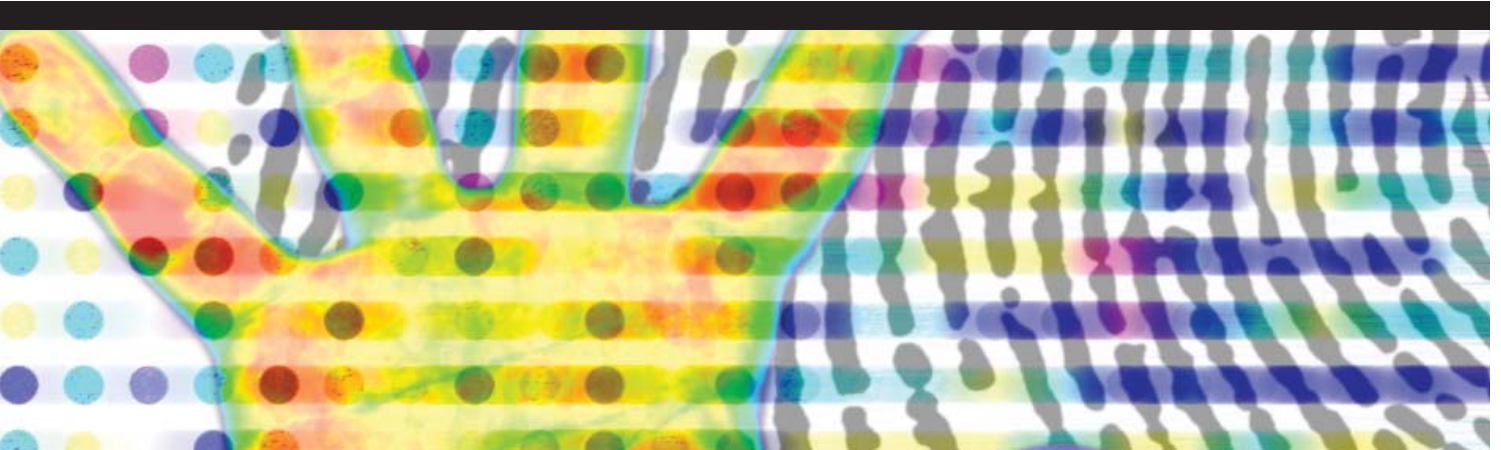


Bioscience and Healthcare



The potential for innovative technology in healthcare and the commercial applications of bioscience is huge: healthcare expenditure alone has been estimated as 7% of global GDP.

The bioscience and healthcare sectors in the UK generated over £23 billion in revenues during 2004, of which £12 billion was directly from the pharmaceutical industry and £11 billion from medical devices. These industries employ well over 400,000 people in the UK, and are second only to the US, with all the global top 10 pharmaceutical companies having significant activities in this country.

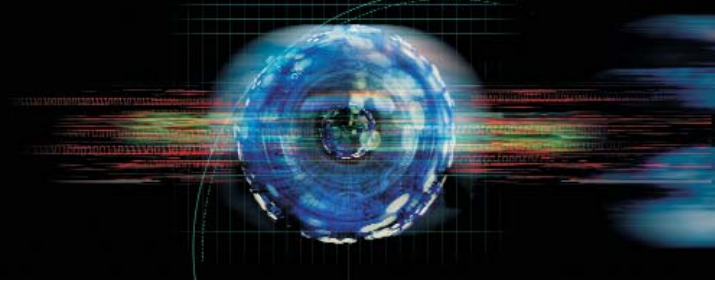
Some analysts consider the potential of other industrial applications of bioscience to be at least as great.

UK capability

Our analysis revealed UK capability in four broad areas:

- **Medical devices** – developing, manufacturing, calibrating and sterilising non-pharmaceutical products for improved healthcare targeting, prevention, diagnosis (including medical imaging), treatment and rehabilitation.
- **Pharmaceuticals including radiopharmaceuticals** – discovery and development of drugs and vaccines.
- **Biopharmaceuticals** – discovery, development and manufacture of pharmaceuticals, vaccines and therapies developed from new biotechnologies such as monoclonal antibodies, recombinant proteins, gene, cell and tissue therapies.
- **Exploitation of bioscience by industry** – use of agricultural feedstocks and biocatalysis/biotransformation technology to develop more efficient, and more sustainable methods of obtaining a significant part of our energy, chemicals and materials needs. Development of novel bioproducts to improve health, energy and water usage, nutrition and efficient use of resources.

While the US is recognised as being the global leader, the UK has the largest and most mature bioscience industry in Europe, based on world leading research in life sciences and related measurement sciences.



Global market opportunity

The trends of an increasingly ageing population; increasing demand for – and costs of – healthcare provision; spiralling costs of drug development; and the challenge of climate change and the need for bio-renewable fuel and feedstocks are global and, as a result, offer UK organisations significant market opportunities.

With the largest healthcare market and cluster of biotechnology firms being located in the US, UK firms will wish to explore the best means of addressing that market. Participating actively in the European Framework Programme is a means for developing capability and establishing partnerships in key European markets. However, the growth of Western diseases in countries such as China suggests that there are wider opportunities to be explored.

Priorities for action

The analysis has indicated that we should prioritise our activities around three main themes, namely:

Medical Devices

- Converging technologies/ regenerative medicine (including bionanotechnology/nanomedicine)
- Assistive technologies
- Improved diagnostic and therapeutic equipment and techniques

Pharmaceuticals/ Biopharmaceuticals

- Delivery of therapeutics
- Therapeutic monitoring including the use of biomarkers
- Biopharmaceutical bioprocessing technology

Exploitation of Bioscience by Industry

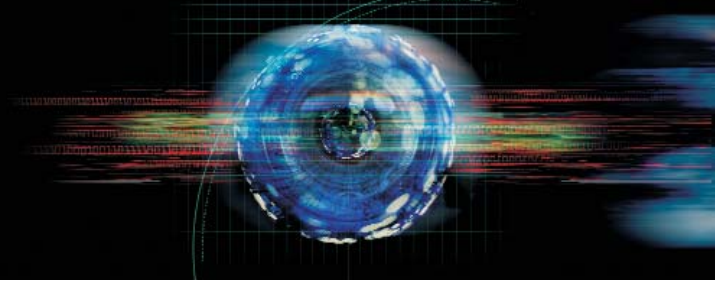
- New, easy and fast tools to discover bioactives functionalities and novel structural biomaterials
- Integrated programmes in development of feedstock, innovative process and extraction technologies and fermentation to deliver multi-product processes
- Biocatalyst design and process optimisation

Consultation to date suggests we need to consider a broader set of measures to encourage uptake. This includes a systematic mapping of the regulatory landscape in healthcare and medical biotech to identify where new standardisation activity would promote more rapid technological development and product uptake. More work on metrology techniques is required to determine pharmaceutical product functionality and in-process purity, as well as in relation to diagnostic and therapeutic applications of ionising radiation and ultrasonic beams. Development and validation of measurement technologies is required to ensure that they improve product safety and activity. We also need to align with technology strategies at a European level, in particular the Innovative Medicines Initiative, to ensure the UK is in the best possible position to take advantage of opportunities under Framework Programme 7.

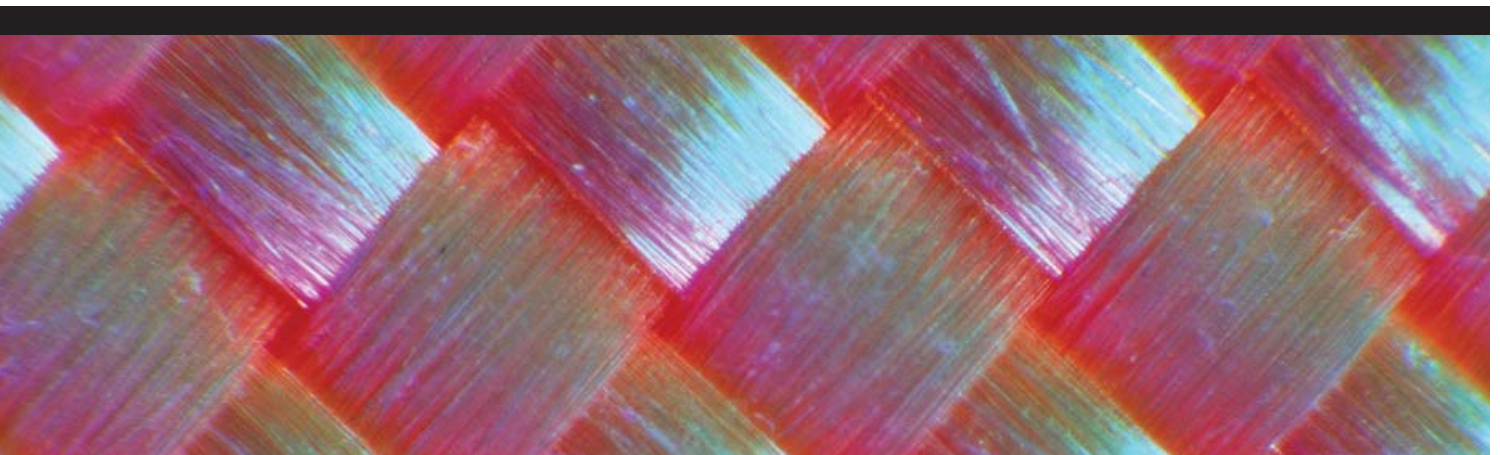
The consultation has highlighted the strength of the UK's capability in the areas above but, in a fast moving market, we need to improve our awareness of global developments and opportunities, and continue to improve our competitiveness by collaborating with the best in the world. Global Watch Missions and the International Technology Promoters provide a powerful vehicle for developing both awareness and contacts.

Take part in the discussion

If you wish to comment, or require more information, please visit www.dti.gov.uk/technologystrategy



Advanced Materials



Against a background of concerns about the environment, resource and energy pressures and increasing global competitiveness, new strategies for materials innovation and application are increasingly vital to sustain advanced manufacturing and methods of construction in this country and to foster the development of a whole new range of activity around new, sustainable, high performance materials. The UK has a strong tradition in materials technologies which is reflected in the success of key value-adding industries in the UK economy.

UK capability

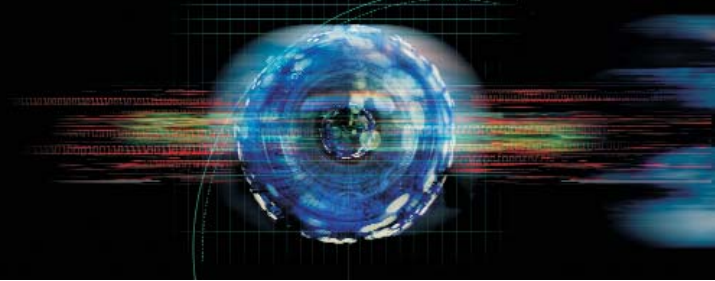
As the recent Innovation and Growth Team (IGT) report indicated, materials are critical to developments in improving the performance of conventional **energy production and distribution** and in ensuring the viability of new, renewable energy technologies such as fuel cells and photovoltaics. The UK has a world class capability in both research and innovative firms in such areas.

In **security and defence**, advanced materials offer new applications in 'bio-tags' and products such as sensors and systems that rapidly scan travellers and luggage or detect dangerous substances. Materials are the essential ingredient of sensing and diagnostic technologies and interdisciplinary work is required in order to model and develop materials and technologies for sensors. Key to bringing these materials to market effectively will be the optimisation of lower cost processing technologies (e.g. direct

writing technology), their successful integration into systems and structures and their subsequent lifetime and reliability.

Developments in materials for **construction and the built environment** are important to improve productivity, reduce health and safety concerns in the industry and to make better use of energy. Construction uses large amounts of protective coatings, structural and insulation materials, so developments in these areas will be of significant benefit.

The UK's large **automotive and aerospace** industries demand lighter, safer vehicles with a smaller environmental footprint. New materials are critical to sustainable transport and therefore critical to achieving the ambitious objectives being set by European regulatory authorities. UK organisations are at the forefront of R&D in materials relating to transport, e.g. composite and lightweight alloy materials.



In **healthcare** there is a growing need for biomaterials and biomarkers to manage and monitor serious clinical conditions over the longer term – another area of UK strength. There is also a growing need for materials that prevent or minimise microbial cross-infections, e.g. control of MRSA in hospitals.

Across a variety of ICT sectors and applications, the UK leads the way with key developments in materials. For example, **organic (plastics) electronics** facilitates the creation of inexpensive, flexible devices, and the integration of electronics with fabrics and a host of other non-silicon substrates. The UK is the acknowledged international leader in organic semiconductors.

Nanotechnology has also been identified as a strong suit for the UK across the following areas – nanofabrication; nanometrology; functional nanotechnology; nanomechanical devices and machines; molecular nanotechnology; particles, clusters and catalysis; nanostructured materials; and ‘extreme’ nanotechnology – which could provide the key to future markets.

Global market opportunity

It is difficult to overemphasise the importance of advanced materials to the UK economy. The development of new products, with improved performance and functionality, will substantially depend on the development of advanced materials. The choice for the UK is therefore stark: global competition in

manufacturing is such that failure to invest in the development of new materials will result in the demise of an advanced manufacturing capability in the UK. This could result in the demise of high value service jobs which flow from the innovation ‘ecosystem’ around hi-tech products. On the other hand, the demand for cleaner transport, new sources of energy, advanced medical devices and a more secure environment is global and the UK has the ability to capitalise on growing demand in these multi-billion-pound markets.

Priorities for action

This exercise has benefited hugely from the work of the business led Materials Innovation and Growth Team (MatIGT) which has identified a number of priorities:

- Materials for energy production and distribution
- Materials in the development of sensors and diagnostic technologies
- Structural materials, in particular composite and high temperature resistant lightweight alloying technologies
- Multifunctional materials, including damage tolerant, self-diagnostic, self-healing materials
- Biomaterials, particularly the development of bioresorbable and bioactive materials

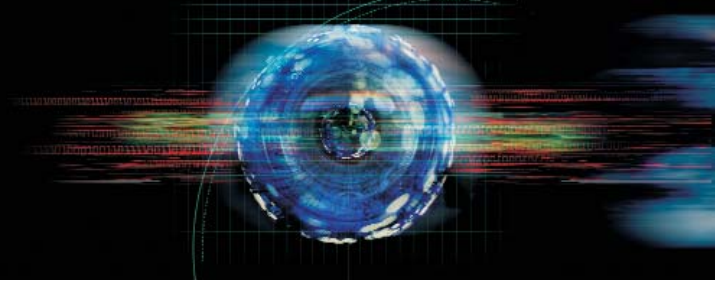
- Nanomaterials, in particular developments that will enhance business capability in working at the nanoscale

Business recommends the acceleration of innovation and diffusion of new technologies in materials by:

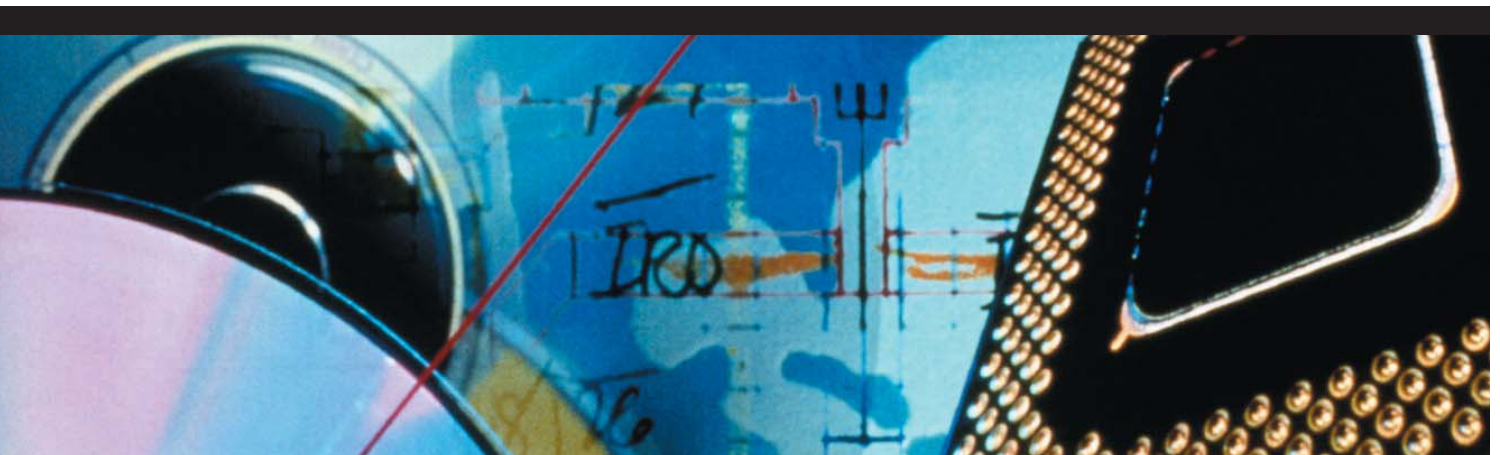
- Better use of UK R&D and National Measurements Institutes (NMIs), to harness the pull of design innovation and facilitate access to the necessary validated materials property data.
- The development of a proactive metrology and standardisation strategy involving the NMIs and the BSI.
- The adoption of a holistic approach to modelling materials lifecycle and longevity underpinned by the data generated from the work undertaken in the diverse materials areas at the NMIs.
- Influencing public procurement to drive through technological innovation for materials and manufacturing facilitated by the availability of reliable metrological data.
- Building on the Materials Knowledge Transfer Network and the National Measurement System's Materials Industrial Advisory and Working Groups to increase the scope of knowledge transfer.

Take part in the discussion

If you wish to comment, or require more information, please visit www.dti.gov.uk/technologystrategy



Information and Communication Technologies



The importance of ICT to the overall economy cannot be overestimated; as an example, a quarter of GDP growth within the EU and 40% of productivity growth can be ascribed to ICT. Alongside this, differences in economic performance between industrialised nations are largely explained by those countries' level of ICT investment, research and use. For this research, an overarching view of ICT was taken – defining it as a means of handling the new currencies of advanced economies, namely data and information. How these are handled by ICT gives us six topics to consider within our ICT strategy.

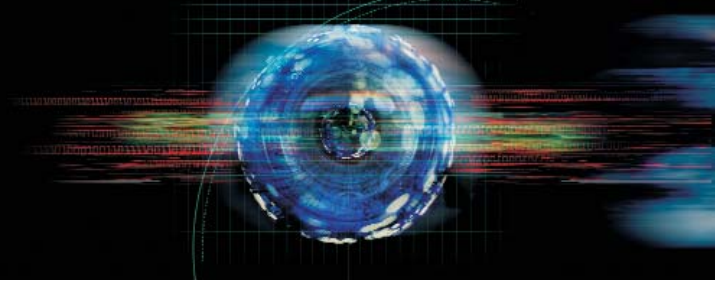
Pervasive systems offer an environment in which billions of pre-programmed or intelligent devices are networked to surround us. In the longer term these interactive devices will disappear and lead to 'attentive computing', in which user interaction is through natural language, gestures or body language.

Key developments in **telecommunications** lie in access and core network systems and the services and content that follow. The challenges include: disintegration, where different economic drivers in the industry cause pressure to separate, convergence of ICT, and fixed, mobile and broadcast technologies, globalisation of the internet and competition from the Far East, and transformational technologies, including ultra-wideband, ad hoc/mesh networks, software radio, all IP networks, Voice over IP, and pervasive ICT.

Inter-enterprise computing is an evolution of distributed computing, providing access to networked resources that are geographically independent in a virtual environment. A key goal will be to allow the creation of new competitive software services

Intelligent systems encompasses techniques such as learning algorithms, adaptive and associative systems. Areas of natural computing include neural computing, evolutionary computing or genetic algorithms and neuro-fuzzy systems. Also relevant here are intelligent agents, knowledge discovery and representation techniques.

The **modelling and simulation** of physical, chemical and biological systems is used to support, reduce and – increasingly – to replace experimentation in engineering. Simulation is especially beneficial when the product development cycle is costly and lengthy, such as in the



aerospace and automotive industries. But it is no less relevant in modelling logistics and traffic flows, financial modelling, simulation as part of the computer games and 'serious' games industries and in architecture – all part of the UK's burgeoning knowledge based economy.

End-to-end **information security** solutions must be considered holistically, including all supporting network and physical security measures, such as identity management methodologies and biometric techniques. There are also soft issues surrounding the human/digital interface, underpinning processes and controls, ongoing management and business continuity strategies. These are being developed through the ICT Network Security Innovation Platform.

UK capability

Thanks to strong academic research and the existence of highly innovative software and communications companies, the UK has developed a powerful capability in these emerging areas of ICT. Many multinationals have located in the UK because of the innovative talent, particularly around clusters of activity such as Cambridge, Bristol, Manchester and in London and the South East. These clusters feed off a range of important sectors, such as pharmaceuticals, healthcare,

aerospace, financial services, retailing, telecoms services, computer games, TV and broadcasting, not to mention the research base itself, all of which have a global capability. It is the synergies between the leading edge research, supplier and user base which underpins the UK capability.

Global market opportunity

To estimate the importance of this market simply in terms of global sales of software and telecoms services would be to underestimate it considerably. All the high value sectors mentioned above rely on the ability to collect, transmit, present, analyse and interpret data. It is early access to, commitment to invest in, and understanding of how best to utilise the latest technologies which will continue to play such an important role in the international competitiveness of all our high value sectors in the years to come.

Priorities for action

Our analysis and consultation with industry has indicated three broad priorities for action:

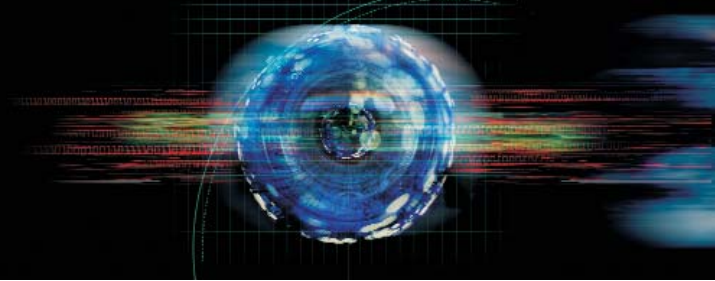
- Developing the technologies above in a way which engages the research, supplier and user communities. We will seek to achieve this in a way which is more challenge or market oriented than hitherto.

- Improving the flow of knowledge about developments, capabilities and market opportunities among the clusters of hi-tech SMEs. The establishment of a Telecoms Knowledge Transfer Network (KTN) to bring together existing networks and initiatives and of a KTN in pervasive systems with a similar remit will ensure the development of sustainable platforms and applications. The recently-established Cyber Security KTN will help address the key barriers to the wider adoption of a range of technologies and techniques that will be key in ensuring trust and confidence in ICT. The Industrial Mathematics KTN must engage further with UK enterprises to exploit the opportunities modelling and simulation provide. Through these KTNs the UK ICT community will also gain a greater contribution to the development of standards in non-traditional settings, such as IEEE, ETSI and W3C.

- Ensuring that the UK's capability in the area of ICT developments and their innovative application is appreciated globally so knowledge based firms, suppliers and users are attracted to the UK as a truly innovative location, regardless of sector.

Take part in the discussion

If you wish to comment, or require more information, please visit www.dti.gov.uk/technologystrategy



Electronics and Photonics



The application of electronic and photonic technologies can enhance the performance of a wide range of products across markets as diverse as transport, security, communications, healthcare and energy.

UK capability

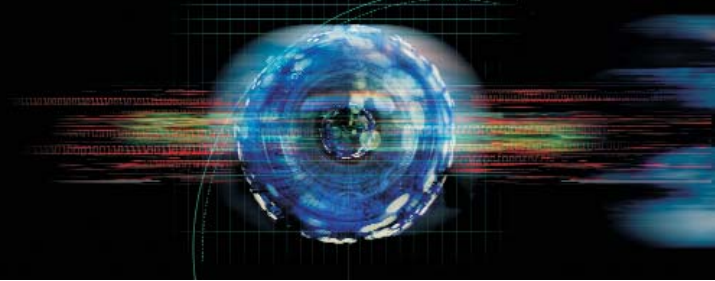
The UK has few indigenous industry heavyweights in this sector. However, we do have many smaller but world-class companies in developing areas like optoelectronics and electronic design. These companies are often powerhouses for creativity and exploitation of our world-class science base in photonics and electronics. In addition, a range of inward investors have R&D and manufacturing bases in the UK.

Globalisation has had a big impact on the industry in the UK. It has led to the offshoring of commodity electronics manufacturing, with a need for UK industry to move up the value chain. This means placing more emphasis on intellectual property-rich technology and design.

Global market opportunity

Worldwide, electronics applications are burgeoning – electronics are performance enhancers, at the heart of most modern products and typically represent over 20% of the cost. Though the market is very cyclical, it has grown consistently and now exceeds £700 billion worldwide.

- **In computing and communications**, electronics and photonics continue to facilitate faster, more versatile and lower cost systems.
- **Security** is a priority – a safer world requires advances in sensing and imaging technologies.
- **Healthcare** is a key area for electronics and photonics applications, such as medical imaging and photodynamic therapy.



- The massive improvements in car safety, emissions and fuel economy are largely due to the incorporation of electronic systems, and this **transport** demand will increase.
- **Environmentally**, electronic and photonic technologies will provide solutions to climate and pollution monitoring. Also, substantial energy savings can be achieved through the development of solid-state lighting.

Priorities for action

Based on the potential for industrial exploitation and UK research excellence, the themes below are priorities for the Technology Strategy over the next three years. The Electronics Innovation and Growth Team, the Photonics Strategy Group, and Foresight identified these as areas of great opportunity:

- Organic/plastic electronics and displays, an emerging field that is poised to disrupt the world of electronic circuits and flat panel displays, with an ultimate market opportunity of over £50 billion. The UK's university departments are doing world leading research, while UK companies have leading positions in early products and a dedicated Plastic Electronic Technology Centre is being developed.

- Photonics, lasers and lighting. The UK has a strong position in this growing field, with a number of significant global players and a world-class science base. The technology strategy will help the exploitation of new opportunities in this £90 billion market.
- Sensors and imaging. The UK has a broad and strong academic base with a range of centres of excellence and businesses with leading activities on sensor systems, materials and image analysis, which we will support to develop this market.
- Electronics design and systems. While the UK is not a major player in the £100 billion market for semiconductors, it boasts great strengths in electronics systems design. We have Europe's largest independent electronics design industry as well as centres such as the Institute for System Level Integration in Scotland.

An embryonic field of great interest is disruptive nanoelectronics. This area is of longer term industrial exploitation potential and supported through EPSRC's programmes.

The European Commission is developing a number of European Technology Platforms in this area, such as Photonics21 and ARTEMIS. We need to ensure that UK industry is well placed to exploit opportunities within Framework Programme 7.

To maintain understanding of developments elsewhere there is potential for a number of Global Watch Missions in electronics and photonics which will be complemented by UK Trade & Investment activities.

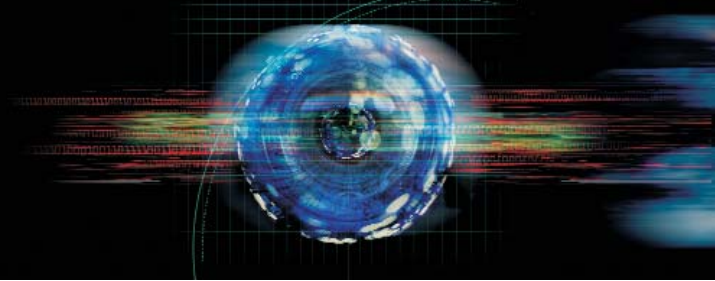
DTI maintains the UK measurement infrastructure, headed by the National Physical Laboratory. In a fast moving area of technology, it is important that R&D programmes in electronics and photonics are tasked to advance measurement knowledge to support the exploitation of future developments in these areas.

User applications

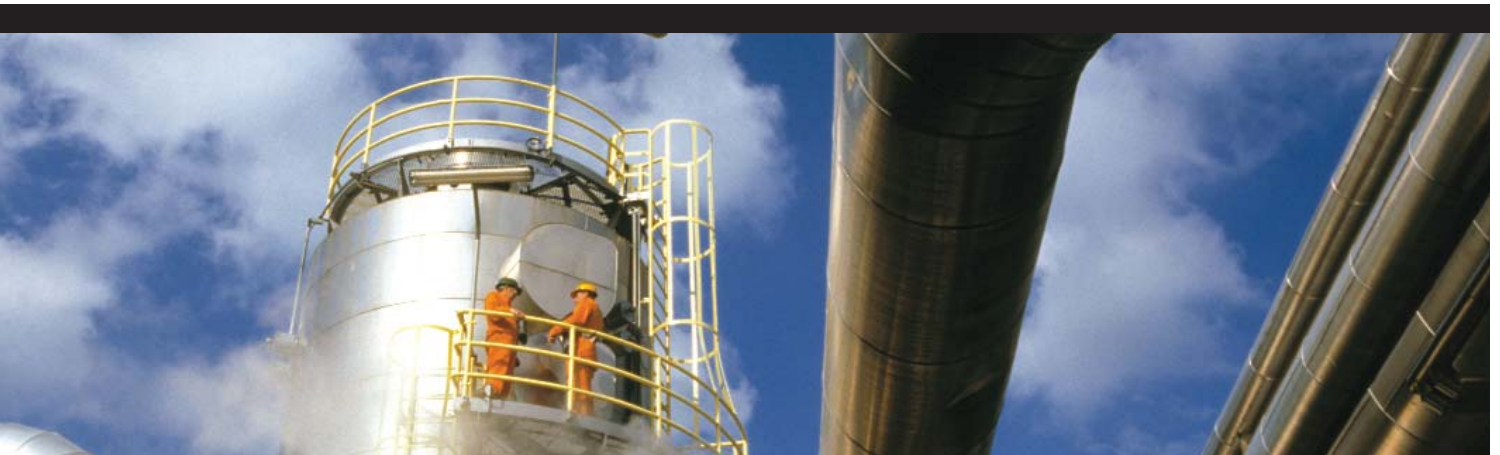
Meeting the needs of users is critical for the UK to stay in the race in this sector. We plan to utilise findings from research to ensure that electronics and photonics developments are 'market-led' and adopt a holistic approach to ensure ideas are adopted and brought to market as swiftly as possible. Recently established Knowledge Transfer Networks on displays and lighting, sensors, and soon-to-be formed photonics, imaging and electronics will also exploit relevant technologies in the UK to increase applications and market ownership.

Take part in the discussion

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Sustainable Production and Consumption



Due to concerns about rising energy and materials costs, and awareness of society's growing impacts on the environment and global climate, the government is committed to setting the UK on a path to Sustainable Production and Consumption (SPC), as set out in the Securing the Future Strategy (2005). We need to achieve economic growth whilst respecting environmental limits, finding ways to minimise damage to the natural world, and making use of the earth's resources in a sustainable way.

Innovative technologies will be one of the main tools used to achieve SPC. Energy- and resource-efficient technologies can reduce operating costs by enhancing the efficiency with which materials, energy and water are utilised, and through the minimisation of waste. They can also help to create new markets, promote competitiveness and enhance corporate reputations, whilst simultaneously providing social and environmental benefits. We hope to support business in addressing SPC across four key areas:

- Resource efficiency, waste and pollution
- Energy efficiency
- Water supply, sanitation and use
- The sustainable food chain

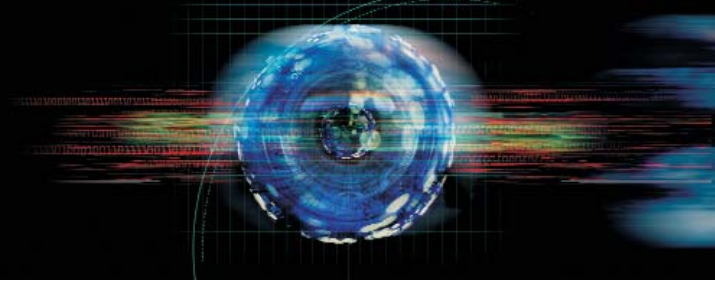
UK capability

In the area of **resource efficiency, waste and pollution**, the UK enjoys a leading position for research and development in resource efficient

products and processes, and end-of-life technologies, with strong industry players in particular markets. Pollution control and remediation technology is a key strength in both research and industry.

The UK has considerable strengths, skills and capabilities in **energy efficiency** innovation, with a strong research base in UK universities, whilst certain UK companies have provided global leadership in championing energy efficiency.

The **water** sector in the UK is well established, with skills and knowledge spanning the whole supply chain, and strong export potential - non-regulated water technology suppliers contribute 80% of export earnings in the environmental industries sector. Future efficiency gains are expected to come in part from innovation, but a sustained effort will be needed to tackle the challenges of increasing demand and climate change.



The **food chain** may be the most environmentally significant aspect of consumption, and the UK research base still retains some of its historic world class capabilities in the three key areas of food chain activity – primary production; food processing; and retail and distribution. There are strong links to bioscience, where the UK is a world leader. Industrial R&D in the UK is limited, but we do have strengths in particular sectors, e.g. chilled food preparation and supply.

Global market opportunity

Worldwide concerns about the impact of economic growth on the environment, not least in the developing world, and the imperative to maintain security of supply – be it in energy, raw materials, water or food – mean that there are substantial opportunities for each of the key priority areas.

- **Resource efficiency, waste and pollution** – the market for environmental products and services is predicted to exceed £315 billion by 2010 (excluding green products/process design and renewable energy), and is currently equal to the global pharmaceutical or IT industry markets. In addition, the global market for resource efficient products and processes is estimated at £98 billion.

- **Water and wastewater** – the global market is expected to exceed £275 billion by 2010, with low cost sustainable solutions for water supply and sanitation an area of particular strategic interest. The desalination market alone for 2005-2015 is estimated at £55 billion.
- **Energy efficiency** – energy efficiency technologies potentially affect all products and industrial processes. Global markets for energy efficiency technologies are extremely difficult to estimate due to the diverse nature of the technologies, sectors and industries involved.
- **Food** – global food retail sales exceed £1.1 trillion annually, with supermarkets and hypermarkets accounting for the largest share of sales. UK spend is £147 billion, including £74 billion gross value added.

Priorities for action

The immediate priority is to build on UK capacity and successful innovation in energy efficiency, resource efficiency, and waste and pollution management, where a more focused and cross-governmental approach is now needed.

Technology strategies specific to sustainable water and food are currently being developed, and we

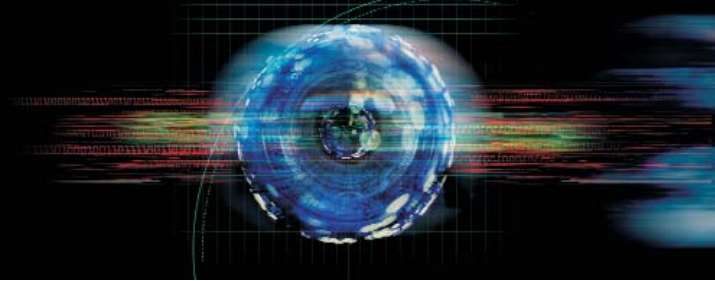
aim to integrate those themes into the SPC innovation agenda as soon as possible.

Regulation plays a key role in driving innovation in SPC technologies, which are also subject to demanding European directives. Working with BSI and the National Measurement System, we need to develop a strategy towards standards and metrology that will help UK businesses cope with the strengthening of regulations flowing from societal concerns about the environment and from concerns about the safety of those working in business. The Knowledge Transfer Networks will have an active role in helping to make more companies aware of developments in technology and the standards/regulatory regime.

There is considerable scope for international collaboration to develop and capitalise on the UK's capability. We also need to work more closely with Global Watch Service and UKTI to develop UK capability and to market it globally. The EU's Framework Programme 7 includes an important SPC element and there is strong interest in the developing world for technologies to meet the very real challenges that they face in terms of water and waste management in particular.

Take part in the discussion

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Design Engineering and Advanced Manufacturing



UK manufacturing employs 3.6 million people, accounts for some 17% of national GDP, and contributes half of all UK exports, but when financial, supply-chain and manufacturing-related services are taken into account, many more UK jobs depend on it. However, the manufacturing sector in the UK continues to face relentless competitive pressures from around the globe, particularly now from the emerging economies of India and China.

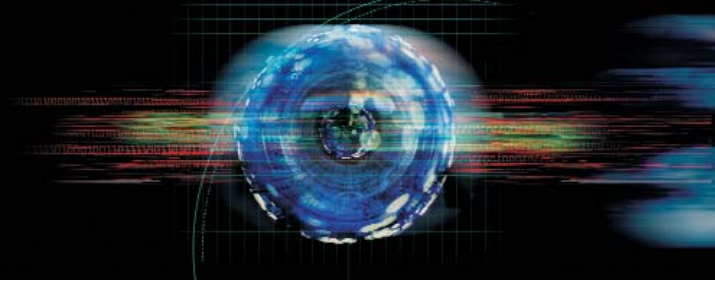
UK capability

Notwithstanding these pressures, the UK retains areas of global excellence, such as aerospace, speciality chemicals, pharmaceuticals, food processing, high performance cars, and advanced/nano materials. In addition, the UK has many successes in prestigious design-led construction projects, and key UK strengths in this sector include problem solving in harsh environmental conditions and for iconic design.

The UK capability is based on strong traditions of excellence in design and manufacturing among our leading companies, high quality research in engineering, biosciences and ICT and a flexible and

innovative approach to business problems. The Innovative Manufacturing Research Centres and Grand Challenges, established by the Engineering and Physical Sciences Research Council, represent a significant research resource for UK businesses which have an interest in the latest developments.

The best companies in the UK are recognised by competitors to be among the best in the world but there is, of course, a range of capability. The Manufacturing Advisory Service (MAS) is helping to address this through assisting companies to improve their business processes.



Global market opportunity

Competition from emerging economies and the speed/reduced cost of communications has moved manufacturing to a system of global supply chains and much greater specialisation of activities between countries. This, together with shortening life-cycles and time-to-market for products and services, increased environmental pressures and sustainability issues, are the key drivers of change facing UK manufacturers. They also present market opportunities for those firms which adapt to the new situation.

These opportunities lie, not only in the markets of the developed world, but increasingly in the developing world where growing affluence and demands for a modern infrastructure are resulting in increasing demand for quality products based on innovative design, high functionality and precision manufacture – areas of UK strength.

Priorities for action

Taking account of a range of Innovation and Growth Team (IGT) reports, national strategies, such as the National Aerospace Technology Strategy, and the major European initiative in this area (Manufuture) together with the feedback from workshops which have been held to discuss this topic, we consider the priorities for action to be as follows:

New business models for enterprises:

- Lean manufacturing and processes (resource efficient, low cost, sustainable manufacturing processes)
- Digital manufacturing businesses (including collaborative environments, networked business, through-life services)

Design, simulation and modelling, validation and advanced engineering research; priorities include:

- Design for reliability, availability and maintainability, through-life support, health management and prognostics
- Design, simulation and modelling of advanced structures
- Validation including non-destructive testing

Advanced manufacturing technologies and processes priorities include:

- Advanced forming and assembling tools and techniques (including robotics and flexible automation)
- Advanced manufacturing technologies for micro- and nano-systems
- Advanced instrumentation and control/use of radio frequency ID

In taking forward these themes we shall wish to develop real applications among our high value industries and to consider the wider barriers to rapid uptake in a holistic manner. This will include a review of metrology needs and standards requirements in these priority areas, as well as working with the Global Watch Service to help businesses appreciate the speed of developments overseas and to identify opportunities to collaborate with centres of excellence around the world, and ensuring that UK organisations can capitalise on European programmes in these areas.

An important priority will be to develop a community of interest around these challenging issues and technologies, building on the capability which lies in the Innovative Manufacturing Research Centres with the further objective of providing the Manufacturing Advisory Service with a continual flow of information and experience around excellence in design and manufacture.

Take part in the discussion

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