establish a web-based or published material library for sale/free issue to the industry. It would be important to provide case material for companies to understand what happened during the process of research. It should be noted that this recommendation is one that is difficult to manage because University researchers are governed and motivated by academic paper writing (RAE process⁴⁴) and such publications (whilst of phenomenal value) are not held in high regard as academic outputs. So either the University materials are written up professionally by commissioned organisations or the RAE assessment is amended to include due regard for such dissemination. To avoid additional costs, the DDM research would recommend the latter course of action.

The four areas identified in this section have broader implications in terms of 'ownership' and 'use' of the research outcomes. It is clear that works concerning the supply chain would be of benefit to the SMMT IF and the colleges involved with the Automotive College. The system therefore exists to develop, from grounded research, the case and teaching materials for the automotive industry and also the methodologies that would be beneficial for engineers in industry. The importance, for the DDM research presented here, is how to integrate these works with the proposed changes to the industry infrastructure (regional Centres of Excellence and the Automotive Academy concept). This process would require national co-ordination and as the DTI is the major sponsor (and providing research funds) to the research councils then it would be sensible for the DTI and research councils to investigate this issue. The key to resolving and exploiting this new opportunity is how to match the legitimate career needs of academics with the commercial exploitation of research works conducted as a result of the funding councils. Failure to reward the academics, in terms of papers or changes to the RAE system will not motivate the dissemination of works beyond the initial industrial collaborators. In parallel, failing to 'write up' and disseminate the findings of the research in non-specialist publications will not promote the adoption of these innovations by the SMEs in industry.

⁴⁴ RAE is the abbreviation of the Research Assessment Exercise that provides the university research quality league ranking. It is one of the most important indicators of 'Value For Money' and the activity of the research sector.

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Key British University Research Initiatives: Foresight Vehicle

- 3 Day Car - order fulfilment (Cardiff University, Bath University and ICDP)
- SCIFI - Virtual reality imaging of vehicles (Glasgow School of Art)
- CDF - Government policies and fair dealing over the next 10 years.
- CUPID - Vehicle design for customer satisfaction (Cranfield University)
- PICSOM - Engineering parameters and modelling (Leeds University)
- KMforPBL - knowledge management and project management (Warwick Business School)
- COGENT - Supplier Development (University of Cranfield)
- CCLPM - Design Verification (University of Bradford)
- PRESCIENT - Reliability Prediction models and Design (University of Cranfield)
- PISCOM - Modelling of Vehicle Handling Processes (University of Leeds)
- INTEGRATE - Integration for Driver Systems (Loughborough University)
- ADAM - Automatic Generation of Design Improvements (University of Warwick)
- DOUGAL - Whole Vehicle Electrical Design (University of Wales)
- VITAL - Visualisation of the Impact of Tolerance Allocation (University of Leeds)
- DSFSCA - Systematic Supply Chain Alignment (University of Liverpool)
- LEAP - Lean Process industries (University of Cardiff)
- RESCOVS - Responsive Supply Chains & Commercial Vehicle Sector (University of Huddersfield)
- SUPPLY CHAIN2001+ - Dynamic Supply Chain Decision Support Systems (University of Cardiff)
- RADICASL - Laminated HP Dies (DeMontford University)
- COMPAG - Component Based Paradigm for Agile Automation (University of Loughborough)
- SimFML - Responsive Design and Operation of Flexible Manpower Lines (University of DeMontford)
- APIP - Accelerated Process Improvements (University of Cardiff)
- KBS-IMPROVE - Maintenance Scheduling Through Knowledge Based Simulation (University of Warwick)

There are many consultants to the industry (represented by a SMMT committee) and these organisations could be involved with the dissemination process as could the professional bodies. More recently, the quality of the EPSRC research has led to a direct invitation for British Universities to present their work abroad (SAE conference Detroit USA). The quality of British research is therefore of a good standard. It would appear that the major obstacle to progress in this field is to extend the research activities to the manufacturers in the UK supply chain and in the dissemination of activities (including 'how to engage with the EPSRC/University System').

A recommendation of the DDM team is to combine the road mapping promotion with a synopsis of the associated research programmes and to disseminate both aspects. The best way of doing this is to generate a web-based system that would allow UK manufacturers to enter the site and probe into key programmes and results.

Intellectual Property and Commercial Exploitation of Research Initiatives

The issue of the commercialisation of research from the University sector was explored by John Baker whose report was, presented to the Minister for Science and Financial Secretary to the Treasury in 1999. His views are contained in the Treasury paper 'Creating Knowledge Creating Wealth' and his recommendations are pertinent today. He strongly supported the commercialisation of public-funded research as a means of disseminating research for the 'public good' and for the altruistic rewards sought by science-based academics. Baker argues that the commercialisation of research is important for both works directly sponsored by government departments and through the funding councils. In comparative terms the UK system is not as advanced as the US in 'joined up' exploitation of research.

Baker⁴⁵ identified the need for the commitment of resources by government, opportunities to improve research skills, and the need to develop an infrastructure to support the UK's exploitation of intellectual property (IP). This intangible export commodity is potentially a high revenue earner for the UK and its automotive sector. To complete the system, Baker proposed that new incentives need to be developed to reward staff for such knowledge transfer and that the government should support and promote 'best practice' knowledge transfer networks. The outputs Baker envisaged included collaboration with industrial sponsors leading to commercialisation, free dissemination, consultancy services by public sector bodies, the sale of data, software development and incentives/support to establish 'spin off' companies. He also recommended that the public and private sector should engage in the transfer of staff in and out of the research process. His views have profound significance for the high quality work conducted by the British Research Universities and the Foresight Vehicle Programme in particular.

The Research Assessment Exercise (RAE)

The RAE is the census of University research that is conducted every five years to assess the quality of research work. The measure favours the publication of international journal papers and this bias does not motivate 'career-minded' academics to necessarily engage in works of practical use to industry. From a review of academics concerned with industry related research, the RAE exercise was considered to disadvantage their work in terms of the ability to get the results of such work published in comparison to large-scale questionnaire surveys which were considered attractive by academic publishers. It is the recommendation of the DDM team that the 'RAE issue', should be further investigated to find ways of motivating high quality yet applied research in the UK and also how best to integrate the truly 'blue sky' research which can also suffer from an inability to publish results in high-standing journals.

Summary and Review

The summary findings of the DDM research team reported in this document have explored a number of dimensions that were identified by the expert interviews conducted at the early stages of the research. The problem of university-industry

⁴⁵ The Baker report (1999) can be found on the Treasury web site.

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interaction concerns access and promotion of the availability of high quality research for industry. It would appear, that the managers of manufacturing firms perceive that research is not concerned with real-life and commercial issues. This is not the reality of work in the University sector and centres, including Warwick, Cranfield, Loughborough, Aston, Cardiff, Liverpool, and De-Montfort all offer programmes of applied research with sponsors that is expected to deliver a commercial benefit for those involved. Many of the research sponsors also provide modest financial support and pay through 'in kind' support (labour time) so this form of research is neither beyond the purse of scope of what the automotive industry needs. The potential benefits of this sort of joint working demand to be promoted at the national level.

It should be noted that many of these research Universities also operate 'Teaching Company Schemes' which is a system whereby individuals - studying for postgraduate degrees work at host companies. This programme is definitely under-utilised by the automotive industry. The TCS system offers placements for both engineering and management related research students - the majority of whom have conducted engineering-related degree courses. This aspect of the British University system requires greater promotion and these 'field' researchers (with direct relations with University host organisations) should be exploited by SMEs in the automotive sector. The projects undertaken by TCS fellows should, in the first instance be concentrated upon engineering, management, design or supply chain issues in order that all parties to the TCS programme benefit.

In summary, the university sector is becoming increasingly 'customer focused' and the quality of research conducted is in-line with industry needs. Higher Education has a role to play in the productivity and quality performance improvement needed in industry and also in the development of the new capabilities (design and supply chain) required for the continued success of the automotive sector. The biggest problem with the university system is in ensuring that there is joined up thinking between Business Schools and Engineering Schools (often within the same institution) allowing engineering innovations to be rapidly exploited in terms of management methodologies. The key issue for the universities is one of promotion to industry and a broader system of collaboration with more automotive firms. In total though, the UK cannot rely upon piecemeal adjustments to the University system to improve the productivity, quality and performance of the automotive supply chain. In general research universities have much to offer the automotive and general industries but find that the current means of measuring individual and school-level performance does not promote engagement with industry on industry issues. Certainly, activities such as Foresight Vehicle are important conduits for such academic-industry collaboration, but the current system is not exploited in the way that other European countries work (notably Germany). The evidence from industry, collected by this study, suggests that there is much untapped benefits that can be exploited from close working relationships between industry and academia.

To progress this matter in the short term, a dialogue held between the DTI and the Engineering and Physical Sciences Research Council⁴⁶ should be held to discuss this

⁴⁶ Such a dialogue should include representatives from the Innovative Manufacturing Industry programme, the EPSRC's DMAP working group (design issues) and the Foresight vehicle Co-ordinators.

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issue in greater depth and to propose changes of mutual benefit to academia and industry.

Summary and Review of Issues

The DDM report forms part of the wider AIGT review process. Presented here is a summary of the findings and some concerning issues that affect the current performance of the automotive supply and its future capabilities.

The primary issue, which must be resolved in the short term to prevent an erosion of the UK manufacturing position is the Euro. This will provide enhanced stability for decision-makers and will go some way to returning profits to the industry. Here it is important that the UK infrastructure that supports the industry is ready and prepared to engage in a series of programmes, co-ordinated at the national level by the DTI, and administered locally by RDAs to the benefit of networks of manufacturing firms. This process of 'joining up' the support to the industry is vital if real gains in the engineering and development capabilities of British firms is to be improved. At the national level, there is a clear need to improve the promotion of the education and research sectors.

Many of the recommendations that will follow in this report concern how best to exploit what exists and how to ensure that new initiatives needed to maintain a vibrant manufacturing base provide 'value for money'. In short, the issues presented so far can be summarised as:

1. Stability in management planning (the Euro) and focused investment plans.
2. Supply chain integration and the development of local sources of competitive advantage for the assemblers and their UK supply bases.
3. The integration of education and professional/trade bodies to promote the engineering agenda.
4. The management of the automotive sector as a dependent and inter-related 'system' that requires focused intervention at critical points to release improvements throughout the chain and for nation-wide promotion of 'best practices' to sustain improvements in the sector (design, supply chain, environmentalism, process improvement, TPM etc.).

The next section of this DDM report will, having presented the issues for the automotive industry, begin to present a considered and justified 'future state' for the industry. The next section will therefore concentrate upon the institutions, programmes and initiatives that would combine to support the industry in closing current gaps and shortages whilst building the capabilities needed for the future.

Recommendations: Automotive Industry Growth

Joined Up Thinking: Reflecting upon the Recommendations of Other Prominent Industry Reports

It is the intention of the AIGT team to make recommendations to Government, industry and others for specific actions including an improved process for discussion and dialogue between industry and Government. The aim to ensure that there is greater mutual understanding of current and future challenges and to develop more satisfactory methods of consultation and support. The industry consultation process and the willingness of the automotive industry to support this programme of research is unprecedented and expectations, concerning the outcomes of the process are high. To assist with the management of national improvement and the short time scales with which the automotive sector operates, this section of the report will offer both short and long term recommendations. The recommendations contained in this report are therefore offered for discussion and for the government to formulate a response for the competitiveness of the automotive and associated industries.

M2020 and the DDM Report

In line with government policy concerning 'joined up thinking', the first report which must be integrated with this research is the conclusions and position taken by the Manufacturing 2020 panel. The conclusions of the group were:

- Manufacturing will remain of major importance to the UK economy
- Manufacturing is Changing - and redefining itself as a provider of lifetime service around a manufactured product.
- The internet is a major enabler and will initiate a paradigm shift
- Much remains to be done to secure the UK's position in what will become a European manufacturing "competition" - but the UK can succeed.

The DDM sub-group concludes that the automotive industry is a significant element of the manufacturing sector (in terms of GDP worth and employment). The team believe that the automotive industry will continue to play a significant role for the economic prosperity of the UK if appropriate policies and adjustments are undertaken to promote and secure the UK's position relative to European competition. From the internet perspective, the business model for manufactured products is changing and this report has found evidence that the industry, led mainly by the powerful vehicle assemblers, have engaged in electronic commerce and the integrated use of the internet. However, there remains much to be done in this area. Recent studies have found confusion amongst manufacturers and a general unresponsive reaction to the opportunities that such a medium offers (business to business B2B applications).

Of most importance to this study is the development of a manufacturing-led service firm or service-led manufacturer. In the context of the automotive industry, this M2020 conclusion implies that manufacturing, by itself, is insufficient to meet the challenges of the modern and global industry. There are fears, from companies at the

head of the British automotive supply chains, that lower manufacturing tiers are insufficiently prepared for the challenges of European and global competition. Manufacturing alone and working to the design drawings of customers is not a form of contracting that engages customers and results in greater control for the manufacturer. The latter are aspects of a trading relationship that result from investments, by the manufacturer in terms of design development and supply chain management capabilities. These capabilities themselves do not offer the 'holy grail' of productivity and quality improvement, and the DDM study finds that much remains to be done. These pragmatic issues concern the development of new management capabilities (design and supply chain), the development of a new approach to engineering as a 'competitive weapon' for manufacturers and how process improvements for operator teams can be extended for greater business benefits.

The EEF/EMTA/ Society of British Aerospace Companies and the UK Steel Association Report Recommendations (2001) and the DDM Report

In discussing the recommendations of this subgroup of the AIGT programme, it would be remiss not to review some of the recent coalitions and interest groups that have addressed similar issues. The 2001 EEF/EMTA/Society of British Aerospace Companies and the UK Steel Association have offered 10 key policies needed from central government to promote the competitiveness of general manufacturing organisations. These recommendations span the different sub-groups of the AIGT programme but are worth considering in light of evidence provided in this report.

The 10 Key National Policies Recommended.

1. Fiscal policy to encourage business investment rather than household consumption.
2. Increased investment in areas fundamental to national competitiveness: infrastructure, lifelong learning and R&D.
3. An R&D tax credit for large firms.
4. 100% first year capital allowances for IT investment.
5. Increased support for near market high technology R&D, particularly demonstration products.
6. Extended funding for Vocational programmes in Crafts and Skills.
7. A review of the performance of RDAs to ensure they are business-led and have sufficient resources and authority.
8. No further employment relations legislation and encouragement of more flexible labour markets throughout the EU.
9. Implementation of the 10-year transport plan to ensure early results in priority areas.
10. Redesign of the climate change levy to allow wider access to negotiated agreements.

Source: EEF, MTTA, Society of British Aerospace Companies and UK Steel Association Recommendations 2001

The team confirms the importance of a balance between business investment and consumption in order to effect a stable economy. Investment in technology, R&D and

lifelong learning are common denominators that unite this report and the DDM sub-groups. This report would support the use of incentives for R&D and other forms of investment. Much evidence has been presented here that confirms that UK engineering research is working at the 'cutting edge' of commercial need and technology itself. The automotive industry is not making the profits needed to sustain high levels of R&D expenditure, especially in comparative terms and the relative position of the UK (America, Japan, Germany for instance).

Near market technology is not traditionally an interest area for University funding yet there are many educational and private establishments in the UK with an ability to contribute to the R&D and new product introduction (Time-to-market) process. Many rapid prototyping facilities exist in the HE and FE sector and it is these public assets which need to be harnessed for commercial use. Overall the team would endorse the general recommendations of the 2001 report.

General Findings & Reflections in Context

The pattern of development from operational effectiveness (quality, delivery and cost performance to customer expectation) to the development of key capabilities involves an 'incremental mastery' of best practices. The knowledge required to gain such competitive competencies is known. Yet the perception of industry representatives during this study was that many British businesses lack this form of 'mastery' and often return to fire-fighting operational issues or delay the investment in capabilities as a result of a turbulent, uncertain and unstable environment. The investments needed to maintain incremental mastery and the development of key capabilities are inextricably linked to the issue of the 'Euro'. Far from being a convenient excuse for the industry, the issue of currency integration is central to current and future investment patterns and any move towards Euro membership would be welcomed.

The announcement of an unequivocal intention to integrate promoted with the key manufacturing industry stakeholders (CBI, EMTA, EEF, SMMT, etc.) would alleviate certain barriers to investment but is insufficient to halt the 'head of steam' to move supply contracts abroad. If it was accompanied with a timetable for integration then the process of supply contract export will slow and investment in the human and technological asset base is likely to be increased subject to entry at an appropriate rate. Should there be no change in the position concerning the Euro there would be a serious risk of a continuation of the losses in contracts to European sources, and resultant limited human and technological investments. Measures to enhance the productivity of the UK industry as recommended by the UK would help to offset this but would be unlikely to reverse the trend to sourcing abroad. The latter could potentially discredit the AIGT process as merely a means of pacifying the industry.

The Remainder of this Document

The next section of the recommendations will focus on the specific findings of this research and the potential ways forwards in forging a greater dialogue and mutual understanding between the automotive industry and government. The following sections of the summary recommendations is divided into the issues affecting:

1. The National Government,
2. The Department of Trade and Industry
3. The University System
4. The Regional Development Agencies
5. Trade and Professional Bodies
6. The Trade Union Movement

Finally, the document will be concluded and relevant appendices presented. The report is offered as a means of improving the dialogue between the industry and the government and to stimulate the change processes needed to support an industry that is entering a new era of competition for which cost reduction and new capabilities are required.

Section 1: The Government's Role

The Government Stance on the Euro Issue

A Positive Position towards Euro

The survey and opinions of senior industrialists collected during this report overwhelmingly supports the need for a positive approach by HM Government towards joining the Euro. At an absolute minimum is the need to 'talk up' such a union as a means of delaying the drain of investments to European countries (both in purchase requirements and in facilities moving overseas). The industrialists saw this action, as slowing the 'hollowing out of British industry'

Joining the currency union would be a major boost for the automotive industry, its competitiveness and will have an impact upon the employment levels and wealth creation of the sector. At minimum, such an integration would 'level the playing field' with European businesses and afford some time with which to improve the productivity and quality of the British supply chain as a preferred source.

The Euro Issue: Impact & Recommendation

A positive resolution of the issue of currency integration has the potential for an major positive effect for the automotive supply chain and investment patterns

Legislation and Labour Laws

The current position of the automotive industry is that the amount of labour legislation is sufficient and that extensions would bring an unnecessary rigidity resulting in competitive disadvantage in the UK. The current legislation would appear to offer significant scope for management and trade union collaboration (partnership).

The Impact & Recommendation

The recommendation of the DDM team is to avoid any intervention that would negatively impact upon the flexibility and management-union collaboration in continuing to develop a flexible workforce in the UK. It is recommended that the 'Partnership fund' be promoted more widely, as a model for 'best practice' manufacturing and to extend the numbers of firms engaged with the trade unions in developing partnerships. Ongoing dialogue between the government and trade union leaders should be established to ensure that beneficial changes in the partnership funding approach can be taken to the benefit of British industry.

An Industry Code of Conduct: Staged Payment for Development Activities

Inevitably the automotive SME sector is subject to problems in terms of payment cycles. The flow of finances is important to this sector and companies, such as toolmakers, have complained that they are disadvantaged by such practices. The issue is one worthy of investigation in order to protect the SME - the core of the automotive

supply chain. To ask the SME sector to fully finance activities such as tool making is unfair and should be replaced with staged payments. A working party should be established within the industry to harmonise and standardise practice. Legislation in this area would be deemed by the DDM team to be excessive and an agreed industry standard would be a preferred option although enforcement is difficult.

Recommendation

The automotive industry has a trend away from large-scale operations in favour of an SME business model and this raises certain issues concerning the trading with SMEs and between SMEs. Smaller businesses are, by nature, more exposed to delays in the cash-to-cash cycle. The issue was raised several times during the research programme⁴⁷ and would warrant investigation. The issues does reflect the trading relationship between customer and supplier and is affected by careful selection of customers but this feature of trading does have serious implications for the viability of the SME.

The UK, for instance, produces approximately 2% of the machine tool assets in global terms and non-payment of debts does risk problems in terms of developing new replacement assets if payment cycles are elongated. These 'tool-based' businesses are not typically dedicated to supply chains and tend to focus on core technologies and therefore there is a 'technological dependency' that crosses between key British industries (automotive, aerospace, general machining etc.). The recommendation is that the MTTA and other stakeholders are brought together to discuss the issue of payment cycles within the broader context of the sector and its potential growth given an 'ageing asset base' in the UK.

⁴⁷ These issues have also been researched by Professor Richard Lamming, Director of Crisps at the University of Bath and his work suggests that the protection of SME firms is necessary to avoid exploitation and adversarial purchasing regimes that potentially threaten the livelihood of specialist technology firms in the supply chain.

Section 2: The Department of Trade and Industry (DTI)

Roles and Responsibilities within a context of Increasing Decentralisation.

At the current juncture, the department is undergoing significant change and this turmoil is not conducive to the establishment focused programmes of work to support the competitiveness agenda. In this context, the problem facing the DTI concerns integration with other departments whilst maintaining British interests at multiple levels (Europe, national and regional). Each of these issues creates instability in a source of major assistance to the automotive industry and any lack of clarity in these subsystems of the DTI will effectively slow progress for the department. A route map that guides the process of change will be vital and will assist in determining the future roles and responsibilities of the central DTI function (its stakeholders, resources etc.).

Recommendation

The Government should ensure a period of stability at the DTI within which new plans can be formulated to scope out how best to contribute and co-ordinate the drive for improved manufacturing competitiveness in the UK. These plans should include recommendations related to which activities should have be run centrally and which can be devolved (and over what time period to transfer these responsibilities). These plans should cover a 15 year time horizon and be broken down into 3 year cycles of activity. Any time period less than 3 years is insufficient due to the complex nature of the issues concerning the UK economy and its competitiveness.

An internal review team of senior officials within the department and representatives from other departments (upon whom the DTI is dependent) should engage in this planning process. Ideally, this process would be facilitated by a senior industrialist on secondment (this will be discussed later in this section).

On-Going Dialogue with the Automotive Industry.

The challenges facing the automotive industry imply that a totally decentralised approach is not conducive to development and the concerted effort needed to support the industry. The centralisation of information systems and the value of the DTI in being a central point that focuses the entire automotive system are an important design consideration. The value of the DTI over regional activities is therefore in managing the holistic automotive system and interacting with the industry trade bodies.

The foundations for high quality dialogue between government, industry and other stakeholders is built upon a DTI infrastructure that retains a central role . Regional development activities may well be devolved to existing and new organisations that are more focused on closing the gaps identified in this report. The key values of the DTI concern strategic analyses of industrial sectors, managing 'at risk' firms and the impact of any loss, and maintaining its role as a conduit between the industry and government.

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“It is essential that regional bodies work together to retain large companies, which are a focus for growth and innovation, maintain jobs right through the supply chain and generate wealth... The use of local suppliers should be supported by strengthening our smaller businesses so that they can overcome obstacles to growth”

Professor Mike Gregory Institute for Manufacturing, August 2001

It is acknowledged that in strict terms the following recommendation lies outside of the AIGT remit, but nonetheless in reviewing the automotive industry, it is impossible to detach the role of the government and importantly the DTI. This recommendation is offered, in the spirit of the on-going industry-government dialogue, as a process that could yield great benefits to the public employees who work with the automotive and other industries.

Recommendation: Clarity in Roles & Responsibility

There is a 'pareto' effect in terms of the 20% of routines that account for 80% of the activities at the region, sector, nation and European levels. An internal DTI team should investigate these activities. If meaningful progress is to be made in the medium term then 'self determination' of roles, policies and priorities by the DTI should be encouraged and the 'future state' of the DTI should be widely promoted (within the government, regions and with industry).

These roles should be classified as 'statutory' for which the department is obliged to conduct (must comply) and these routines should be made as efficient as possible so as to allow the skills and capabilities of the department to be directed towards more 'value-adding' routines for government and industry (automated). The second set of activities concerns 'performance systems' in terms of information, programme execution, cross-departmental working and budgetary routines. The latter activities conform to the 'value for money' principles of good government. Finally, a substantial budget should be allocated to 'improvement and capability' works by the department. The latter represent the focus of proactive improvement for the sectors and nation-wide agenda. Such an analysis of activities and roles would allow the process of centralisation and decentralisation to be managed effectively in terms of planning changes to the DTI roles and responsibilities (relative to decentralised control) over time and at a pace that is itself sustainable.

In broad terms, departments such as Japan's MITI structure enjoyed a position of respect and collaborative support by industry, especially the automotive industry, as a result of the proactive management, information availability for the decision-making of industrialists and national promotional activities to support industry. These proactive activities also included the support for export activities and overseas investment. These are important roles for DTI and should be the main focus of future work.

Managing the ‘Domino Effect’: DTI, SMMT and University Collaboration

One of the main responsibilities of the department is to collate information, this information is typically beyond the financial resources of individual businesses and has profound importance to how UK industry develops. A key concern here is the establishment of ‘relational databases’ to monitor the sales (distribution) and supplies (inbound) dependency of the British automotive supply chain. Currently, the information contained and circulated within DTI ‘At Risk’ reports requires extension and a holistic view of the supply chain. To reinforce this point it is important to understand that the industry is consolidating and increasing dependencies between assemblers and manufacturers and the manufacturers and the raw material providers. It is important that the complex set of dependency relationships is understood and that scenario plans are conducted to interpret the effect of major businesses reducing or terminating their operations in the UK. The establishment of such a database would also greatly assist the focusing of development efforts and inward investment activities needed to support and develop a robust British supply chain.

The issue therefore is who should administer the programme and this falls to the SMMT and University system. In line with the general government trend to decentralise decision-making it is important that central information is collated from decentralised (regional) sources. As such, the preferred system would be for the university system supporting the RDAs to be used as a means of collecting such information and for this to be collated electronically in a central database held by the SMMT and made accessible to the DTI. If this information had been available the recent announcement of BMW’s intention to divest Rover cars could have been handled much more easily. All suppliers and their dependencies upon Rover would have been known as well as the impact of the suppliers upon lower tier companies and the raw materials providers. The information that needs to be collected is straightforward and would include the sales volume attributable to customers, the percentage of purchasing budgets attributable to major suppliers and the number of direct employees working on products for such customers. To be of use the database would need an annual census of companies (same questionnaire administered by local universities to automotive companies) and for the data to be confirmed again during the year. In this manner, the DTI would have access to data that was never more than 6 months old.

Financing the relational database system is an issue of concern. Several alternatives for funding exist:

1. Existing regional programmes collect the information as part of their role.
2. The university funding councils could provide funds for the regional universities to collect the data (a list of such institutions is provided in the appendices of this document).
3. The SMMT is used as the central hub for this data collection programme.
4. The DTI funds the programme itself.

Which programme and options are best is a question that is best determined by the DTI. The more important issue is the means of collecting the data and how frequently it is 'gathered'/validated to keep the database up-to-date. A short questionnaire would appear the most appropriate form that is updated twice a year. Ideally this data would

be collected by a combination of RDA/University with the data entry taking place in the regions whilst standard reports are designed at the central DTI level.

Recommendation

Access to high quality information for use by government and also, through collaboration with trade associations, by senior management decision-makers is an important feature of the national system. Such data is typically beyond the finances of most businesses, and if the trend towards SME business models continues will become increasingly difficult to obtain. There is, as a result, a business case for such data bases to fall under the responsibility of the DTI yet for the data supply (maintenance) to be the responsibility of RDAs and regional universities. The development of an integrated database system is critically important when the issue of the 'domino' effect is considered especially with the recent history that led to the formation of MG Rover.

At a minimum, the DTI should be supported by the development of a national relational database for the automotive industry. The cost of maintenance and operation of such a system should be minimised to allow greater time to be spent analysing and conducting scenario planning.

DTI Initiative Listing (Web site)

Another area of great national worth would include the promotion of the DTI activities and initiatives by the development of the DTI web site and links to trade associations. The latter might include regular trade association and industry briefing sessions to promote the initiatives on offer. One of the problems of conducting a survey of this nature is joining up what is being done, has been done and what the other government departments are conducting. It is often hard for people within national and regional government to keep track of everything that is going on. Little imagination is needed to appreciate how difficult it is for business. A good example of such a 'shop window on the DTI' is the AutoIndustry web site operated by the Directorate. The point being made here is that the DTI is a major provider to the automotive industry and could have a central responsibility in promoting government works. Such initiatives would include the new Nation-wide Network of Manufacturing Advisory Services (NNMAS) and other groups. This promotional activity would enhance the image of the government, the focusing of inquiries to the DTI and would raise the profile of this web site as an authority for the industry.

Recommendation

To enhance the services of the DTI, to industry and the automotive sector, it is important that new priority is given to the use of the internet. The DTI offers many new services and information points through the internet. This data is valuable and, as has been previously argued, this data set is beyond the scope of most manufacturers. An extended use of what has already been achieved would be a major benefit

Internally, the database system, with appropriate restrictions, should be extended to give visibility to each department of current and recent initiatives throughout government. A central 'clearing house' should be established within government and

its departments which collates programmes and presents them on servers that are accessible throughout the different government departments and agencies. It is suspected that, given the current government system that efforts are duplicated, other efforts repeat without exploiting the findings of previous works and that some initiatives will not have appropriate representation of the departments concerned. This issue is not presented to offer another reason for 'market testing' but rather it is presented as a means of 'joining up' the current system without the need for external intervention. The proposal is therefore to establish a project database with adequate information to allow other government departments to understand and participate in these activities. As most issues and other departments impact upon trade and industry then this would be a powerful addition to the DTI system and how it interacts with the industry and other stakeholders.

The Education and Skills Debate

The knowledge base of the British automotive industry has been identified as a major inhibitor to progress and progress in broader manufacturing sectors. At the moment, the concerns involve the quality and quantity of engineering. These skill sets are the 'lifeblood' of a vibrant automotive sector and the UK has a mixed track record in delivering high quality employees upon which, all commentators agree, future prosperity and productivity depend.

The Education and Skills Debate: Promoting Shop Floor Improvements

The debate concerning the development of professional engineers has generated more 'heat than light' and can be an over-simplistic response to a complex problem. It is true that concentrating on graduates is not necessarily the avenue for step change improvements for industry. It remains however, a key route for improvement that must not be ignored. A parallel activity that has not to date been pursued by government is to promote heavily the up-skilling of the shop floor operator, team leader and shop steward employee grades. Put simply, there are many more team leaders than managers and engineers in the UK and these people often struggle with changes to job roles. We have also seen a growing age of the UK working population and a drain of good employees from the working population. The key countermeasure, for regional promotion and implementation, yet central promotion and co-ordination by the DTI is the 'Total Productive Maintenance' (TPM) concept. This issue is even more important when, as we have demonstrated in this report that there are concerns about asset investment programmes and the age of the UK working asset base.

TPM is widely promoted in Japan (trade associations, government and industry supply chains) and Japan has the highest concentration of world class businesses and highest performing companies. Following the lean and Total Quality Management (TQM) phases of Japanese development, the TPM evolution occurred in the 1970s with exemplars such as Toyota and Denso championing the movement. Unlike Total Quality Management, TPM involves a technological up-skilling of workers in the function and front line maintenance of productive equipment - as such new problem-solving skills can be used to identify the real quality issues with manufacturing processes. In the UK we have few exemplars (Pirelli, 3M and Unilever) and promotion of the TPM cause would be a means of lowering barriers between

engineers and the shop floor. It therefore approaches the engineering skills issue from the bottom-up rather than a purely 'graduate elitist' approach. The approach will only work if government, unions and the automotive industry promote the approach. Even if moderately successful, the interest generated as a result of the initiative in the automotive industry would stimulate interest by general manufacturing sectors.

Recommendation

Many industry concerns have been expressed with reference to the age of UK productive assets whilst this is important it is not necessarily correctly stated. The true concern is that of the management of the asset and not its age. The same is true of the team leader issue - it is the management capabilities of these individuals that is important.

This research team has found a substantial gap in the maintenance and technical engineering skills at the graduate level. To date, the focus of efforts has been in changing the role of the graduate and maintenance technician but this is misleading. The research has found that supplier quality levels have improved dramatically and yet there remains a lot to be done in this area (it was the main concern of the vehicle assemblers). This would suggest that the UK industry needs a new approach to quality and a much stronger 'engineer out' philosophy. To achieve this with low levels of engineering expertise can only be achieved if routine maintenance engineering tasks are deployed to shop floor teams and time is released for the engineer to engage in project works (an attractive aspect of the job according to the EMTA Mori Poll 2001).

The promotion of TPM by the DTI, trade unions and as part of every regional improvement programme (such as 'Accelerate') is vitally important. In addition, the promotion of TPM could be assisted if the universities, the SMMT Industry Forum and Trade Unions were to form an alliance to promote and disseminate the approach and its benefits.

The Education and Skills Debate: Industry Forum

The development of the SMMT innovation, the Industry Forum, would be an advantage to general manufacturing industry that could supplement that offered to the mainstream automotive activities. The development of IF activities including direct interaction with other trade associations (such as materials-based associations) would create a 'weave' effect whereby 'awareness' in the automotive sector can be combined with awareness at the 'sub industry level (i.e. glass, rubber, cast metals, machine tools etc). It would also help Industry Forum to access a number of companies at the lower tiers of the automotive industry where, as this survey has found, awareness is limited. For the current SMMT Industry Forum a logical extension of activities would be to invest in market intelligence information (in combination with the SMMT and DTI) to support the direction setting as well as the operational improvements at British businesses. Another extension of the current SMMT Industry Forum model should include, as previously noted, the development of Total Productive Maintenance services to assist with the development of technical diagnostic skills of the workforce.

Recommendation

The main finding and recommendations of this report are related to this industry issue and the DDM team would support the extension of the automotive Industry Forum (IF) given the good track record and benefits of the forum as confirmed by the research. To enhance the value-adding of the IF, the automotive industry (and the other sectors now covered by IF models) must step-up and extend the range of services and improvement activities offered to the industry. The new role will also allow the IF model to grow and exploit their knowledge base and apply their skills to new issues of greater commercial impact for businesses.

The new role calls for the creation of
"an Automotive Centre of international standing providing
a comprehensive range of support for process improvement".

The implications of this change are many and affect the quantitative nature of the IF activities and also a qualitative shift towards issues of greater management significance. Firstly, the IF needs to step-change in the activities to enable it to spread its shop floor improvement techniques to more businesses including larger companies. The latter approach will extend the IF beyond its current focus on SME businesses.

Key to the development of the IF will be the creation of a standard curriculum for provision to trainers working within businesses. These trainers would have the opportunity to learn, at first hand, the shop floor improvement techniques by working alongside IF Engineers and process masters. To spread the benefits of the new approach, the RDAs would have responsibility for co-ordinating the delivery of programmes.

The IF has developed new training materials to assist this improvement drive and the priority areas of management that will be added to the current service provision include new product development (including programme management) and supply chain management. These latter processes reflect the industry need for greater professionalism and the competitive advantage that can be derived from proactive and effective design and supply chain processes.

Finally, once the new curricula has been developed, newly graduated engineers would be able to develop themselves by taking part in and leading lean productivity improvement activities at a finishing school at which professional skills can be combined with practical skills at the beginning of their careers. The anticipated costs of this new programme of improvement would be in the region of £15 million over the next five years.

It is essential that the governing body of the centre should comprise of senior industrialists⁴⁸. The board should also review the nation-wide and regional delivery of the improvement agenda and a process would need to be established to ensure that the materials developed are employed and managed to a common standard.

⁴⁸ The management committee/board of the Centre would ideally reflect the structure currently adopted by the SMMT Industry Forum.

In the longer term, it is proposed that the Centre should be combined and integrated with the proposed Motor Sport and Automotive Technology Centres to create a national system of hub and spoke improvement activities/capabilities. This integration process would allow many of the existing industry stakeholders to contribute meaningfully to the competitive agenda⁴⁹. The new system would also allow 'world class' and 'best practice' knowledge to be collected from around the globe and new programmes to be developed that support practical implementation. As the network of centres develop, it is also important that these training and educational programmes will become integrated and influence courses taught, at degree level, by the nations universities.

A second aspect and recommendation of the DDM team is for the DTI and the RDAs to establish a funding mechanism and administrative structure to promote and sponsor 'Supply Chain Management Groups' throughout the UK. These groups would allow companies, united by a common 'end product' to work together to improve efficiency and effectiveness of the material flow process throughout the supply chain. This approach has a proven track record and has been employed during the Accelerate programmes in the West Midlands and Wales. The lack of funding in the regions has, to date, prevented the spread of this management 'best practice' and the realisation of benefits in the regions⁵⁰. The cost of this activity is in the range of £5m per annum.

These recommendations represent the two key mechanisms needed to support the development of the automotive industry and its future growth opportunities. These recommendations, of the many in this report, will be presented in the document for general circulation (the Executive Summary).

The Appointment of a 'Manufacturing Guardian Angel' to the DTI/Government: Recommendation

The authors of this report would strongly support the employment (on a fixed-term 3-year contract) of an adviser on manufacturing issues to the DTI/Government. This recommendation goes beyond the exact remit of the AIGT project but the findings of this report support those of the Manufacturing 2020 panel. The position would be used to support policy decisions and to act as a focal point of contact for manufacturing issues. The appointment would serve many purposes including the promotion of 'manufacturing' at a national level and the development of a high-profile manufacturing 'hero'. To date the UK has few manufacturing personalities of near celebrity status and this position would be instrumental in improving the poor public perception of manufacturing and engineering in particular. The manufacturing advisor should also participate and facilitate cross-department negotiations. It is obvious that many of the issues raised in this report do not sit comfortably in any single department and that 'boundary spanning' personnel are required. Working parties are effective but tend to be dissolved shortly after implementation whereas a fixed

⁴⁹ In this respect, the new system would provide opportunities for the Automotive College, wider university system, and others to support industry in a co-ordinated and focused series of activities.

⁵⁰ A practical implication of the supply chain is that suppliers in one region (not that of the customer organisation) may receive development by one RDA on behalf of the customer who works with a different RDA. Processes of cost or transfer will need to be developed using an appropriate protocol. The use of 'outreach programmes' operated by major automotive assemblers/manufacturers with non-automotive SMEs (i.e. Ford Dagenham) could be included within the new system outlined and would add to the 'local' benefits of the Centres of Excellence network.

position from outside would not interfere with civil service career routes and would enjoy a tenure that would allow change to take place properly.

A Manufacturing Club of Winners: Promoting Manufacturing Excellence

Two of the major weaknesses of the current system of awards and recognition in terms of manufacturing excellence awards are the lack of government-endorsed prizes and individual prizes offered to high performing factories. Japanese system, prizes such as the TPM awards are not limited in number. The system of manufacturing prizes in Japan are very high in profile and adopt an approach whereby a high performance standard is set and companies are monitored through impartial audits throughout the year (regional consulting auditors). If the business reaches the necessary standard and the audit process confirms that the business has made sustainable improvement efforts, to a set standard, then the prize is awarded. In effect if all companies that enter meet the (high) standard then all companies receive the prize.. If a national prize was established to promote the areas of deficiency currently experienced in the UK automotive and more general industries then this would increase the population of 'world class' performing manufacturers and provide a visual indication of government support for manufacturing. The financial sponsors for this activity should be the government via the DTI (and other departments), the trade unions, and Regional Development Agencies.

Recommendation

The DTI should conduct a review of the 'Prizes' that it endorses and should investigate the development of a national award system that recognises high performing British companies. This recommendation goes beyond the Inside UK Enterprise initiative and the recommendation is for a regional/national prize system. This approach would be conducive with establishing a 'club of manufacturing winners' and to promote 'best practice'. The prizes would also promote engineering as a challenging and rewarding career path and do much to overcome the poor image held by teenagers (EMTA Mori Poll 2001). At the moment, only the 'Best Factory' prize system exists and it attracts high levels of media attention but an extension of 'excellence' in manufacturing is required⁵¹. The recommendation is that this form of 'award' should be discussed at an internal review of DTI activities.

⁵¹ Cardiff Business School is currently developing such a 'club of winners' prize in the Welsh region in association with a leading trade union and national training provider using the annual on-going audit approach.

Section 3: Recommendations for the University Sector

The British University sector has an undoubted role to play in assisting the development of manufacturing and the automotive industry. To date there are many inhibitors that prevent a meaningful integration of industry and academia.

"British universities have always consistently undersold themselves ...have been relatively slow in really capturing the imagination of governments as to their power, influence and what they can deliver to society in general and the economy in particular"

Barry Sheerman, Chair House of Commons Education and Skills Committee 2001

According to the Education and Skills Committee, the university sector needs to:

- Improve their dialogue with government,
- Develop working relationships with Regional Development Agencies,
- Work with Local Councils and Authorities,
- Develop and extend their influence through the membership of academics in bodies that influence government, and,
- Tax breaks for donors to research should be investigated and introduced.

The DDM report agrees with the general recommendations of the Commons committee. The theme is one of integration, influence and focus in the system that supports industry. Comparatively, the UK does less work with industry in terms of engineering and management issues, and it is not clear whether this is a reluctance of the university system or a lack of demand generated by industry. From our research there are issues that should be considered in overcoming this situation.

University-Based Training: Incorporating Latest Thinking.

A criticism of the local university support to the vehicle assemblers and their supply chain concerned the quality of the staff and quality of materials used in the training of senior and middle management. The requirement therefore is to standardise these materials in a manner that the trainers at these institutions can deliver materials based on the most current research findings. To be properly effective, then these materials must cover the latest thinking in engineering and management.

Recommendation

The EPSRC Foresight Vehicle programme has interests in both these aspects of research and some of the funding councils activities should be directed towards the development of 'teaching notes' (ideally held in a web based library). These teaching materials could therefore be used by regional universities as a means of incorporating latest research and thinking with local training delivery. It should be noted that our research also concludes that the automotive industry prefers a local training support. This is best displayed by the ASSA model that supports Nissan (and supply chains in the North East) and this form of training solution should be used for employment grades below senior and middle management.

The Research Assessment Exercise (RAE): Enabler or Inhibitor?

The Government has significant levels of influence over the metrics used to assess the quality of University research in the UK and has major powers in distributing the wealth, from the public purse, allocated to research themes. The automotive industry is a microcosm of general industry and this relationship between the Government and academia is an important feature of UK competitiveness. The issue has also been identified during the Trade and Industry Select Committee meeting held in December 2001 and attended by the Trade and Industry Minister (Innovation), Lord Sainsbury and the head of the university funding councils (Mr. Taylor). At this session, criticisms concerning the allocation of monies between 'blue sky' research and commercial research were expressed and this issue needs to be further investigated.

Recommendation

The RAE exercise is, at best, a process that attempts to measure the performance of Universities in a fair and equitable manner. It is based primarily upon written outputs in academic journals. The recommendation of the DDM team is to extend the RAE submission to deal with improvements to the performance of industrial concerns. To date, the RAE performance of universities misses this output and the extension of this aspect of the report would allow assessors to gain an holistic understanding of the University's performance. It should also be noted that certain classes of University worker contribute greatly to the quality and commercial success of academic research. The writing of academic papers does not necessarily motivate these individuals nor are they necessarily motivated by traditional academic career routes. It is the recommendation of the DDM team that a greater element of the RAE assessment is accorded to works with industry and commercial improvements enjoyed by the sponsors of university research. This would necessitate dialogue at the DTI and funding council level.

Extend the Foresight Vehicle Process: Integrate the Industry with the Blue Sky

The Foresight Vehicle Technology Road Mapping process is a core contribution of the university system in its relationships with government and academia. The process is long and does not necessarily involve consensus in either the prioritisation or timing of key issues (the latter is a healthy dimension of the process and it is not presented as a criticism). There are many stakeholders who own parts of the road mapping process and the output is highly valuable. To be truly effective, the issues raised must be translated into policy insights or commercially effective research output (management and engineering solutions). An improvement to the system would be to present the road maps to regional dialogue groups, drawn from automotive industry senior managers, to validate the findings of the research and to provide an additional quality assurance process.

Recommendation

The FV road maps are an integral influence on government thinking and an exercise that offers tremendous rewards for the economy if the correct direction of change in the industry is established. The road maps should be presented to the major automotive assemblers, large tier one businesses, and raw materials for individual

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review. The use of regional seminars would also assist this process and gain the involvement of a wider group of automotive business that would benefit from this intelligence.

For lower tiers in the supply chain, the road maps should be summarised and entered in to the extended DTI database for public access. This activity would assist the development of management capability in the SME sector and should cement relationships with stakeholders such as the SMMT Consultants Committee who could promote the road mapping process and are highly likely to reference the materials in their sector reports. The 'Road mapping' process is a subject that is shared with the AIGT Technology team and progress in this area should reflect their findings contained in the AIGT final report.

Section 4: The Regional Development Agencies

The automotive industry is quite clear when it comes to the development of local activities. In the main they like them but they are critical of the quality of the service and the calibre of many of the individuals they interact with (in terms of the delivery of training and also in the delivery of change programmes by consultants retained by the RDAs). The main recommendations of this report (the national/regional centres of excellence and the supply chain group programmes) encompass the activities of the RDAs and seek to integrate them with the development and growth of the automotive industry.

The Centres of Excellence Network

The proposed new Centres of Excellence offer the RDAs many benefits compared to the current system and allowing for maximum flexibility whilst the centralised approach to the quality of training materials counteracts some of the criticisms concerning variable quality. The new system offers the efficiency and effectiveness of a standard yet flexible approach to the productivity challenge. With the extension of the current system, to include design engineering and supply chain management processes, the proposed new system allows for a greater management involvement in performance improvement whilst developing the sources of competitive advantage needed in the regions.

A National Automotive Database

The supplementary recommendations of the DDM team include the engagement of the RDAs in the collection of data concerning the supply/output dependency of automotive firms in each region. This data is important in the development and mapping of the UK automotive chain and will allow scenario planning to be conducted including offering a substantial improvement to the current 'at risk' reporting system. The data collected would therefore need to be entered into computer systems at the regions and enter directly a centralised national database of firms with automotive interests.

**Section 5: The Trade Associations & Professional Bodies:
Recommendations**

Trade associations and professional bodies are powerful groups within the manufacturing industry and many of these groups are integral parts of the automotive system. The main issue with these organisations is how best to promote the interests of their membership. A secondary issue concerns the use of resources and how best to influence industry and 'professional practice'.

The SMMT is the main trade association for the automotive manufacturing sector and any increase in dialogue with the association will enhance the information flow to government and the adjustments undertaken throughout the industry. The SMMT obviously has a role in the development of any new database system and the information exchanges needed to create and maintain an effective information management system with the DTI.

The professional bodies are important additions to the development of an effective system of dialogue with industry and the automotive sector in particular. One of the issues here is 'professionalism' and the influence of the bodies concerning 'educational standards'. Dialogue with the 'engineering' professions is essential to ensure that best practice developed in response to the AIGTs recommendations is to influence university teaching. For engineering schools, the SARTOR standards dictate what is acceptable curricula and which courses receive accreditation to the professional bodies. The views and interests of these bodies are important but the automotive industry membership does not account for high enough levels of concentration to establish administrative structures solely focused on automotive issues. Instead, dialogue with the professional bodies and DTI should be encouraged, through joint working parties, and should build upon the good relationship that exists. The endorsement and the branding of the professional bodies are important especially when the issue of the education system is concerned.

In parallel, many of the trade associations that were integrated with this study expressed concern over the issue of education and an interest in the on-going training of engineers and their interest should be acknowledged and integrated with the design of the new Centres of Excellence system. Together with training issues, the trade associations are active in the conduct of research. The most active associations, which engage in thought-leading research of manufacturing issues, are the EEF and EMTA and their agenda is common to that of many other sector bodies. To engage in a greater dialogue and to plan research processes would be a major benefit and cost saving for the institutions concerned if the research was conducted as a collaborative process within the recommended new system.

An issue that will impact upon the recommendation for on-going dialogue is any process that could potentially erode professional membership levels. The Total Productive Maintenance (TPM) and process improvement initiatives described in this report reinforce professional engineering and equips engineers to return to their 'true value added' (using their specialist diagnostic skills to change and improve entire manufacturing systems not to routines best performed by team leaders). If the new

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proposed network of centres is to embrace the promotion of TPM it is important that the professional bodies are fully integrated in the process before it is launched. The interest in programmes of TPM by RDAs and automotive manufacturing firms is rising and trade unions, such as Amicus, have actively promoted this approach in recent years. As a result of the promotion of TPM a small number of UK exemplars exist and RDAs are likely to wish to launch such regional improvement programmes. To create a system that meets the needs of all these stakeholders and industry requires the integration of professional bodies, trade associations with automotive interests, the RDAs (in determining regional priorities) and also the trade unions to maximise the promotional activities needed to ensure national and regional success.

Section 6: The Trade Unions: Recommendations

No report would be complete without recommendations for one of the automotive industry's biggest institutions, the trade union movement. In the UK automotive industry, the trade unions have a major role to play and should be integrated with an industry-level improvement programme. The trade union network is a powerful influencing body whose members are vast in number. Many of the team leaders and shop stewards employed in the automotive sector are union members and, as this report has found, represent workers who are too old for the modern apprenticeship and have not necessarily experienced the further and/or higher education. As such, one role of the trade union is promotion and education of members. Employers, as we have found, tend to use local educational establishments for training and many miss the opportunities offered by the trade unions themselves.

The 'Partnership fund' has demonstrated the power of union and management collaboration across a number of sectors. The integration of the trade unions with improvements to the automotive sector is both timely and important. In conjunction with other industry stakeholders (EEF, EMTA and such like), the trade union movement could be incorporated to promote Total Productive Maintenance as a means of improving the technical skills of shop floor workers. This activity would include regional promotional seminars, open to members and managers, that would target the following issues:

1. Safety and Morale initiative to improve the basic levels of housekeeping in the factory and to generate the stability needed to monitor and improve the production cell or area.
2. Problem solving skills and techniques including how best to manage teams for continuous improvement in the workplace.
3. Greater awareness and education in asset management (TPM) as a result of a 'partnership approach'.

The initiative would be aimed at closing the gap in team leaders skills such that these employees could be integrated and equipped to take a lead in continuous improvements within the factory. It is upon these workers that the newly qualified engineers (passing through the centres of excellence) depend in terms of participating in and sustaining process improvement. The trade union movement is also organised by regions and therefore there exists many possibilities for the integration of the unions and the promotion of regional change programmes could be co-ordinated with the RDA concerned. The activity should also be used to promote the national importance of management-union partnerships and key business processes such as TPM that improves the skills of industrial workers to a new level.

The DTI should solicit the views of the trade union leaders and determine the best way of integrating the union movement with the national productivity improvement challenge as well as for the DTI to outline the new Centres of Excellence system. The dialogue should encompass a broad agenda of what exists currently and how to exploit synergies or to develop alliances to promote factory-wide improvement.

Closing Comments...

The process of research that underpins this study has covered a lot of ground. The intention was to capture the 'current thinking' of the automotive sector and to find ways of bringing the industry and government closer together in a dialogue. The study has therefore taken breadth and depth of study rather than adopting the traditional and superficial approach of issuing small but large-scale questionnaires.

The UK is in a period of transition and the automotive industry requires a new form of support from the institutions that act as sector stakeholders. The industry is not at the meltdown point that this must be stressed to avoid 'talking' ourselves into such a scenario. Instead, the industry rests in an uncomfortable state of reacting to economic changes rather than proactively planning for the future. Industry is therefore in a process of adjustment within which new improvement efforts are required to develop the sustainable means of competitive advantage.

There remains a lot to do in the UK. In the short term, macro-economic stability is required to halt and reverse the outsourcing of supply to Europe. When this instability removed then investments are likely to result. These investments, as this report has described, need to be focused on improving the design and supply chain management capability of British factories if profitability is to result.

A key concern for the modern UK automotive sector is in 'joining up' the support system in the UK in order to exploit the synergies that exist in the industry regardless of the currency integration issue. Once broader economic issues are resolved, the automotive industry must be in a position and prepared to rapidly introduce and operationalise the new systems of central and local support needed to improve productivity and quality performance. The ability to do this will depend upon the establishment of a manufacturing agenda and the crystallisation of efforts involving the DTI at the forefront of change and the industry bodies, trade unions and universities acting in a co-ordinated fashion to yield the performance improvements needed. Too many jobs in too many regions rest upon the quality of the national response to this improvement call for us to neglect it. For the economy, there is a lot of value that can be retained and correctly exploited by 'joining up' the system in an effective manner.

The key recommendations of this team include the development of the network of Centres of Excellence in management issues that support the technological centres proposed by other AIGT teams. These institutions will provide the UK with the technical and management capabilities needed for automotive industry growth. The centres will also serve to close the current weaknesses associated with 'time-to-market', cost reduction through effective design processes and an integrative approach to supply chain development.

Failure to develop these new industry capabilities has high penalties, due to the 'dependencies' in the automotive supply chain, and will result in direct losses of work and a secondary 'domino effect' that threatens the viability of the lower manufacturing tiers. This threat is real and without the enhancements to the competitive capabilities of the sector offered by the Centres of Excellence, the broader economic

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disadvantages acting against the UK will inevitably force companies to restructure further.

The DDM report has shone light into many aspects of the automotive industry, it is hoped that this document goes some way to the development of greater levels of integration between the automotive industry and government and that real action results from the overall AIGT study. The recommendations in this report are designed to equip British firms with the systems of capability needed to exploit best practices across a range of key business processes. These key business processes unite firms, in the UK supply chain, that depend upon each other to sustain the performance improvements necessary to rise to the productivity and cost challenges of the global automotive industry.

APPENDICES

The Review of Automotive Taught Courses in the UK (including those with automotive management elements)

Cranfield

- Auto product engineering MSc, Motor Sport engineering MSc and Engineering and Management of Manufacturing Systems

Warwick Manufacturing Group

- Engineering or management courses at undergraduate level and postgraduate engineering and management courses.

University of Bath

- Engineering, Management (Japanese management techniques)

University of Hertfordshire

- BEng and MSc in Automotive Engineering.
- MSc in Automotive Engineering Design, Manufacture and Management, a part time course for students already employed in the auto industry.

Leicester

- Traditional business and engineering degrees

Coventry

- Auto Engineering Design
- Auto Manufacturing
- Auto Engineering
- Auto Technology
- Business school has a small automotive content (Management practices)

Leeds

- Engineering and management courses prefer JIT or operations management as a general course without much lean other than as a stereotype contrast with mass production systems

Cardiff

- Business School – Lean Manufacturing MSc, MBA in Supply Chain, MBA Japanese Management
- Engineering School (UG and PG)

Imperial College

- Mainstream Engineering courses
- Management School has MBA programmes with very small amount of lean production lectures

University of Central England

- Design BSc and other courses for team leaders that contains a small amount of lean production.

Birmingham

- Motor Sports section and Engineering courses are much like mainstream and contain some lean manufacturing and production scheduling.

Loughborough

- Aerospace and Automotive Engineering, B Eng. Automotive Engineering, M Eng. Automotive Engineering.

UMIST

- Many engineering courses with varying amounts of lean manufacturing content usually held in the 'business management' options.

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Higher Education Sector Automotive Courses (EMTA data)

<p>Motor Vehicle Engineering</p> <ul style="list-style-type: none"> • Clacmannan College, Alloa, (National Certificate) • Carlisle (National Certificate) • Salford (National Diploma) • Hartlepool (National Diploma) • Hull (National Diploma) (HNC) • Leeds (National Certificate) • Ceredigion Wales (National Diploma) • Barnfield (midlands) HND HNC ND NC • Chesterfield NC ND 	<ul style="list-style-type: none"> • Stoke on Trent HNC • Walsall HNC • Cambridge Regional College HNC • Norwich City NC ND • Brooklands (London) ND • College of NW London NC ND • Farnborough College of Technology NC ND HNC also Motor Sport options • Kent ND • Bridgewater ND HNC
<p>Automotive Engineering</p> <ul style="list-style-type: none"> • Clydebank College, (National Certificate) • University of the Highlands (National Certificate) • James Watt (National Certificate) • Blackpool Higher (National Certificate) • Leeds (National Certificate) • Suffolk HNC GNVQ • Surrey HNC also auto management course, and Motor Vehicle Science NC • Somerset College NC ND HNC 	<p>Motor Vehicle</p> <ul style="list-style-type: none"> • North Lincs (National Certificate) • Ceredigion Wales (National Diploma) • Colleg Gwent (National Diploma) and HNC)
<p>Motor Vehicle Systems & Motor Vehicle Diagnostics</p> <ul style="list-style-type: none"> • Cumbernauld College National Certificate 	<p>Motor Vehicle Body Studies</p> <ul style="list-style-type: none"> • Hull (National Diploma)
<p>Motor Vehicle Management</p> <ul style="list-style-type: none"> • Shrewsbury HNC 	<p>Motor Sport Technologies</p> <ul style="list-style-type: none"> • Derby HNC • Rycotewood college GNVQ
<p>Engineering Motor Studies and Vehicle Body Design</p> <ul style="list-style-type: none"> • Leeds (National Diploma) 	

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Degrees and HNDs (EMTA Data)

<p>Vehicle Engineering and Management Courses</p> <ul style="list-style-type: none"> Barnfield college HND, Cambridge Regional College HND, NorthWest London HND. 	<p>Motor Vehicle Technology</p> <ul style="list-style-type: none"> Chesterfield College HND, Hull Engineering Mechanical and Motor Vehicle HND, Landrillo College HND
<p>Automotive Engineering</p> <ul style="list-style-type: none"> Clydebank HND Coventry (4 different BSc And BEng courses including manufacturing, engineering technology and design) also BEng and BSc in automotive systems and electronics Farnborough college of technology HND (also Motor Sports course BSc) Hertfordshire (MEng, BEng and BSc) in Automotive Technology and Management James Watt Automotive Engineering and Management HND 	<ul style="list-style-type: none"> North West Kent Auto Eng. and Management BEng West Kent College Auto Eng. and Management BEng Kingston 5 courses at BEng in Auto Systems Engineering Leicester Industry options from general engineering degrees at BSc and MSc levels Somerset College HND University of Surrey HND
<p>Design</p> <ul style="list-style-type: none"> Buckinghamshire College BSc (Hons.) 	<p>Mechanical and Auto Engineering</p> <p>Newcastle MENG</p>
<p>Automotive Design and Manufacturing Engineering</p> <ul style="list-style-type: none"> University of Sunderland BEng 	

Other Courses:

UMIST – around 50 degrees at BEng and MEng some focused on Automotive industry but mainly Aerospace.

Cranfield - Many courses including Automotive content.

University of Warwick - many courses and all traditional with bolt on options at BEng and MEng levels.

Nottingham - has engineering with languages and management.

Universities & Regional Assistance/Data gathering for Relational Database Management

Aberdeen Aberystwyth Anglia Ashford Aston	Bangor Bath Bedford Birmingham Bournemouth	Bradford Brighton Bristol Buckingham Cambridge	Canterbury Cardiff Carlisle Chelmsford Cheltenham
Chester Chichester Colchester Coventry Cranfield	Crewe DeMontford Derby Dundee Durham	Edinburgh Exeter Falmouth Farnham Glasgow	Guildford Hatfield Henley Herriot Watt Huddersfield
Imperial College John Moores Kent Lampeter Lancaster	Leeds Leeds Metropolitan Leicester Liverpool London Business School	London School of Economics Loughborough Luton Manchester Metropole Manchester	Manchester Business School Milton Keynes Newcastle Newport Northampton
Norwich Nottingham Nottingham Trent Oxford Oxford Brookes	Paisley Plymouth Pontypridd Portsmouth Queen Margaret College	Reading Robert Gordon College Salford Sheffield Sheffield Hallam	Southampton St. Andrews Stafford Stirling Sunderland
Swansea Teeside UMIST University & HE Network University of Central England	University of Central London University of Sussex University of Central Lancashire University of Lincolnshire and Humberside University of West of England	Warwick Winchester Worcester Wrexham York	

Further Information and background information on the Lean Enterprise Research Centre can be found at www.cf.ac.uk/carbs/lerc.