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A Tidal Wave for Change

The case of the automotive supply chain in the West Midlands

Barbara Tilson

■ ABSTRACT

The focus of this paper concerns change in the automotive supply chain,[1] industry responses, and policy and strategic implications. Automotive components suppliers are buffeted by global trends and forces, including rising quality standards, environmental issues, and product and process innovation. Although the higher ranks of the supply chain adapt to change continuously, new technologies on the horizon threaten to make many automotive components manufacturers obsolete within some three to ten years. The West Midlands region is particularly vulnerable given its high concentration of automotive suppliers. The potential for related diversification is limited and investment is needed in new manufacturing activities (rather than assembly or sales/distribution) related to environmental, alternative power and electronic technologies. This will position the UK's automotive supply base at the forefront of technological advance against strong and aggressive global players notably from the US, Germany and the Far East. Both the private and public sectors have a strategic and supporting role to play in ensuring that opportunities are maximised. The West Midlands case study has a broader currency for initiatives targeting diversification both in vehicles production and in other manufacturing sectors. Its significance is heightened by the increasing tendency for other sectors – such as food and drink production, and domestic appliances – to adopt automotive practices.

■ INTERNATIONAL TRADE AND INDUSTRY: PRACTICES AND PRESSURES IN THE LATE 1990S

The production of vehicles and components remains important to the UK economy through the presence of some leading volume players and a variety of specialist manufacturers. Operating as multinationals, vehicles manufacturers are engaged in a struggle for global competitiveness through reducing costs, exploiting market opportunities, introducing differentiated products,

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1. A supply chain is a tiered structure headed by a vehicles assembler (ie original equipment manufacturer, OEM), such as Rover or Toyota (see Figure 2). The OEM is supplied with complete assemblies – eg chassis, body – by the first-tier supplier, such as Lucas Varity. A second-tier supplier does not usually supply direct to the OEM, but produces subassemblies (eg mouldings, castings) which are delivered to the first-tier supplier. A third/fourth-tier supplier may be a very large producer of materials (eg British Steel) or a small producer of parts such as nuts and bolts (ie fasteners) which are supplied mainly to the tier above. In practice, the supply pattern is more fluid than this tiering would suggest, and firms may occupy more than one position on the supply chain if their customer base is composed of, say, a mix of assemblers and first-tier suppliers, or second and third-tier suppliers.

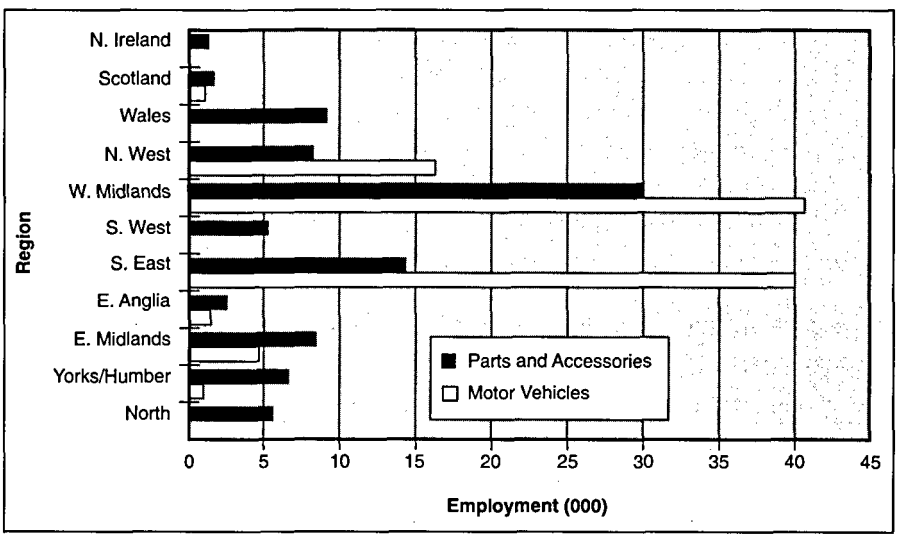
developing advanced technologies, or raising the quality of their products, processes and services.

The automotive components supply chain, too, is undergoing major restructuring, forced by procurement policy and process changes by vehicles manufacturers. Supplier numbers fell by between 40 and 80 per cent as manufacturers introduced new models sourcing parts from fewer suppliers and moved towards the requirement for systems, rather than individual components, supply. Closer relationships between assemblers and suppliers (including through sole supplier contracts) and longer contracts are becoming more common in the UK. This radical restructuring was recognised in the early 1990s (see Womack et al, 1990; Lamming, 1993), and will continue into the early 2000s. By then, a powerful top tier of privileged world-class suppliers is expected to supply a global customer base, leaving the lower echelons of the supply chain to fight for survival (Sako et al, 1995; Delbridge, 1996; Tilson, 1997a).

The national and regional economic context

The automotive supply chain is particularly centred on the West Midlands, where 30,000 people (31.7 per cent of the UK total) were employed in the manufacture of parts and accessories in 1995 (Figure 1). Another 44,800 (30.9 per cent of the UK total) were employed in producing vehicles and bodies. The production of motor vehicles, parts and accessories contributed 8.5 per cent (£10.9 billion) of total UK manufacturing gross value added in 1995,

Figure 1. Regional Distribution of Employment in the Production of Vehicles, Parts and Accessories, 1995



Source: Office for National Statistics (1998)

Table 1. UK Trade in Parts and Accessories, 1993–1997 (£ million)

Year	*Imports*	*Exports*	*Trade balance*		
			Total	*EU*	*Rest of world*
1993	5,023.9	2,846.4	−2,177.5	−2,142.0	−35.4
1994	5,593.9	3.481.8	−2,112.1	−2,051.7	−60.5
1995	6,682.8	3.857.9	−2,825.0	−2,736.4	−88.6
1996	7,860.5	4,621.2	−3,239.3	−3,549.6	310.3
1997	6,473.0	4,928.1	−1,544.9	−2,203.0	658.1

Source: Office for National Statistics (1998)

while also providing 8 per cent of all manufacturing jobs (ONS, 1998). UK car production rose steadily after a low point in 1991 to reach 1.7 million units in 1997, while output of commercial vehicles stagnated (SMMT, 1991–98). But, compared with France, Germany, Spain and South Korea, and especially with the two dominant global nations, the US and Japan, the UK is the poor relation of international vehicles production (Key Note, 1997).

Indices of production, input prices of raw materials and output prices of finished products, a measure of sector efficiency, show that UK producers of parts and accessories performed increasingly competitively in 1996–97, a turnaround since 1995 when they sold goods below cost (ONS, 1998). It is with Europe that UK manufacturers of automotive components mainly compete. Although the recent record (1993–97) of UK exports in parts and accessories has shown year-on-year increases, the UK's trade balance was in deficit overall, notably with EU partners (Table 1). Little headway was made in reducing the overseas penetration of the UK market, as imports constituted almost half (48.6 per cent) of UK home demand for parts and accessories in 1995.[2]

2. ONS (1998) data indicate imports of £6.68 billion and home demand of £13.75 billion in 1995.

The research objectives and methodology

Research into the automotive components sector was undertaken over the period October 1996 to July 1997 with the following objectives: to identify the current drivers for change within the sector; to assess the responses made by West Midlands industry; to evaluate the business opportunities in new technologies, products and processes; and to recommend policy and strategic actions to maximise the region's strengths.

The methodology comprised, firstly, a literature review of international sector trends and prospects, with a strong leaning towards innovation and technology issues. Secondly, five face-to-face and 12 telephone consultations were carried out with 17 public and private-sector bodies, and telephone consultations with 16 components producers located across the UK. Thirdly, in-depth questionnaire-based interviews were conducted during January to

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February 1997 face-to-face with senior management of 17 first- and second-tier suppliers located within the West Midlands region.[3] The interviews covered a broad spectrum of business and technology issues, practices and prospects affecting their entire supply chains, as well as the individual companies concerned. Fourthly, parallel studies were also conducted of 16 plastics and rubber processors and 16 electrical/electronic engineering firms (Tilson, 1997b; 1997c). Thirteen of these included vehicles assemblers or first-tier automotive suppliers among their broad sectoral distribution of customers, raising the total number of automotive-related interviews to 30. This augmented the overall picture of automotive supply chain pressures and practices.

The main automotive supply survey sample of 17 firms included producers of original equipment and aftermarket components,[4] underbonnet, interior and exterior applications involving metals, plastics and rubber processing, and mouldings, forgings, castings and extrusions. Over three-quarters were first-tier suppliers, and nearly one third were second-tier suppliers (a small proportion operated as both). Only two employed under 100 people, and five employed over 500. Just over half were in overseas ownership, substantially European, but also US and the Far East. Annual turnover varied from under £5 million to over £100 million, most lying in the range of £10–£50 million.

Key change drivers

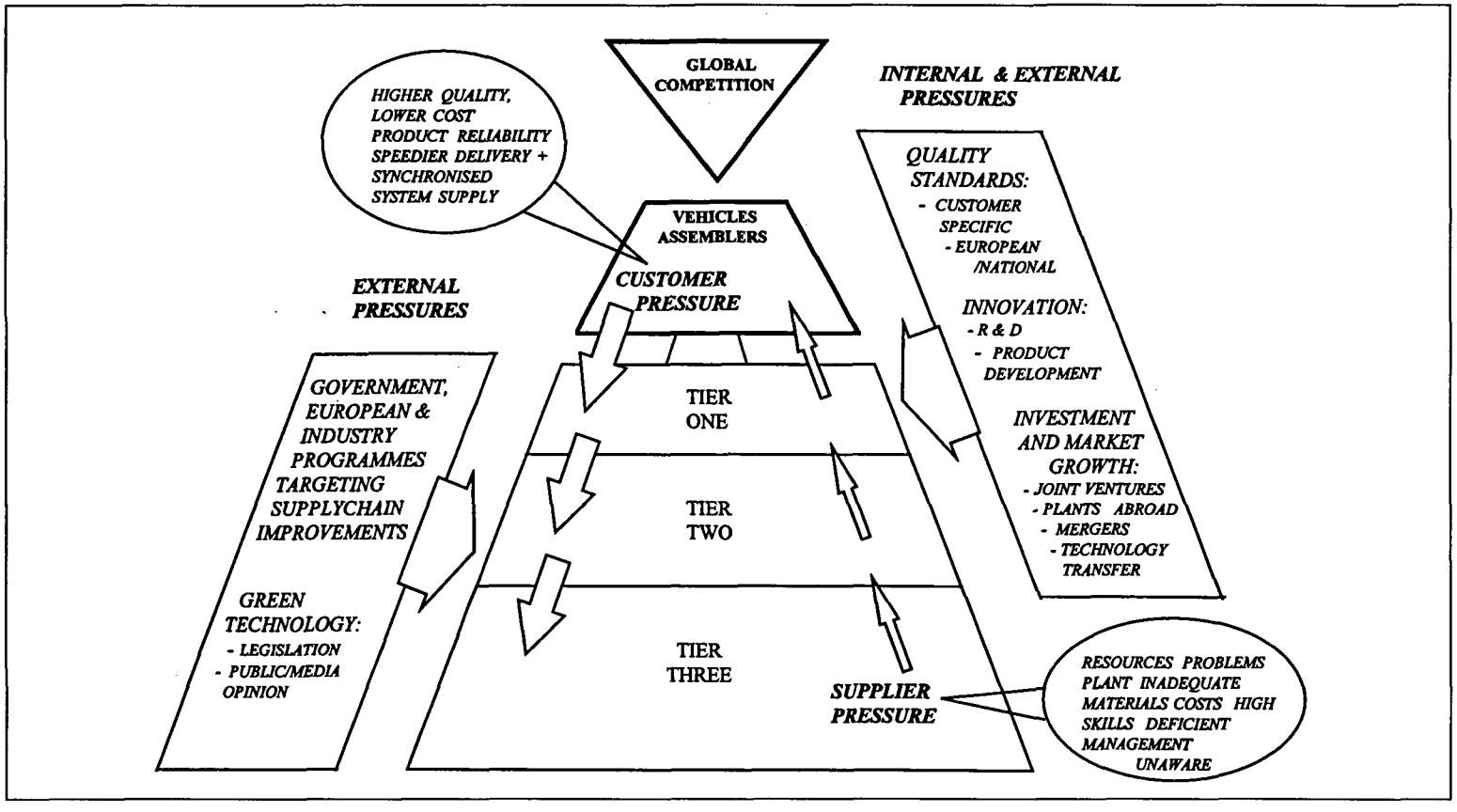
The study highlighted the tremendous pressures building up to a tidal wave for change in the late 1990s. They spring from within and outside the supply chain (Figure 2), importantly:

- Quality standards operated by automotive manufacturers (notably incoming QS 9000) or externally (especially ISO 9000).
- Legislation on emissions, pollutants, components recycling, and waste disposal. EU legislation on car recycling is expected to come into force by 2002. However, a large proportion by weight of steel (75 per cent+) in cars is already recycled (British Steel, 1996) though other materials, such as plastics, will be particularly affected by new legislation.
- Accentuated need for investment in R&D and product – as well as process – design, highlighting the role of technology transfer in innovation.
- Alliances and joint ventures are increasing. Many are with overseas companies to open up markets, for example in China, Eastern Europe, South America and Asia, and/or to access new technologies in Europe.
- Public and private-sector agencies are supporting supply chain improvements, aided by UK and European funding programmes.

3. The research comprised a review of the West Midlands region's economy commissioned from the Centre for Urban and Regional Studies, University of Birmingham, by a consortium headed by the West Midlands Development Agency (WMDA), its partners including the Government Office West Midlands. A summary of the findings of all eight sectors and a general economic overview was published by the WMDA (1998) as *Opportunity West Midlands: Understanding Business Change in the West Midlands Economy*, Birmingham, WMDA, January. The writer's automotive and plastics/rubber processing reports (Tilson, 1997a; 1997c) are published separately by CURS.

4. Makers of original equipment supply parts for the production of new vehicles. Makers of aftermarket components supply parts for the used vehicle repairs market.

Figure 2. Supply Chain Pressures



■ THE SUPPLY CHAIN: MANAGEMENT AND LINKAGES

Supply chain restructuring

Supply chain restructuring is forcing the pace for suppliers' adoption of efficiency measures associated with lean engineering: speedier new product lead times, greater reliability in delivery and quality at reduced cost, a greater role in innovation, and the supply of complete assemblies. A key question is how well they can respond.

The University of Birmingham research (Tilson, 1997a) unearthed considerable determination by the first tier to meet their customer needs and thus to retain existing contracts. But some second-tier suppliers, for whom the concept of supply chain partnership was largely notional, were anxious about being cast adrift by their customers, whose preparation to source globally meant radical supply chain cuts. This was confirmed by a study of Sandwell suppliers, the majority of whom asserted that "increasingly, our customers are sourcing the product we supply from abroad" (Doel, 1997). The University of Birmingham research showed that West Midlands firms were adopting one of three strategies: those unable or unwilling to change because they were in mature "sunset" technologies adopted the "do nothing" option, merely hanging on as long as they could. A second group sought supplier contracts with vehicles assemblers outside their existing customer base, whether local, national or international. And a third group were reducing their dependence on automotive supply by expanding their customer base in other engineering or communications-related sectors.

There was little indication for a counter current of sourcing activity, with West Midlands-based second-tier suppliers benefiting from a strategic change of supplies purchasing from global to local; only one firm surveyed – part of a large US-owned multinational group – was going down this route. But, as Doel (1997) has pointed out, large firms have a vested interest in the competitiveness of the local supply base through the "enormous advantages to local sourcing of ... just-in-time delivery, sustained interaction and shared problem solving ... [when] two firms are in close geographical proximity". This is clearly a factor of competitive advantage for the West Midlands, and worthy of nurturing by development agencies. It is crucial, therefore, that the West Midlands retains not only its vehicle manufacturers but a strong first-tier supplier base manufacturing in the region.

Resources and innovation issues

The University of Birmingham research showed that their customers' pressure for year-on-year cost decreases, combined with their own materials price increases, severely weakened second-tier firms' ability to invest in shared new product developments, new processes, and more complex supply arrangements for subassemblies to enable first-tier suppliers to produce complete sys-

tems. In part, this reflects the way in which many lower-tier firms have had only a limited involvement in R&D and product development, though the survey (which contained a mix of first/second tiers) indicated that a surprisingly high proportion (eight/almost half) undertook R&D, and nearly one fifth (three firms) had specialist design centres. The heightened importance of innovation was also indicated, as over half (nine firms) stated that they needed to undertake more product development.

West Midlands firms were classified according to the Kamath and Liker (1994) hierarchy of supplier roles of Japanese product development. The hierarchy from high to low reads as (1) partner (2) mature (3) child and (4) contractual. Lower-tier suppliers in the West Midlands were usually engaged in "child" arrangements, whereby the customer set out the design specification, and the supplier achieved this; or in "contractual" arrangements, where the supplier merely built to standard order. Real evidence was seen only from first-tier suppliers for the "mature" (full-system) supplier or "partner" (full-service provider) arrangements, where responsibilities extend to the supplier developing systems on its own to the customer's specification or as a participant from the pre-concept design stage onwards.

Although there were exceptions of exceedingly efficient second-tier suppliers investing for success and in expansion mode, the survey indicated that many were already overstretched, unable to expand capacity to supply reliably under just-in-time conditions. The imposition of Electronic Data Interchange link-up throughout the whole supply chain was therefore unwelcome and unworkable and the first tier supplier's achievement of synchronised delivery problematic. Second-tier suppliers also feared their own success because increased demand would stretch delivery lead times beyond the already unacceptable one to two months and accentuate recruitment and skills shortages, notably in graduate engineering and technical shop floor jobs.

Rather than being oblivious to their customer needs, technological change and innovation trends, some second-tier plastics, metals and rubber processors revealed a sense of impotence, aware that their current products and processes were threatened with obsolescence by emerging technologies, but powerless to avoid their firm's death. Examples include materials substitution (such as the switch from iron and steel to plastics, or to other metals such as aluminium, or from high-cost to low-cost plastics); new vehicle power technologies (including optic fibres replacing copper in wiring harnesses); electronic technologies; or new forming techniques such as hydroforming, laser cutting, and new casting techniques for aluminium (Table 2). Radical changes introduced by incoming "green" technologies include active manifolds within integrated air intake systems, new gearbox designs, new types of transmission (eg hydrostatic), noise cancellation techniques, fuel cell technology, emissions handling techniques, and electric cars.

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Table 2. Thematic Summary of New and Emerging Techniques and Innovations

Technique or innovation	*Number of firms*
Substitution of existing material by another	6
Electronics applications	3
New forming techniques	2
Continuous incremental change/improvement to existing technology	4
Radical change to existing technology	2
New technology making existing products obsolete	3
Lightweight structure/product	3
Environmental improvement	2
No change: in mature stable technology	1
Don't know	1
Cases: 17	Multiple responses were possible

Source: Tilson, B. (1997d)

The evidence was that suppliers simply do not possess the resources necessary to restructure and re-equip their plants for diversification. A further difficulty was that much of the research into leading edge technologies – for example into plastics with improved characteristics such as light weight, flexibility, and temperature resistance – is conducted overseas, posing questions for West Midlands suppliers about their access and technology transfer capability.

Clearly, resources limitations obstructed their commitment to change, perhaps as much as, if not more than, any cultural or management limitations. It also runs somewhat counter to findings of the European Innovation Monitoring Survey (EIMS). The EIMS holistic view of innovation regards this as a *system* rather than as a *process*, and embraces the total *costs* of innovation, where innovative activity consists not only of R&D, but also in which accessing information and marketing research is important; similarly the acquisition of patents and licences and expenditure on product design. From this perspective, R&D represents no more than 50 per cent of total innovation costs in any European country. Information problems are a big hindrance to innovation. Contrary to expectations, it appears that smaller European firms are more connected to the innovation system than large firms, the latter focusing more of their expenditure on R&D than on other elements of innovation such as information and marketing. This is a crucial finding given the expectation that top-tier firms should be supportive of those further down the supply chain in establishing vertically integrated partnerships for innovation, as it implies that large firms do not have the innovation expertise, or "connectedness" to all the requisite factors of innovation that we would expect of their higher spend on R&D. Like SMEs, large firms, too, need help with accessing re-

Table 3. Summary of Factors Underpinning Increased Competitiveness

Competitiveness factor	*Number of firms*
Cost-related improvements	10
Engineering and process improvements	8
Winning out over the competition	7
Product improvements	6
Human resources-related effects	4
Cases: 17	Multiple responses were recorded

Source: Tilson, B. (1997d)

sources for innovation activity, particularly information – including both technology- and product-related – and help with marketing research (Bosworth et al, 1996). These areas were also raised by West Midlands suppliers as key to their attainment of competitiveness (Table 3).

■ QUALITY AND SPECIFICATION AS SUPPLY CHAIN MANAGEMENT TOOLS

A recurrent and primary concern of West Midlands suppliers, as the research demonstrated, was the growing competition from inward investors – from the US and Germany especially, and from Japanese and other Far Eastern electronics specialists. Another was the very real fear that their customers would transfer contracts to other suppliers by "going global" on purchasing. This heightened anxiety about future prospects, even in the short term. Customers also played suppliers off against each other to achieve the best prices, paring down suppliers' profit margins. But in some respects competition was a misnomer. Japan and Germany were cited as operating protectionist policies. The difficulty of patenting UK technologies in Germany was highlighted. Another area of concern was that inward investor assemblers tended to retain their traditional (foreign) suppliers, even if these remained overseas, rather than drawing up contracts with West Midlands firms. One Birmingham-based second-tier supplier maintained that contracts between the assembler and first-tier supplier at the top of their supply chain specified foreign manufactured components from overseas suppliers, despite the ability of West Midlands second-tier firms to match or even to exceed the required quality. As a result, up to 80 per cent of the so-called West Midlands-made components were actually produced overseas.

While this might be a case of pique, it raises the issue of how "quality" can be employed in procurement practices as an anti-competitive tool to enable customers to retain their traditional supply chain linkages. Although customers may argue that UK suppliers are not able to meet their specifications, this does not necessarily equate to any deficiency in standard. Nevertheless, well over half of interviewed firms (10 cases) reported a problem with the

Table 4. Problems and Constraints Experienced by Automotive Suppliers

Problem/constraint	*Number of firms affected*	*Number for which factor was most serious problem*
Location	4	0
Space	6	4
Quality of suppliers	10	4
Supply chain pressures	10	4
Markets	9	2
Competition	10	1
Labour	8	5
Access to finance	2	0
Profit margins	11	2
Legislation/regulation	6	0
Utilities provision	1	0
Communications and IT	1	0
Transport/roads	6	3
Exchange rates	2	2
Security/vandalism/theft	1	0
Cases: 17	Multiple responses were recorded	

Source: Tilson, B. (1997d)

quality of their suppliers, and for nearly one quarter it was their most serious problem (Table 4).

Vertical linkages also raised issues about the balance of power and dependency in supply chains. A study of Sandwell suppliers found that "customers had some influence not just on their internal operations, but on their sourcing strategies", with the power of the customer extending two or more stages down the supply chain (Doel, 1997). The University of Birmingham research provided clear confirmation that the Ford, Chrysler and GM quality standard, QS 9000, is set to become the industry standard, supplanting ISO 9000. Two-fifths of those surveyed were in preparation to achieve it. Indications are that it will be used by assemblers as a negative force to restructure supply chains and as a tool to wield increased power over suppliers to force them to comply with stringent value chain requirements in order to retain, or obtain, supplier contracts, in a way which Stannack et al (1997) have termed "bureaucratic sourcing".

■ SUMMARY OF RESPONSES TO SUPPLY CHAIN RE-ENGINEERING

Industry responses

The University of Birmingham research showed that firms displayed mixed responses to their problems. Some felt impotent about realigning their businesses to meet insurmountable emerging change; others were determined to transcend their problems. Coping mechanisms included investment, related

and unrelated diversification – including through joint ventures, strategic alliances, acquisition and inter-firm technology transfer – niche production, workforce reduction, outsourcing of labour to retain core teams and use more temporary staff, multiskilling of the workforce, outsourcing of warehousing and delivery operations. Some two-fifths of companies were involved in intra-chain supplier development programmes.

Nine joint ventures or strategic alliances were reported, of which around half were with European partners (Germany, France and Poland), and three were in developing economies of China (two) and India (one). At least two-fifths of firms anticipated more joint ventures in the near future with overseas partners to gain strategic mass in order to compete with large foreign players, to share the development costs of R&D, to install partnership contracts to supply products for distribution, or to achieve business growth by accessing new markets. Acquisitions were also envisaged, overseas investment decisions resting on technological considerations, risk reduction, the need to overcome foreign nationals' investment barriers, or to facilitate international expansion into markets pioneered by their assemblers. Acquisition, too, is virtually the only (certainly the easiest) way for suppliers to expand their customer bases.

To a lesser extent, new methods of process management were evident. One Birmingham supplier had moved from the traditional flow line to teamworking in cells. Resistance to change on the part of the workforce concerned resulted in the failure of the new system. The solution was to construct a new workshop operating the new system alongside the traditional one retaining the old methods, and to phase the latter out slowly. This was a clear instance of workforce attitudes requiring cultural change. Indeed, when managing any change, whether conducted by the firm itself or through a supplier development programme (including Accelerate), a big question mark hangs over how wholeheartedly the internal stakeholders will embrace the opportunity for improvement.

External support

Research brought into sharp focus the fact that support – to manage change, and to invest for the future – was primary. Limited linkages were evident with research institutions (Higher Education, consultancies or research agencies) or with the private-sector agencies such as the Society of Motor Manufacturers and Traders, or the Chamber of Commerce. Trade unions such as the Transport and General Workers Union have a continuing role to play in helping to overcome obstructionist labour practices where they still persist.

Suppliers employed a variety of external sources of support for initiatives such as training and plant investment, mainly from the public or quasi-private sector through grants, including those from the DTI, TECs and Business Links.

The West Midlands also benefits from funding under various UK government and EU funding (ERDF and ESF), targeting supply chain improvements. Key examples include the DTI/SMMT Industry Forum, and the Accelerate Programme.

■ CONCLUSION: POLICY AND STRATEGIC OPTIONS

The pressures endured by automotive suppliers are eliciting mixed responses from them. How well firms can adapt to meet the challenges of change depends particularly on their position in the supply chain, and their technology, not only regarding what materials, products and processes they employ, but also the maturity of their production activity. If the dismal projections of their own death made by firms which took part in the University of Birmingham survey come to pass as soon as forecast, emerging new technology could make many suppliers obsolescent within three to ten years and force them to cease trading.

This raises an important question about intervention – whether to intervene at all, or to allow the cessation and formation of new firms to occur as they will. Letting market forces operate would, in this scenario, result in some sort of equilibrium as supplier numbers will shrink in any case through assemblers restructuring their supply chains. The "do nothing" option, it might also be argued, would entail no wasted effort or resources on assisting firms which were in terminal decline, and thus resources could be targeted at improving or nurturing suppliers with better life expectancies.

This stance is counteracted by a strong conviction that market forces should not be allowed to operate unchecked, given the gravity of the economic impact this would have. It is unlikely that lower-tier suppliers in particular would be able to undertake unaided the radical changes necessary to diversify and survive. It is equally improbable that adequate numbers of new leading-edge firms would be formed. An automotive industry-wide intervention strategy which extends across the West Midlands region, and beyond, should be adopted, which has as its primary goal the proactive stimulation and formation of industry activity in new technologies. This contrasts with, but is not intended to replace, existing intervention strategies which aim to improve the competitiveness of individual firms.

New firm formation or related diversification opportunities include technologies and products with "green" attributes, alternative power sources, and high specification electronics and materials. A dilemma, however, exists in how to determine which fuel/power technology will become mainstream and therefore where to invest tactical resources. Another key question concerns the potential for developing "green" technologies and products. While automotive assemblers like BMW/Rover, GM, Toyota and Peugeot have stepped into the "green" route, much of the R&D is occurring outside the UK (Tilson, 1997a),

and it is therefore likely to be largely overseas suppliers who will reap the benefits. Given this scenario, added strategic responsibility is placed on other agencies such as the HE/FE sector to focus on developing and commercialising leading-edge products, including environmentally friendly ones, in conjunction with first and second-tier suppliers. The strategic direction, co-ordination of the activities of disparate agencies, and the targeting of resources, may be better accomplished when the West Midlands Regional Development Agency is up and running. The new RDA could well emulate the Welsh Development Agency, which has plans to build a "green" car in Wales, with components sourced – and therefore perhaps developed – locally.

There is recent support from Bosworth et al (1996) for the strategic innovation-centred approach from research into achieving innovation potential in European industry, although from a larger spatial perspective. "Innovation", they argued, is not "a stand alone activity ... the implication [being] that ... it may not be sufficient to direct policy at individual firms ... [but] to improve the working of the whole innovation system." Sternberg (1996), too, has drawn attention to the role of "implicit and explicit technology policy" at the regional level as a key determinant of high-tech regional development. And, in respect of learning economies and innovation systems, the role of government policy has been described as "crucial ... to support learning" (via training institutions and systems, incentives and access to learning) "... and, sometimes, forgetting" (through retraining, labour market mobility etc) as well as "keeping options open by protecting technological and institutional diversity and promoting an openness to learning from abroad in different fields of knowledge" (Gregersen and Johnson, 1997; Dalum et al, 1992).

Exploiting opportunity in the West Midlands therefore does not solely concern technological development, but also new structures and systems to underpin innovation activity, and new ways of working, for example through attaining synergies between firms in different sectors collaborating on R&D/commercialisation. And, not only across sectoral linkages, but also via a new type of collaboration between suppliers who are erstwhile competitors, much on the lines of development partnerships in the IT/communications field – not talking shops like networks or business consortia, but actively pooling resources on R&D projects to develop the next wave of technologies and products. This accords with the notion of "untraded interdependencies" involving a range of structures, processes and values, and including public and semi-public institutions, advocated by Morgan (1997) as vital elements to nurture the innovation process; or, the value of networking and the development of a robust business support system which have been identified as among the key ingredients (together with "distinctive interventionism and free enterprise") for Wales' economic success (Thomas, 1996).

Encouraging existing companies to develop and spin out environmental

and leading-edge technologies requires risk taking and venture capital. A higher electronics industry profile would also benefit the West Midlands region's development of advanced electronic technologies, not only for automotive but also for other applications, including communications and consumer electronics. It needs better skills development in this area, too. A Fraunhofer-type institution is needed, based in the West Midlands conurbation with a broad technological remit and a commercial focus which is not hindered by relying on consultancy contracts (Tilson, 1997c). But all this must be directed and managed, not by the various public and private-sector agencies operating almost adversarily, but in a concerted manner to ensure that future challenges are met.

Note

This paper expresses the opinions of the writer and does not necessarily reflect the views of the West Midlands Development Agency or its partners.

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