Foresight

Making the future work for you

UK Manufacturing: We can make it better

Final Report
Manufacturing 2020 Panel

M2020 Foresight panel

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The following Foresight Associate Programmes are affiliated to the Manufacturing 2020 Panel, have made specific contributions to the work of the Panel and are building on generic Manufacturing 2020 findings for the benefit of their own sectors, professions, organisations and technology fields.

Associate Programmes underway:

■ Manufacturing Machinery in 2020 – The Advanced Manufacturing Technologies Research Institute – Contact: Derek Palethorpe Tel: 01625 425421, Fax: 01625 434964, email: *palethorpe@amtri.co.uk*

■ Productivity Futures – The Institute of Management Services in the UK – Contact: Steve England Tel: 020 8363 7453, email: *dg@imgtserv.co.uk*

■ The key economic, technical and social influences on manufacturing – The Institute for Manufacturing – Contact: Professor Mike Gregory Tel: 01223 338195, Fax: 01223 338076, email: *mjg@eng.cam.ac.uk*

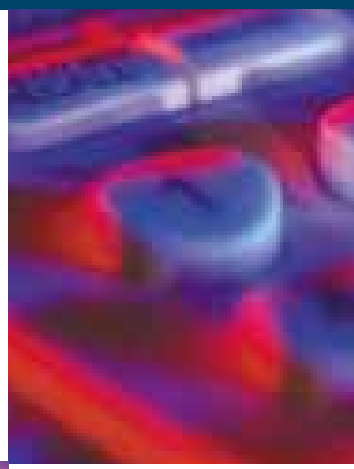
■ Energy and resource efficiency in a variety of manufacturing sectors – The Institution of Mechanical Engineers – Contact: Brian Robinson, IMechE Research and Technology Manager, 1 Birdcage Walk, London SW1H 9JJ, Tel: 020 7222 7899, Fax: 020 7222 4557.

■ 'Vision in Foresight' – The British Machine Vision Association – Contact: Dr T J Ellis, Department of Electrical, Electronic and Information Engineering, City University, Northampton Square, London, EC1V OHB, Tel: 020 7477 8126, Fax: 020 7477 8568, email: *t.j.ellis@city.ac.uk*

■ An initiative to advance the commercialisation of microsystems technology – Faraday Foresight North West – Contact: David Tolfree, Daresbury Tower, Keckwick Lane, Daresbury, Warrington WA4 4AD. Tel: 01925 264347

For more comprehensive information on the work and findings of the Manufacturing 2020 Panel, visit the Foresight website at: *www.foresight.gov.uk/manu2020* or send a fax to: Manufacturing 2020 Team on 020 7215 6715

Foreword



The United Kingdom has a long history of manufacturing and for many people manufacturing has "had its day". For the last eighteen months I have chaired a panel of experts from academia, industry and public service who have looked into the future.

This report, *We Can Make it Better*, is our view of what the future holds. It is not, however, our view alone: we have consulted broadly across the country and with Foresight teams around the world; with key experts in developing technologies and across industries; and with academics and computer modellers. The report reflects these and other inputs from affected bodies and areas.

The Panel sought to respond to these key objectives as we developed our thinking:

1. to deliver a robust, relevant vision of 2020 which UK manufacturing industry, encompassing the entire process from market to product delivery, can use as a basis for strategic planning and action today.

2. to provide an insight into the technologies which may present opportunities or threats to UK manufacturing in 2020.

3. to encourage a true partnership between Government, the education system and manufacturing industries to create the economic, legislative and physical infrastructure and to foster the development of the skilled workforce, working practices and methodologies to support UK manufacturing in 2020.

4. to work with Sectoral Panels and provide visions of the future that can be developed to address specific industry sectors and cross sectoral issues.

5. to change the corporate behaviour of UK manufacturing industry by encouraging, supporting and celebrating soundly based entrepreneurial practice and supply chain relationships.

6. to deliver an implementation process for embedding Foresight into UK manufacturing industry practice.

Our fundamental conclusions are:

- 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 be a European manufacturing "competition" – but the UK can succeed.

The key issue now remains:

- Putting the recommendations into action, not just nationally but at the level of every company and individual involved in manufacturing.

To this end, I encourage all to reflect on the insights and recommendations contained in the report. Think purposefully and creatively about your own future in this context and then, most importantly, ***act.***

The main task of the M2020 panel is now over. I would like to thank my fellow Panel members, all who contributed and, importantly, the dedicated Panel staff. For me it has been a personally enriching and broadening experience which has provided new and challenging perspectives. I hope it does the same for you.

Nick Scheele, Chairman, Ford Europe

Strategic recommendations

Government to Improve the Climate for Manufacturing Industry (see pages 7-8)

Manufacturing is critically important to the UK's economic vitality and sustainability. Therefore a clear message should be sent throughout Government to give substantially more weight to the potential short and long term impact on manufacturing of any new macro-policy, and particularly to maximising the positive implications for the climate for manufacturing industry. The Government should seek, as a continuous process, to raise the attractiveness of the UK as a manufacturing base.

A Chief Manufacturing Adviser should be appointed from industry for a limited period to catalyse the necessary culture change across Government and to provide a focus for manufacturing issues within the DTI.

Companies to Increase Strategic Focus and Strengthen Service (see page 10)

- Manufacturing businesses need continuously to reassess their core strengths and competences against globally competitive standards and benchmarks. Companies will need sharply to increase their focus on key, high added-value products and technologies, yet simultaneously broaden the total service spectrum within which these are brought to market.
- Companies should actively seek strategic alliances, often of necessity internationally, to meet these increasingly demanding and superficially conflicting objectives. The DTI and CBI should encourage, promote and facilitate this restructuring, the need for which is not confined to the so-called (and misnamed) old economy.
- Company boards and shareholders need, via improved mutual communication, to recognise that the returns on required investments will not always be short term. There will be an increasing role for private finance in this total process.

Companies to Lead in Environmental Standards (see page 11)

The DTI and the CBI should collaborate actively to encourage companies to use ISO 14002 certification and the certification of all their manufacturing sites to ISO 14001 to drive the reduction for waste and demonstrate the sustainability of their operations.

Research Community to Strengthen Relevant Research Areas (see page 12)

Research providers and delivery systems must become more agile, responsive and approachable. Research in innovative products, technology and business processes should be dramatically stepped up to complement the UK's existing world-class science base research. Specific areas for future research need to include:

- Understanding how UK supply chains are structured, developing the tools and web based applications to enable real time modelling and decision making inside a company and shared with customers and suppliers in the chain.
- Technologies for distributed manufacturing, micro-manufacturing and intensive processing, using less water and energy.
- Technologies to enable the more effective and intelligent use of physical logistics infrastructure – of road and rail – to enhance customer service, reduce distribution costs and reduce the impact on the environment.
- Agile, lean and remote manufacturing technologies and systems greatly to increase added value in manufacturing processes, drive out waste and at the same time enable mass customisation or 'manufacturing to a unit of one'.

Stimulate Mechanisms to Improve Applicability and Transfer of Research (see page 13)

The DTI should stimulate mechanisms (processes, bodies, programmes) for further development of research results into implementation-ready products, technologies, applications, processes, skills and knowledge. As part of this process the profile and support for Universities' third leg funding needs to be enhanced. There should be an active conduit for matching business needs and opportunities with demonstrated research results and capabilities which would particularly benefit small and medium sized companies. This would ideally include the temporary transfer of people between research centres and operating companies and between customers and their suppliers.

This recommendation could sensibly be taken forward through the office of the Chief Manufacturing Adviser.

Improve Public Understanding of Industry and Attract Young People (see page 14)

To raise awareness of manufacturing industry across society, improve the image of manufacturing industry and attract high quality young people, industry should participate in providing all school children and teachers with direct experiences of industry, closely related to the national curriculum and with classroom activities encouraging innovation and creativity, revealing industry as an exciting place to work. The Government should support the activities of Young Foresight, the Industrial Trust and similar initiatives as part of a coherent mechanism for providing the experiences described.

Educators to Develop Responsive Learning Products (see page 15)

The drive for lifelong learning offers educators a strategic opportunity to develop their role and increase their influence by providing education products and services quickly and responsively to companies and individuals. The value of these services will be enhanced if they can be integrated into 'on the job' learning and offered through open systems enabling access at a distance.

Educators should increasingly seek to form alliances with companies and industry groups to provide a complete staff skilling service, becoming a strategic part of their customers' people development programmes.

Individuals to Take Ownership of own Skills (see page 15)

While companies clearly have an obvious need, not least in their own interests, for continual training and development of their workforce, every individual needs to take advantage of opportunities regularly to enhance and refresh his or her skill levels, both within employment and in his or her own time. Taken across the whole of manufacturing industry, the result will be dramatic and necessary increases in skill and capability of the workforce serving UK manufacturing industry, increasing its international competitiveness and enhancing the attractiveness of the UK as a manufacturing base for international companies.

Build and Maintain a Reliable Logistical Infrastructure (see page 16)

Government should ensure that the physical infrastructure in the UK, which includes the telecommunications network as well as the road, rail, air and shipping links, is brought up to world-class standard to support and maintain the world-class manufacturing base the UK is aiming for.

The importance of UK manufacturing

Manufacturing is by far the largest single contributor to the global economy accounting for nearly three-quarters of the World's trade.

It is a significant component of the UK economy. It adds to the well-being of the nation by fundamentally affecting employment, wealth creation, international standing and quality of life.

Manufacturing generates two-thirds of the value of the UK's exports, directly provides 4.3 million jobs and accounts for 20% of GDP. In certain regions, the manufacturing sector is the major employer.

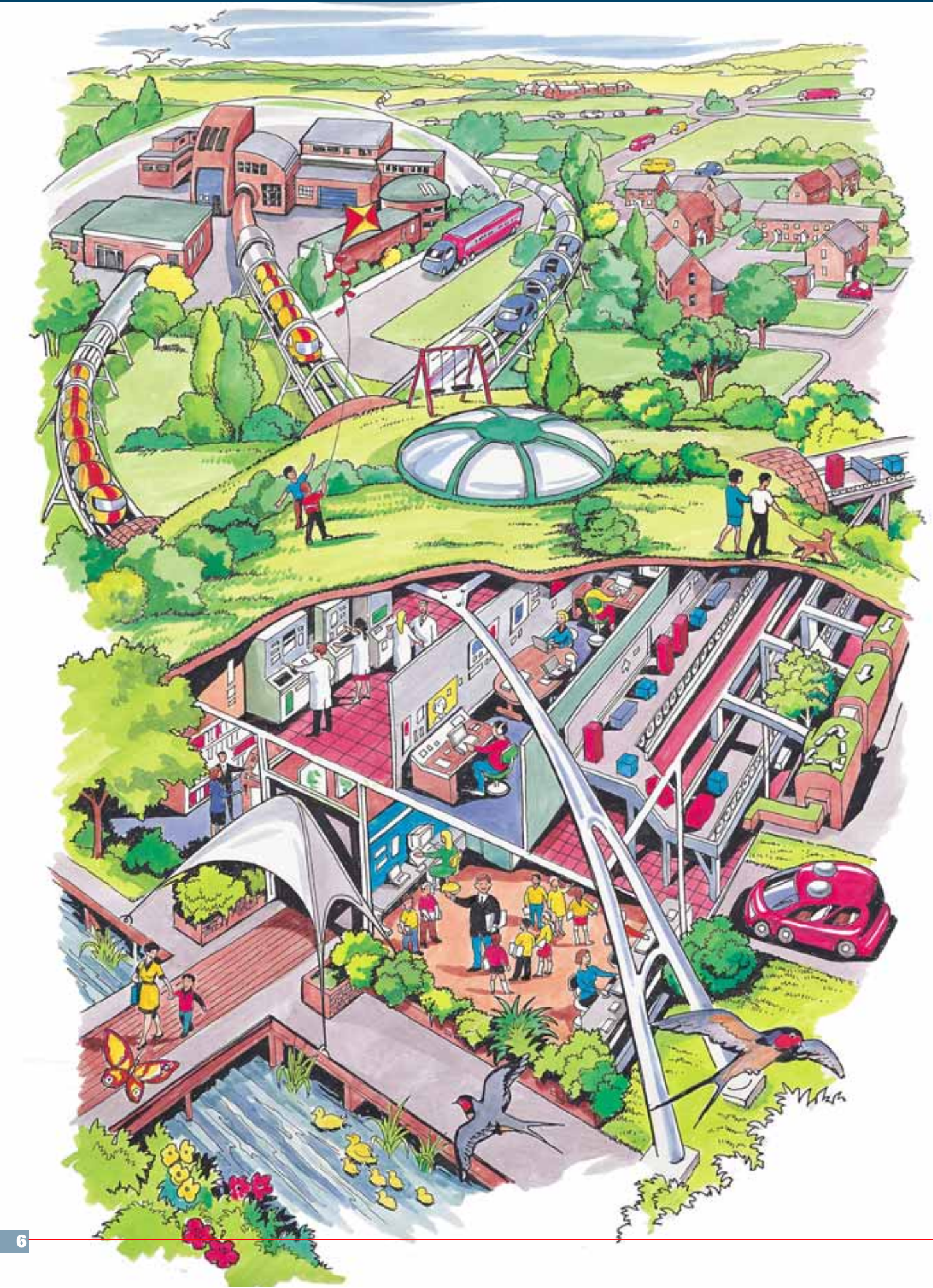
However, what is often overlooked is that other sectors in the UK are interlinked with manufacturing and could not exist without it. Many service sectors, such as wholesale and retail distribution, maintenance and after-sales, have manufactured goods as their *raison d'être* – and these services contribute further to GDP. So the proportion of GDP that depends on manufacturing is greater than the 20% figure mentioned above. This fact is often hidden by the re-categorisation of service functions that were previously classed as part of manufacturing, once they have been outsourced.

Manufacturing output in the UK is rising: it went up by 0.9% over the last year. This contrasts with, for instance, the early 1990s, when it fell by over 7%. Productivity is rising by around 4% this year and exports are rising; goods export volumes are up by over 9%.

UK manufacturing is an important part of the global knowledge-driven economy. The UK plays a leading role in a number of sectors, such as pharmaceuticals and aerospace. In addition, the profitability of UK manufacturing increasingly depends on high value-added output, so manufacturers are constantly looking to develop and exploit new and specialised knowledge.

In a global manufacturing society, the UK is in direct competition with other countries to be the base for individual companies' operations, both regionally and globally. For the UK to succeed in the face of this competition, it must provide an attractive environment for manufacturing companies. As well as retaining its current strengths, the UK must provide an attractive fiscal structure, minimise bureaucracy, improve the logistical infrastructure and provide good standards of education and lifelong learning opportunities.

Manufacturing 2020



The changing nature of manufacturing

Manufacturing is being redefined. No longer is service seen as something outside the realm of the manufacturer; rather manufacturing is becoming the provision of complete service over the whole product lifecycle. This new service provision requires manufacturers to get much closer to their customers and to operate far more responsively than they have in the past.

One of the pioneers of this new approach is the jet engine industry, where both Rolls-Royce and, subsequently, General Electric, have offered power by the hour rather than selling their jet engines, bringing benefits to both sides. The customer gets assured service and a strategic partner to help develop its business, releasing it to concentrate on core value-adding activities. The manufacturer gets an increased and smoother revenue stream from taking on the burdens of maintenance, repair and replacement, is better able to schedule the use of its capacity and receives constant feedback to improve future engine designs.

GE's mission statement is to be a services-led company based on the supply of manufactured products – an approach that surprised many when it was launched in the 1980s. It has since become something of a blueprint for industry.

In this country, industrial gas supplier BOC has found that it can serve its major customers better by setting up gas production facilities at their sites, rather than delivering gas by tankers. Again, both parties benefit: the customer gets assured, just-in-time supply, while BOC cuts the costs of its logistics operations and reduces the environmental impact of its transport fleet.

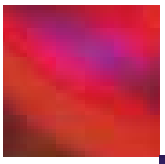
The BOC example is interesting because not only does it illustrate thinking 'outside the box' – away from functional separations between manufacturing and services – it also shows how localised manufacturing can be used to reduce the strain on the road network.

Changes in the business model are going to be very rapidly accelerated, and driven, by the internet. It is the catalyst and prime enabler for the most radical change in manufacturing since the Industrial Revolution.

It will impose real-time transparency on all manner of transactions from point of sale to initial point of raw material manufacture and continue customer (and product) contact throughout the life of the product. It will reduce the barriers to entry, empower consumers and reinforce the need for manufacturers of commodity products to differentiate themselves.

Business, in general, has the most to gain from this on-line revolution because of the amazing levels of flexibility it offers across all parts of the business spectrum and the potential for eliminating non-value-adding data transfer and manipulation.

The reason why manufacturers traditionally concentrated on operations on their own sites was that they had little detailed information about the outside world. Today, the rapid exchange of information afforded by the internet brings the formation and operation of strategic partnerships, with supply chain partners, and the creation of closer relationships with individual customers within the grasp of companies of all sizes.



Customers too are already benefiting from the Net. It empowers them to source supplies from anywhere in the world and the price transparency that it offers ensures that they will get the best deal. This is where UK manufacturing needs to be especially careful. While giving attention to reducing costs by eliminating waste, manufacturers must not be lured into price battles with competitors, particularly those benefiting from low wage costs. Service, reliability, quality and delivery time are all examples of other parameters for competition on which customers will base their choice of supplier. By getting to know their customers better, manufacturers can compete on the total service package and look to add value rather than cut margins.

The UK has a leading position in a number of manufacturing sectors and world-beating companies in a much wider range of sectors, from Formula 1 to control systems.
Stephen Byers, Secretary of State for Trade and Industry

Strategic Recommendation

Government to Improve the Climate for Manufacturing Industry

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Better communication with customers also enables manufacturers to have extensive and increasing involvement with the customer throughout the life of the product. This means that they can take a much more holistic, or lifecycle, approach. Customer comments can be fed back to influence product redesigns and suppliers of capital equipment can have a greater influence on after-sales service by making use of data gathered automatically, for example, through on-line monitoring and remote diagnostics.

There is already increasing legislative pressure within Europe for companies to take scrapped products back from customers, re-using or recycling as much of them as possible and, indeed, designing them with these objectives in mind. The strategic challenge for manufacturers is to modify their supply and distribution chains to handle returned products on a large scale.

All this means that manufacturers must consider very carefully what their core competencies are. What can they do better than anyone else, and what would be more efficient to outsource?

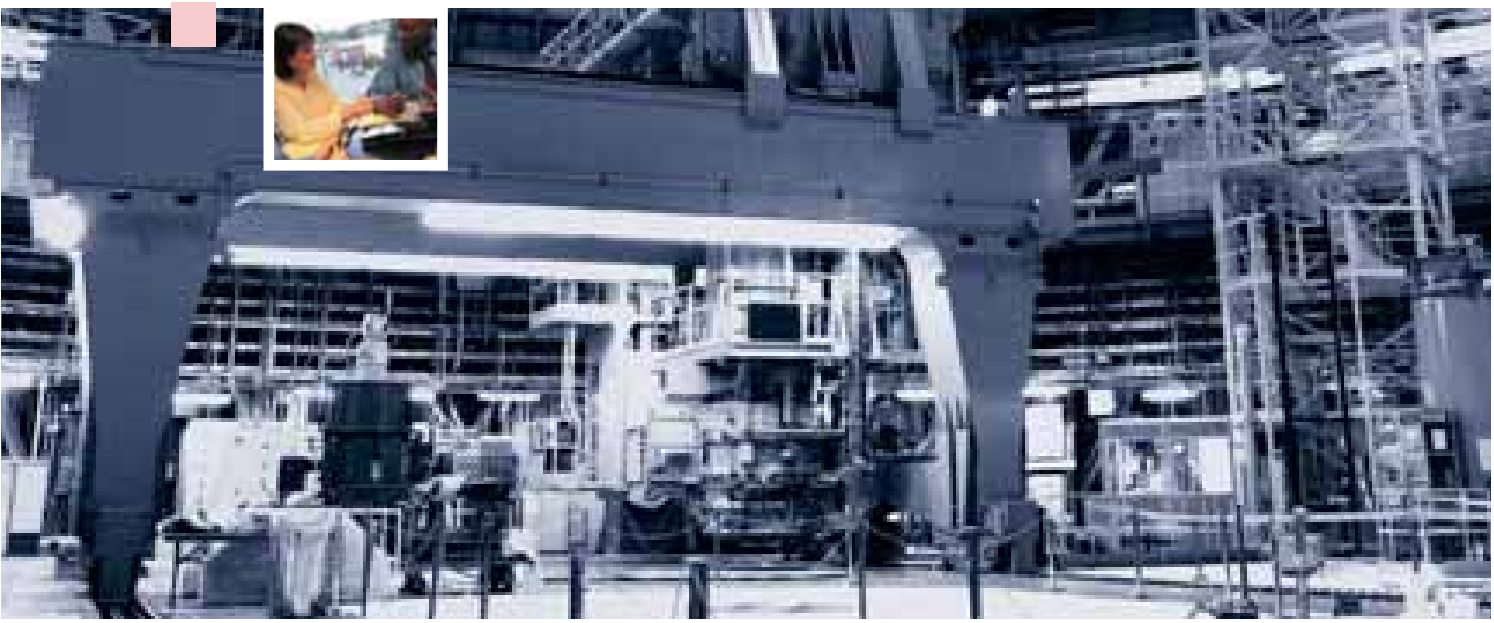
This will lead to manufacturing companies increasingly overseeing the activities of a wide range of partners, who these partners are and what each of them does is not of interest to the customer: what the customer relates to, and trusts, is the brand, in the broadest sense.

So, as manufacturers look to reorganise their operations, perhaps diversifying horizontally into related products and services, their brand – their reputation – will become an increasingly powerful tool in winning and retaining customers.

So far, this trend has been most evident in financial services and in energy markets, but could be equally attractive to manufacturers.

The speed and scope of these changes will vary with industry sector and company size. Some products, for instance, do not lend themselves to on-line specification and purchasing as well as others, so traditional sales channels will continue to be important. After-sales service is not a major issue for makers of disposable goods.

Not all brands can sensibly be applied to products or services very different from that of their origin. But it is vital that every company considers its route map for the future in the light of the changes to the manufacturing environment discussed here.



Manufacturing to a unit of one

Our vision of manufacturing in 2020 is of a customer-driven, high value-added environment with an emphasis on the manufacture of individual products to meet individual requirements.

Mass customisation brings the benefits of customised manufacture – individual tailored products that better satisfy the needs of the customer – to mass production. Under mass customisation, the economic order quantity will fall – making manufacturing to an order of one a reality for many makers of non-commodity products.

Manufacturers will produce, at high speed and in high volumes, differentiated products tailored to the demands of individual customers. Components will be brought together, manufacturing operations carried out, chemical processing undertaken, necessary checks made and the product shipped to the right customer in an order that may be only one-thousandth the value of today's bulk order.

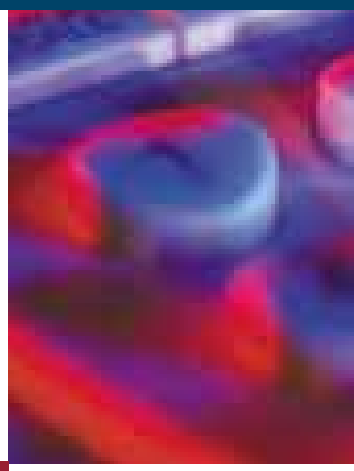
For those industries where larger orders are likely to remain the norm – such as fast-moving consumer goods – the challenge is slightly different. Here, the issue is to increase flexibility with short runs to meet market demands that can change suddenly, and to accommodate ever-shorter product lifecycles due to changing fashions fuelled by aggressive marketing. These manufacturers could also introduce a level of customisation aimed at a geographical region, or district, or a specific retail customer rather than the consumer. To do all these things a number of enablers are required:

- Information systems that can quickly turn customer orders into work orders for the factory, and 'pull' production through the factory in a sequence that satisfies customer demands and those imposed by the factory itself
- Agile production facilities that can switch between making different products, or be reconfigured to re-sequence manufacturing operations (deferring final product differentiation), without incurring long changeover times
- A lean, just-in-time supply chain, so manufacturers do not have to hold large stocks of raw materials and components – some of which they may only need infrequently
- An efficient, low-cost logistics infrastructure

Manufacturers need to be aware of the implications of having a vastly increased number of possible variants available under mass customisation. They must ensure that their systems do not enable customers to order products that the manufacturer cannot make, perhaps because of component compatibility problems, or does not want to make for reasons of brand identity. Systems must be capable of steering customers towards more feasible alternative product configurations. In addition, manufacturers must be able to cost each of these variants by simple rules, so that they do not quote unrealistic prices for their one-off products.

Importantly, because many variants will only be made for the first time when an order is placed, current procedures for certification, based on samples taken from production, will no longer be appropriate – we must move to more process-based certification and approvals mechanisms. If not addressed, these factors could inhibit the exploitation of agile and lean manufacturing in delivering personalised products and bringing new products to market. Current production and tracking processes will also be inappropriate in the world of greater mass customisation.

Because these changes will require just-in-time delivery of components on a large scale, they will create huge opportunities for efficient regional suppliers. The key test for a company in Britain will be to out-perform rivals based in continental Europe and thereby secure the role of preferred regional supplier.



Bombardier Aerospace Shorts

Belfast's Bombardier Aerospace Shorts has won MX2000, the UK's premier award for Manufacturing Excellence.

As well as winning the overall award, Bombardier was placed second in the Product Innovation, Resource Efficiency and People Effectiveness awards. While Bombardier's big win is a culmination of its excellence in multiple fields, an innovation that stands out is its development of a method of reducing the time required for changing an aircraft engine from hours to a matter of minutes. The method, whereby engine covers are peeled back like 'petals', received acclaim from the judges, and is set to revolutionise the way aerospace manufacturers across the world perform maintenance on aircraft.

The IMechE's Manufacturing Excellence Awards MX2000, were sponsored by the DTI and had a particular emphasis on Foresight.

> **The MX2000 experience has been a great opportunity to share in and learn from best practice in all facets of manufacturing.**
> ***Alan Higgins, Six Sigma Master Agent, Bombardier Aerospace Shorts***

Value chain co-management

As we have seen, manufacturing is becoming the provision of complete service over the whole life-cycle of increasingly mass-customised products, conducted in the environment of e-businesses. Every business must take more responsibility for its own future against this background.

Businesses must expand their sphere of strategic consideration if they are to remain competitive. They can do this by either deepening or broadening their scope, or both.

An enterprise, its customers and its suppliers together form a value chain, which competes against other value chains for the attention of consumers. Thus companies in a value chain should view the whole chain from the perspective of the final customer in understanding and developing their respective individual contributions. This applies to all companies, of all sizes. The extended enterprise must comprise all functions that together generate and service the customers' needs in connection with the manufactured product. So, for example, maintenance, finance, logistics, data management and R&D could all be parts of the value chain.

Not every customer and supplier will be strategic partners, but understanding which partners are strategic and which are transactional will be an important choice for the management of every business to make. Manufacturers supplying customers in the upper tiers of supply chains should actively seek to differentiate their offering in a way that helps them become a strategic part of their customers' businesses.

Partnerships will change with time: the same customer may see a manufacturer as strategic for some products and transactional for others. Equally, a supplier may provide some bespoke products and services that cannot be found elsewhere and, at the same time, deliver off-the-shelf products.

All of this means that we have to see these relationships forming and reforming with an agile mindset – constantly scanning regional and global markets to find world-class customer and supplier partners with whom we can increase our chances of winning.

We must also recognise that the UK's flexible workforce ethic is one of our great strengths and nurture it by capturing not just the hands and the minds, but also the hearts of the workforce.

KILLER FACT

"Less than 25 per cent of UK businesses have a comprehensive supply chain strategy and over 15 per cent of those believe it is not integrated with their overall business strategy."

Andersen Consulting Study, Integrated Supply Chain Management – Work in Progress

Strategic Recommendation

Companies to Increase Strategic Focus and Strengthen Service

- Manufacturing businesses need continuously to reassess their core strengths and competences against globally competitive standards and benchmarks. Companies will need sharply to increase their focus on key, high added-value products and technologies, yet simultaneously broaden the total service spectrum within which these are brought to market.
- Companies should actively seek strategic alliances, often of necessity internationally, to meet these increasingly demanding and superficially conflicting objectives. The DTI and CBI should encourage, promote and facilitate this restructuring, the need for which is not confined to the so-called (and misnamed) old economy.
- Company boards and shareholders need, via improved mutual communication, to recognise that the returns on required investments will not always be short-term. There will be an increasing role for private finance in this total process.

An environmentally and socially sustainable future

Manufacturing will change in another way too. Environmental issues will impact at different times and in different ways. Companies will be affected, and will respond differently, depending upon their arena of operations. This fundamental change is the extent to which UK manufacturers operate on a basis of environmental and social sustainability.

The demographic shift will accentuate competition for good staff and individuals will choose to work with and for companies whose values mirror their own: values increasingly biased towards environmental and social sustainability.

These values are spreading throughout society and some consumers are already including these considerations in their purchasing decisions. The impact of this will propagate through the whole supply chain.

Over time, external pressures from the supply chain, final customers, competitors and potential employees will combine with national and international legislative pressures and agreements to require businesses to operate with increasing environmental sustainability.

Those who lag or actively resist this model of operation will eventually be subject to legislation and are likely to have curtailed their customer base and potential employee pool along the way. In addition to individual companies capitalising on the resulting process efficiencies and supply chain partnership opportunities, supply chains who choose to move ahead early will be able to turn these ethical and sustainable operating characteristics into marketable competitive differentiators yielding additional economic business benefits for all partners.

Strategic Recommendation

Companies to Lead in Environmental Standards

The DTI and the CBI should collaborate actively to encourage companies to use ISO 14002 certification and the certification of all their manufacturing sites to ISO 14001 to drive the reduction for waste and demonstrate the sustainability of their operations.

ing manufacturing industry needs to be improved both in terms of research topics and implementation.

In addition to a balanced portfolio of long-term background research and applied strategic research, there is an increasing need for research to be conducted by cross-functional and multi-disciplinary teams to address growing complexities in manufacturing processes. Cross-functional and multi-disciplinary research will be increased if there is a change in the way research funding proposals are valued.

The Panel therefore recommends revising the ways in which academic research is evaluated, by moving from measuring primarily the numbers of technical papers and citations to including applied measures such as patents, patent citations and industry-targeted publications.

Strategic Recommendation

Research Community to Strengthen Relevant Research Areas

Research providers and delivery systems must become more agile, responsive and approachable. Research in innovative products, technology and business processes should be dramatically stepped up to complement the UK's existing world-class science base research. Specific areas for future research need to include:

- Understanding how UK supply chains are structured, developing the tools and web based applications to enable real time modelling and decision making inside a company and shared with customers and suppliers in the chain.
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Technology and innovation

As Michael Porter of Harvard Business School has stated: "There are no low-technology industries, only low-technology companies: companies that have not yet woken up to the potential of technology to transform what they do."

The UK has a proud history of invention and scientific endeavour and must maintain and apply its innovative capacity to succeed in tomorrow's increasingly high-tech world.

The reality is that we are currently living off the legacy of previous innovation. Having reduced spend on research and development to just 1.9 per cent of GDP, near the bottom of the scorecard of industrialised nations' R&D spend.

One of the difficulties is that R&D is often seen as an area where expenditure can be cut without immediate apparent harm. An emphasis on short-term returns has lowered the perceived value of what is, in effect, wealth development for the long term. The effectiveness of applying the UK's competitive research base in support-

In addition, success in a few focused topics will benefit the UK's intellectual capital more substantially than incremental development across a very wide front. In the context of research of relevance to manufacturing and industry the Research Councils should work together in identifying key topics for focused funding.

Globally, the time between the development of research results and financial exploitation continues to reduce dramatically. In order to compete against this background, the UK's research 'master craftsmen' should be involved in developing applications for the exploitation of their innovations. The mechanisms and methodology for technology transfer from research establishments to companies needs to be improved, as does the communication of needs from companies to the research community.

One means of encouraging this dialogue would be to create websites that are industry sector or application specific rather than research centre specific. These sites will catalyse the connections between those who have knowledge and those who seek it, creating a distributed cluster.

However, to be effective these websites need to be managed, so they should be aligned with Industry Sector Fora and embedded in a strategic framework.

Strategic Recommendation

Stimulate Mechanisms to Improve Applicability and Transfer of Research

The DTI should stimulate mechanisms (processes, bodies, programmes) for further development of research results into implementation-ready products, technologies, applications, processes, skills and knowledge. As part of this process the profile and support for Universities' third leg funding needs to be enhanced. There should be an active conduit for matching business needs and opportunities with demonstrated research results and capabilities which would particularly benefit small and medium sized companies. This would ideally include the temporary transfer of people between research centres and operating companies and between customers and their suppliers.

This recommendation could sensibly be taken forward through the office of the Chief Manufacturing Adviser.

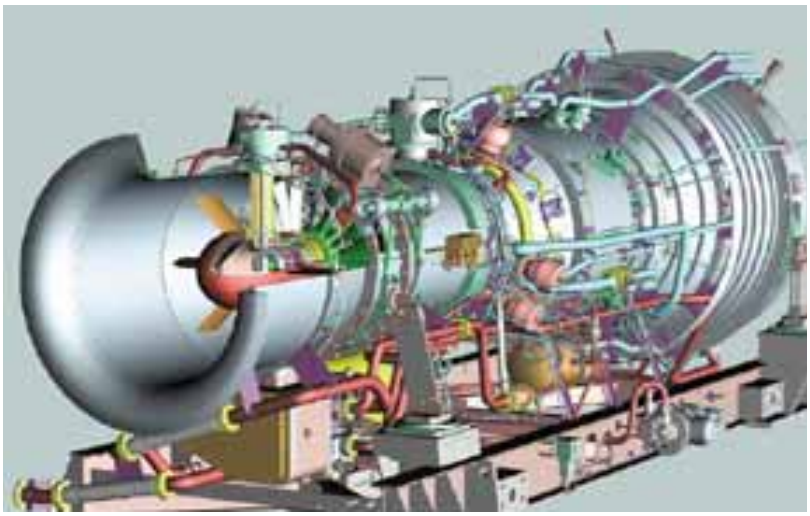
Renishaw

Renishaw is a world-leader in automated metrology, creating products that enable manufacturers to machine components accurately and perform measurement traceable to International Standards. Since it was founded in 1973, Renishaw has undergone rapid expansion, particularly in export markets, which account for over 90 per cent of the Group's sales. Subsidiary companies have been established in the major markets of the USA, South America, Europe and the Far East.

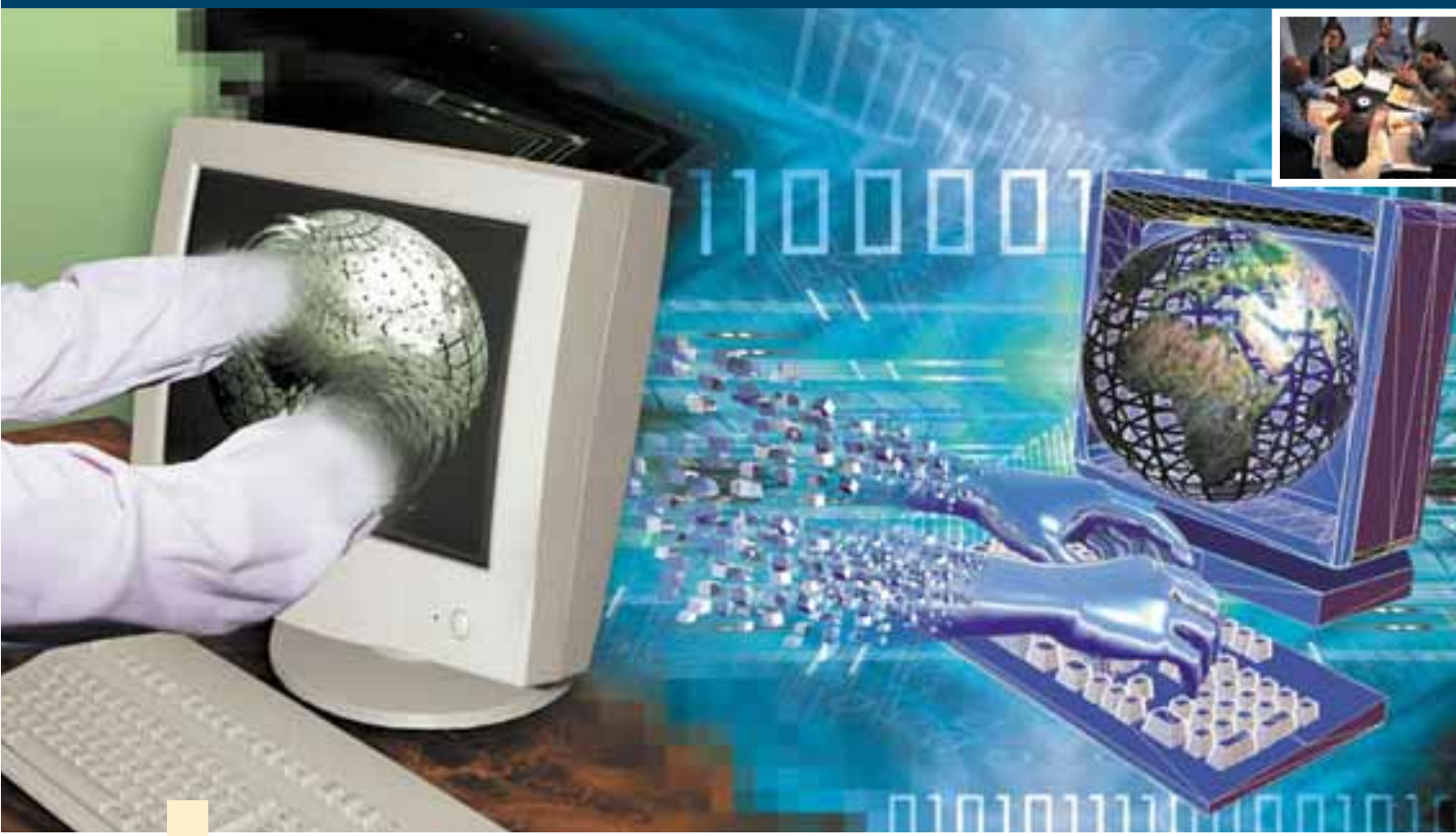
The MX2000 assessors praised Renishaw for the precision engineering that has enabled it to simplify and standardise its processes. Key to its three finalist nominations, however, was its vision. The assessors reported that it is very unusual to see such a strong company vision remain so consistent for so long, while also being clearly communicated. Part of this vision is the approach that Renishaw takes to satisfying the demands of its customers. Against the conventional wisdom that you 'ask customers what they want', Renishaw uses its own deep specialist knowledge and experience as the basis for developing market opportunities.

To promote greater collaboration between research centres, and between industrial research workers and academic researchers, collaborative proposals for research funding should be favoured above single-centre proposals.

To ensure that research is capitalised upon as soon as possible, research proposal project plans should contain a resource commitment to the development of applications.



The UK currently attracts the greatest proportion of US and Japanese R&D facilities in Europe, and universities in the UK are at the forefront of attracting R&D activities from overseas business. *Invest in Britain Euro Bureau*



An educated constantly re-skilled flexible workforce

People will be the key to our future. People and machines working effectively together are more powerful than systems based on either one working alone.

We have to recognise that improving education, skills and training is integral to manufacturing success in a high value-added, service-based economy.

This implies less emphasis on repetitive, low-skilled production work and more on high-skilled services and innovative technology. We will still need craftspeople, perhaps more than now, but we will need a much higher proportion of technicians at National Vocational Qualification Levels 3 and 4. Changes of this kind are already taking place today. In some branches of manufacturing it could make sound business sense to use people effectively to extend the agility and capability of manufacturing systems, enhancing the scope and responsiveness in producing more differentiated goods.

Unfortunately, we are starting at a disadvantage. In developed world terms, the UK's workforce is relatively low skilled.

We must start by attracting the right people to work in manufacturing. We must raise public awareness of what our industry is about, particularly as defined in this report. If companies engage in providing school children with relevant and exciting experiences of manufacturing, young people will understand the exciting opportunities available to them in manufacturing and make better-informed career choices.

Strategic Recommendation

Improve Public Understanding of Industry and Attract Young People

To raise awareness of manufacturing industry across society, improve the image of manufacturing industry and attract high quality young people, industry should participate in providing all school children and teachers with direct experiences of industry, closely related to the national curriculum and with classroom activities encouraging innovation and creativity, revealing industry as an exciting place to work. The Government should support the activities of Young Foresight, the Industrial Trust and similar initiatives as part of a coherent mechanism for providing the experiences described.

Strategic Recommendation

Educators to Develop Responsive Learning Products

The drive for lifelong learning offers educators a strategic opportunity to develop their role and increase their influence by providing education products and services quickly and responsively to companies and individuals. The value of these services will be enhanced if they can be integrated into 'on the job' learning and offered through open systems enabling access at a distance. Educators should increasingly seek to form alliances with companies and industry groups to provide a complete staff skilling service, becoming a strategic part of their customers' people development programmes.

The rate of change in our business is set to accelerate. Moreover, new skills need to be acquired as manufacturing moves towards total service provision over the lifetime of a product. Therefore individuals will require radical updating of their skills several times during their working lifetime. So, as well as improving the overall level of education and training, we must produce a workforce with the generic learning skills to update knowledge and change direction quickly.

The type of training used most in industry is experiential action learning, which teaches the tools needed to manage processes. This is in contrast to conventional education, which trains the mind. We must ensure that our universities and schools prepare us for both.

Education

The education and learning process will increasingly be part of everyone's life, not just for the first few years but spread over one's whole life. Demands on educators and education systems will approximately double and become more complex.

Educators should consider themselves as servicing industry's learning supply chain and become more in tune with and responsive to the rapidly changing needs of industry, in both content and delivery mechanism.

To become a profitable and strategic part of the learning supply chain, educators should seek to form alliances with companies and industry groups to provide complete staff skilling services.

To improve and maintain industrial relevance, educators should seek the free interchange of quality personnel between academic institutions and industry. This message is also for industry and for Government who should provide the mechanisms and the financial support for companies, particularly SMEs, to take advantage of such opportunities.

The demands for skills and capabilities from those involved in manufacturing will change rapidly. The sector will continue to be exciting to work in, offering great opportunities and salaries at least equal to those available in other sectors.

Increasing individual value

Individuals should seek to increase their value and potential through the acquisition of new skills and competencies and become a strategic part of their employer's resource base. Failure to do so will render the employee of the 21st century less secure and more dispensable.

However, for individuals to make the most of the reskilling opportunities available, a supporting culture will be needed. This would offer information on the available options and enable people to pursue them without harming their careers in the short term, perhaps even offering incentives.

The rapid reskilling envisaged here implies that individuals will need access to training in much smaller 'chunks' – the training that they need, exactly when they need it. 'e-learning' lends itself perfectly to this 'just-in-time' approach to training.

Strategic Recommendation

Individuals to Take Ownership of own Skills

While companies clearly have an obvious need, not least in their own interests, for continual training and development of their workforce, every individual needs to take advantage of opportunities regularly to enhance and refresh his or her skill levels, both within employment and in his or her own time. Taken across the whole of manufacturing industry, the result will be dramatic and necessary increases in skill and capability of the workforce serving UK manufacturing industry, increasing its international competitiveness and enhancing the attractiveness of the UK as a manufacturing base for international companies.

Nichols Foods

Merseyside's Nichols Foods won the 'People Effectiveness' award in MX2000. It is the UK market leader in the traditional vending sector and after 19 years in operation, has sales of over £40m annually.

The company supplies food goods to the vending, food service and retail markets and is a strong proponent of excellence in customer service, driven by investment in its people.

Only recently, the company moved into a new area of business under an initial start-up agreement with one of its key customers as a direct result of outstanding customer service.

Nichols has created a unique culture using 'Kaizen' principles which ensures the involvement of all staff in the on-going development of improvements to all processes. The firm was specifically praised for the working environment it had created.

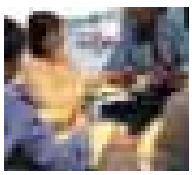
> ***It's about people.***
> ***Martin Lee, Operations Manager, Nichols Foods***

Logistical infrastructure

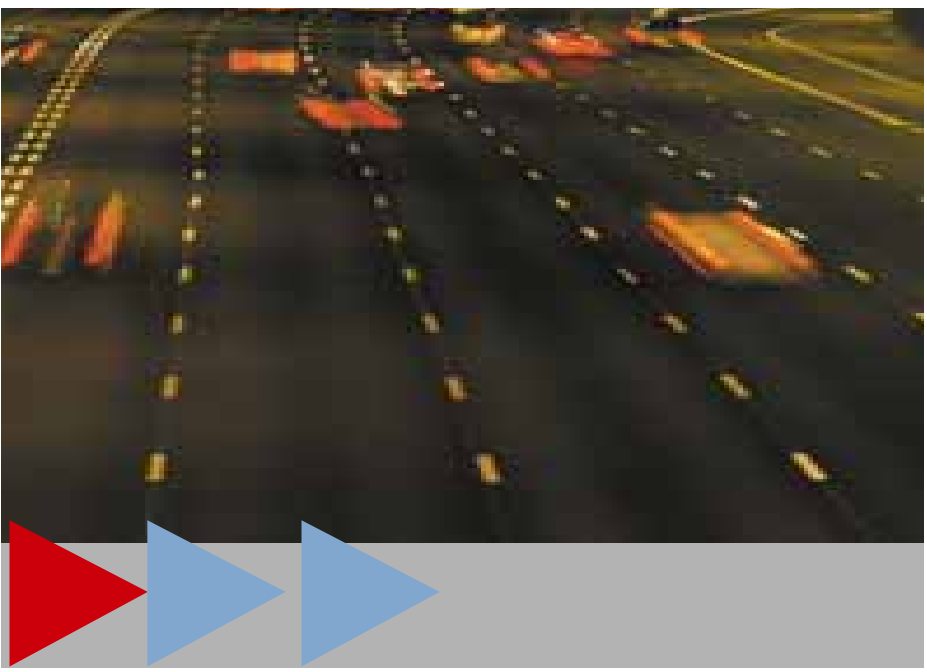
A modern manufacturing society needs a modern infrastructure for delivering finished and semi-finished goods. However, the logistical infrastructure of 2020 will be radically different from today's. In the customer-pulled, high value-added environment, there will be a greater emphasis on delivering individual products as a part of individual solutions; appropriate, effective logistics are critical to achieving this.

On the geographical supply line, from raw-material source to consumption of finished product, manufacturing could take place anywhere.

With manufacturing lead times continuing to fall, delivery time will become a more significant part of the overall lead time to customers. So, to satisfy customer demand more quickly and efficiently, we are likely to see more local, distributed manufacture take hold. This will bring final product fixing closer to the customer, enabling a far shorter time to be spent on non-value-adding activities such as transport and warehousing after the customer order is placed.



Many of the customer-perceived benefits of mass customisation would be lost if products are bundled together and transported over long distances. The logistical infrastructure of 2020 must be able to accommodate more, shorter journeys carrying smaller loads. This will put a premium on the effectiveness and the flexibility of the road network. Achieving both the ideal road infrastructure and its intelligent use will be a critical challenge for manufacturing and, of course, for Government.



The growth of recycling and reuse of materials will accelerate this trend, as 'raw' materials and components could increasingly be sourced locally from disassembled, returned products, creating, in the limit, a closed material loop – shrinking the geographical supply line in distance and time.

The rate at which this happens will depend greatly on fiscal factors – such as fuel prices, road taxes and financial incentives to recycle. In addition, local planning policies will have a bearing on the extent to which small, localised manufacturing facilities are set up, or top-tier suppliers are able to gather their first and second-tier suppliers around them.

A faster supply chain is also a leaner one. Currently, the European automotive supply chain has $140 billion tied up in parts and raw materials en route to factories, stock, work in process and finished cars waiting to be sold. A fully Net-enabled supply chain – just a concept today but clearly achievable within the next few years – could reduce this to some $20-30 billion, freeing up significant amounts of working capital.

Improving cashflow

There are other ways in which different logistical arrangements can improve manufacturers' cash flow. Manufacture during transit is one such example. This can either be literally when the product is on the move, such as picking and packing orders aboard a ship, or when the product form is finally fixed somewhere between the factory and the end customer, say in the dealer or distributor.

In the UK, there is clearly scope for some of the later stages of product configuration to be carried out by third party logistics providers on receipt of customer orders – made easier by new technologies such as digital printing.

Strategic Recommendation

Build and Maintain a Reliable Logistical Infrastructure

Government should ensure that the physical infrastructure in the UK, which includes the telecommunications network as well as the road, rail, air and shipping links, is brought up to world-class standard to support and maintain the world-class manufacturing base the UK is aiming for.

Two futures for manufacturing

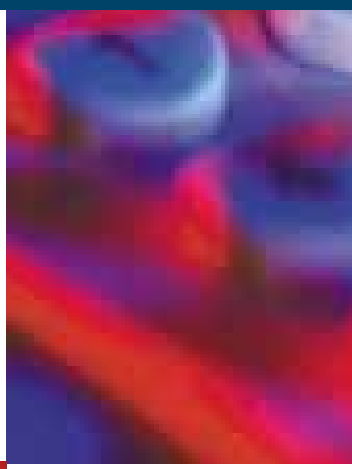
Building on the thinking extended from the input of experts, the Panel commissioned computer modelling to develop two scenarios for the future of UK manufacturing. This was mapped out over the next twenty years.

In this exercise, it was not intended to develop scenarios that would be extreme or far reaching. It was, instead, to provide robust and defensible scenarios of what is generally expected to happen to UK manufacturing, and also what kind of future UK manufacturing could realistically hope to achieve.

This analysis shows a real opportunity window, indicating what potential is open to UK manufacturers on average if we exploit opportunities and address the barriers. This is not just about 'high flying' companies, or large companies, but represents an attainable future across the board.

The futures are mapped out in some detail and are available in full from the Manufacturing 2020 Foresight website. A brief summary follows:

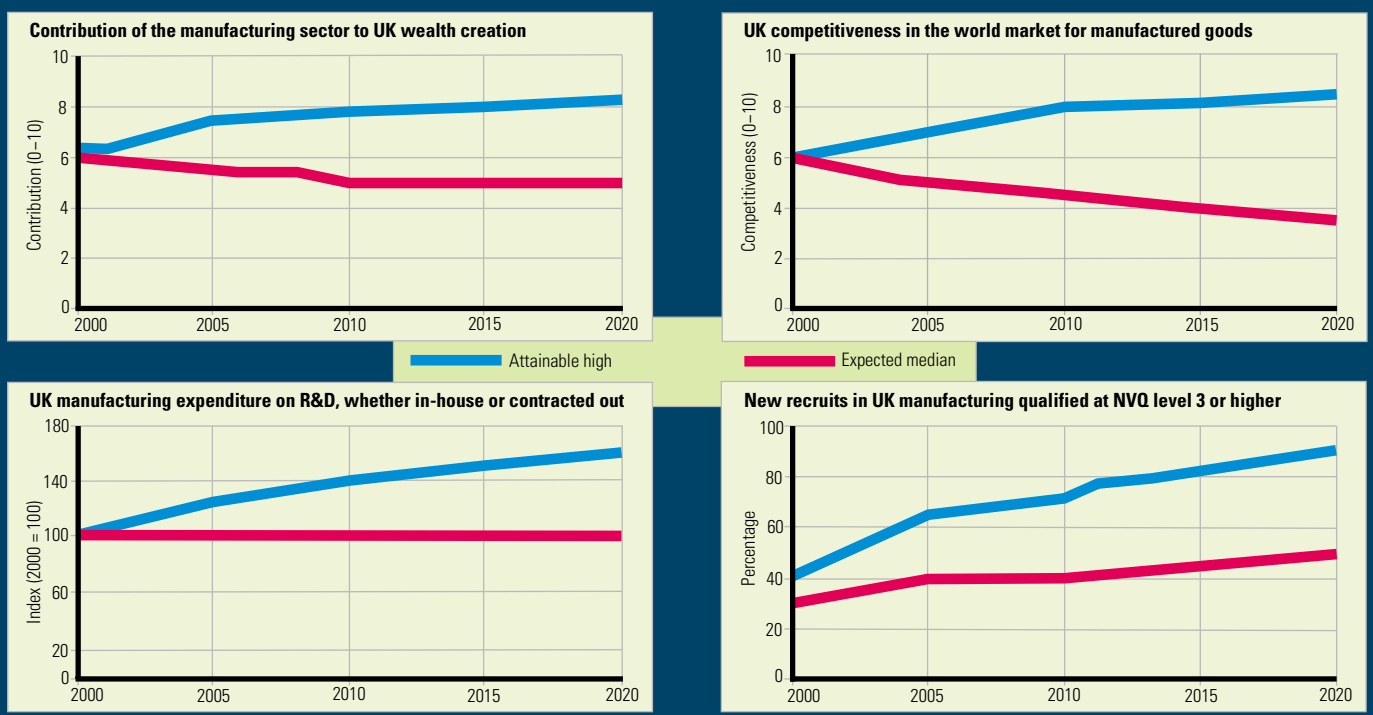
The **expected median** future shows a UK manufacturing base continuing to improve in measures such as output index per hour, time to market for new products, just in time delivery, and workforce qualifications while remaining steady in terms of R&D expenditure. But sadly, in none of these measures does the UK improvement match that of much of the rest of the world. UK manufacturing is still a significant contributor to the UK economy but there is a sense that it could have been much better.



Dramatic growth

The **realistically attainable** future is much more positive than this, with output growth just ahead of the average for the Big Six manufacturing nations, dramatic growth in percentage of GDP attributable to knowledge-intensive products and a steady and sustained rise in competitiveness in the world market for manufactured goods. Workforce qualifications have risen substantially – the study shows 90 per cent of new recruits with qualifications at NVQ level 3 or higher by 2020. More enlightened investment policies contribute to this brighter future for UK manufacturing with total investment rising by over 80 per cent over the period, inward investment by 35 per cent and R&D expenditure by 60 per cent.

By using such a study to build on the Panel's thinking, companies and other stakeholders in manufacturing can be confident of a sound basis for developing their plans and actions for the future.



Making Foresight work for you

Having developed a robust vision of what the future of UK manufacturing is likely to bring, how can we use this to help us be better prepared for the future and, where possible, to shape it to our advantage?

Foresight has devised a toolkit for use by companies, supply chains, trade and professional organisations to help them do just that. The toolkit guides you through a series of steps to help you think beyond your current horizons, formulate viable and relevant strategies and crystallise these into tangible and immediate action plans.

For readers of this report the raw materials for this process would be the broad vision for UK manufacturing industry presented here, sectoral visions developed by other Foresight Panels and Associate Programmes and your own knowledge of and aspirations for your own company, sector, region or organisation.

Several manufacturing companies have already used this new tool and have described it a means of deriving real value for their businesses from Foresight, in a timeframe they can work with today.

For more information contact Foresight Business and the regions team on 020 7215 6706
Some regions have their own Foresight co-ordinator who can help directly:

Region	Name	phone	email
Northern Ireland	Tim Brundle	02890 468362	tim.brundle@nigc.org.uk
North East	Terry McStea	0191 516 4400	terry.mcstea@rtcnorth.co.uk
North East	Samantha Pearson	0191 516 4400	sam.pearson@rtcnorth.co.uk
Scotland	Ewan Mearns	0141 228 2213	ewan.mearns@scotent.co.uk
East Midlands	Steve Fathers	0115 9888 300	stevenf@emd.org.uk
West Midlands	Clive Winters	02476 236812	c.winters@coventry.ac.uk
North West	Stuart Yeadon	01535 636880	

Looking into the future armed with calculated vision can give you territorial advantage in an ever changing landscape. ***Dr Kerry J Mashford, Assistant Director, Manufacturing Foresight***

Sources of Help and Information

Foresight Web: *www.foresight.gov.uk/manu2020*
Fit for the Future A national best-practice campaign, led by the CBI, supported by the DTI. Email: *fitforthefuture@cbi.org.uk* Web: *www.fitforthefuture.org.uk*
Inside UK Enterprise A programme of one-day visits to UK companies committed to sharing best practice. *www.iuke.co.uk*
Living Innovation Shows how, through a commitment to innovation, UK firms can outperform their competitors. *www.livinginnovation.org*
Partnerships with People Helps organisations bring the best out of their people. *www.dti.gov.uk/pwp*
Small Business Service Provides business support, advice and access to experts. Email: *enquiries@sbs.gsi.gov.uk* Web:*www.businessadviceonline.org*
DTI Management Best Practice Provides a range of information and services designed to help companies improve their business performance. *www.dti.gov.uk/mbp*
IMechE For manufacturing professionals and the Manufacturing Excellence Awards. *www.imeche.org.uk*
IEE For manufacturing professionals. *www.iee.org.uk*
CONNECT A series of best-practice CD-ROMs supporting the Partnerships with People practical guide. *www.connectbestpractice.com*
Benchmark Index This allows a company to measure its performance against others in around 80 aspects of finance, operations, management and business excellence. *www.benchmarkindex.com*
ISO The international Standards Organisation *www.iso.ch*
NVQ National Vocational Qualifications *www.lccieb.org.uk*

About Foresight

Foresight is about being ready for the future. The UK's Foresight programme is the Government-led initiative that looks at what might happen in the future and what we need to do now to secure a long-term competitive advantage.

Foresight brings together the voices of business, government, the science base and others to identify the challenges and opportunities that we are likely to face over the next ten to twenty years or more. In doing so, Foresight aims to bring about a culture change for the better in the way business and the science base relate to each other and to the future.

The programme, launched in 1993, followed the white paper on science, engineering and technology *Realising our Potential*. Its panel-based structure operates on a five-year cycle. The current round of Foresight began in April 1999 and work is being taken forward through three thematic and ten sectoral panels – each looking at the future for a particular area.

All panels consider the implications of their findings for education, skills and training and sustainable development.

This report, and those of the other panels, represent the culmination of over a year's intensive research, debate and discussion. They provide the basis from which panels and others will work to help turn the recommendations into action.

Foresight Panels

- Ageing Population
- Crime Prevention
- Manufacturing 2020
- Built Environment & Transport
- Chemicals
- Defence, Aerospace & Systems
- Energy & Natural Environment
- Financial Services
- Food Chain & Crops for Industry
- Healthcare
- Information, Communications & Media
- Materials
- Retail & Consumer Services

A further industry-led panel is looking at Marine issues and there is a task force addressing the impact of E-commerce on business processes and supply chains.

Copies of the full reports for all panels are available from the Foresight web site (www.foresight.gov.uk) or by sending a fax to the Office of Science and Technology at 020 7215 6715.

The views expressed in this report are the personal opinions of panel and sub group members and do not represent the official views of the organisations they represent, the Office of Science and Technology or the Department of Trade and Industry.

Website: ***http://www.foresight.gov.uk/manu2020***

Email: ***info@foresight.gov.uk***

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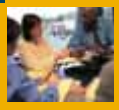

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