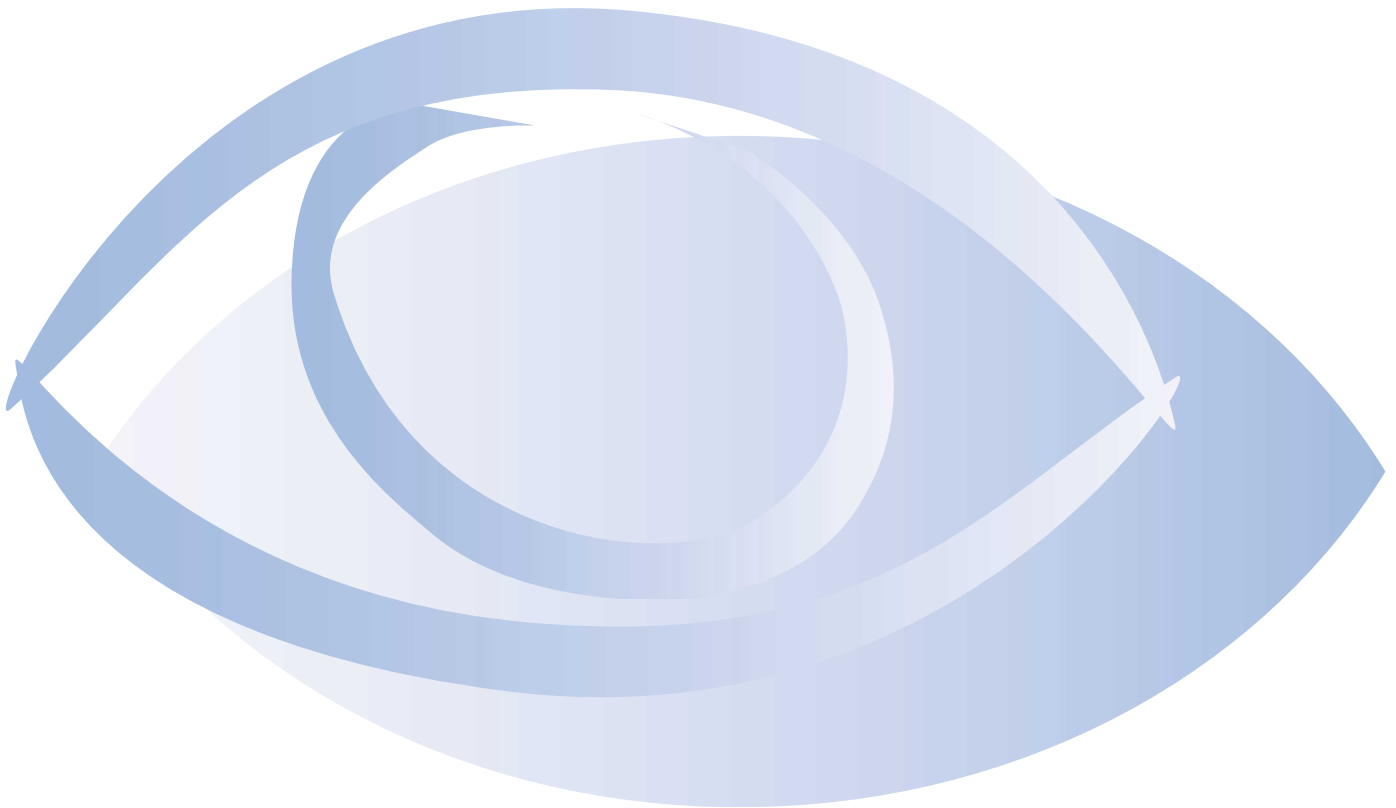


Institute of **Physics**

Foresight for the 21st century

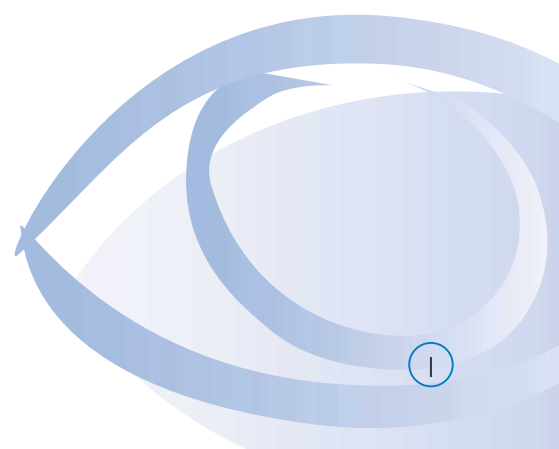
A forward look for physics





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Introduction

Physics and physicists play a vital role in underpinning our way of life, influencing both its quality and contributing in a large way to wealth creation. With innovations as powerful and diverse as the worldwide web and medical resonance imaging having emerged from physics and grown, in a little over a decade, seemingly from nowhere to become everyday technologies, it is indeed a challenge to speculate where physics could lead us in future.

It has long been recognised in industry that physicists bring with them a unique combination comprising not just their knowledge of a wide-ranging and multifaceted subject, but also the analytical and problem-defining and -solving skills learned during their training. Physicists find employment in every sector of the economy, their skills as much in demand in the City as in business or in industrial or academic research environments. Some physicists start and run their own businesses; others attain senior technical or commercial positions in international companies; yet others choose a vital role in education, informing and firing the enthusiasms of those who will lead the next technology revolutions.

As the professional body and learned society representing physics and physicists, the Institute of Physics is an enthusiastic contributor to the UK's national Foresight programme, with its stated aim of developing "visions of the future to guide the people who make today's decisions in business, academia and government". The Institute was therefore pleased to respond to many of the consultation documents issued by the Foresight panels in their latest attempts to identify the challenges and opportunities that the UK is likely to face in the next 10-20 years. A compendium of these responses, *Physics for Foresight: Physics at the heart of the future*, was published in February 2001 as the fourth report in the Institute's Foresight series.

The second round of Foresight was conducted by thirteen panels. Three of them dealt with thematic issues: the ageing population; crime prevention; and manufacturing. The others scrutinised sectors: materials; energy and natural environment; healthcare; defence, aerospace and systems; information, communications and media; chemicals; financial services; the food chain; the built environment and transport; and retail and consumer services. In response to a perception that the previous round of Foresight had concentrated on technical issues in a way that was perhaps too distant from people and their everyday lives, the panels this time included consumers in their consultations and recommendations. The result is a widely varying portfolio of reports. Some panels describe fairly detailed future scenarios and consequent opportunities for the UK; they make direct recommendations about where funding and research should be focused. Other panels adopted a less specific approach and indicate in general terms where they feel developments will occur.

This document, which is the fifth in the Institute of Physics' Foresight series, focuses on the reports published in December 2000 and highlights areas identified within them where physics and physicists will contribute vital knowledge and/or expertise.

Further information on Foresight is available from the following website www.foresight.gov.uk

Further information on the Institute's policy activities is available from our website at www.iop.org



Dr Alun Jones
Chief Executive
April 2001.

A common purpose

Amongst the many recommendations contained in the thirteen Foresight panel reports published in December 2000, a handful of common concerns resonate time and time again:

- the growing interdisciplinarity of the research needed to meet identified needs and concern that such research is too often “falling down the cracks” between funding bodies;
- the lack of sufficiently good technology transfer mechanisms to get research out of the universities and into commercial application;
- worries that a lack of able and enthusiastic science teachers will most likely lead to potentially disabling skill shortages in the critical areas of science, technology and IT.

Of the thirteen reports, only three - those compiled by the Built Environment & Transport Panel, the Food Chain & Crops for Industry Panel, and the Retail & Consumers Services Panel - contained in their recommendations no explicit messages for the world of physics (although undoubtedly physics in some guise does connect with and impinge on all of them - food processing and manufacturing, for instance, is very dependent on physics concepts such as heat transfer, crystallisation, colloid physics, rheology, mechanics and hydration). What follows uses the other reports as a framework to examine the ways in which physics will continue to form a central pivot in our future world.



Health Care 2020

The Healthcare Panel's consultation recommendations report

The ability to handle large quantities of data, process it in some way and take decisions in consequence is central to a number of the radical changes foreseen by the Healthcare Panel. The Panel believes that the huge growth in information and communication technologies will increasingly permit telediagnosis, with the first point of contact with healthcare becoming by 2020 a consultation with a virtual "cyberphysician" accessed through a TV screen. Ways of increasing automation and regularising diagnostic procedures to exclude human error (for example, in cervical cancer screening) will be needed, and the Panel calls for the setting up of a National Health Diagnostics Advisory Group to develop intelligent systems for data analysis. As well as exploring the ways in which image and signal analysis could replace individual diagnostic judgement, this group is asked to consider how to integrate the analysis of signals from diverse sources such as magnetic resonance, electrocardiography and genetic testing to convert data into clinical information. In moving forwards this kind of de-skilling, physicists are uniquely placed in their ability to integrate hardware (equipment) and the software that provides visual images; in addition, the defence industry already has considerable expertise at integrating the analysis of signals from diverse areas.

Physicists are constantly working to push back the boundaries of what is achievable in medical imaging and diagnostics. Increasingly, techniques being developed in areas like remote sensing, where sophisticated methods of handling high-speed high volumes of data are necessary, will find numerous other applications.

The Healthcare Panel acknowledges that the physical and engineering sciences will play a pivotal role in areas like whole-systems engineering, mimicry of natural sensor/effector pathways, image analysis, predictive modelling of biological behaviour and clinical decision support. Improved patient surveillance will result from the miniaturisation of physical and chemical sensing

devices (and, indeed, instrument miniaturisation across the whole spectrum, will become necessary). Physicists have always been at the forefront of sensor development and our growing understanding of the potential of tiny nanotechnology devices opens the way to tools such as *in vivo* robotic systems and tools for endoscopic surgery with a feedback link to navigation. Intelligent implantable devices that can, for instance, release drugs when measurement of the local environment indicates it is necessary, are already on the horizon. Physics-based advances in surface engineering - for example, using plasmas to modify the surface of prostheses so that they are not only biologically accepted but actually knit into new tissue growth - are already in the clinical arena.

Without doubt, new medical imaging techniques, advances in image resolution and the ability to see real-time three-dimensional images will have enormous clinical impact. In particular, the Panel calls on government and industry to maintain research in functional brain imaging, collectively deploying the country's strengths in engineering, physics, medicine and biology to further the development by UK companies of advanced neuro-imaging techniques. Improved understanding of brain function is likely to lead to electronic prostheses interacting directly with neural tissue, such as optical sensors driving the visual cortex to restore a degree of sight in blind people.



As imaging techniques improve, allowing clinicians to see ever more clearly where treatment needs to be delivered, physicists will continue to be at the leading edge of new therapies like proton oncology, creating safe and accurate ways of delivering highly focused and accurately targeted beams of elementary particles to therapeutic effect.

In common with other panels, the Healthcare Panel points to a need for encryption, envisaging that every individual will have his or her own health biography held on the internet and accessible through a smart card or biological identifier. The Panel calls for the establishment of a National Health Informatics Forum to assess the costs, benefits and risks of establishing electronic healthcare systems.

Integrated science and technology, and efficient technology transfer mechanisms are also highlighted, with the Panel suggesting that technology transfer should be established as a profession. A London health science park is mooted and the Research Councils and Higher Education Funding Councils are called on to produce proposals for mechanisms that will specifically address the need for cross-disciplinary R&D. In particular, ways of creating better integration between mathematics, biology, medicine and the engineering and physical sciences are needed.

It is perhaps important to note that the behaviour of biological systems is ultimately describable in terms of physics concepts - forces at molecular level, charge fields, flows, colloid physics and fractal behaviour, to name but a few - and bringing the ideas of physics to bear on biology is already opening up exciting possibilities for the future of biomedicine.



Stepping Stones to Sustainability

The Energy & Natural Environment Panel's consultation recommendations report

Long before environmental concerns came to the forefront of public consciousness, the physics community has been active in assessing and investigating issues like pollution, climate change, energy efficiency and the need for alternative energy sources. Physics continues to play a crucial role in both understanding such processes and, where appropriate, mitigating their effects.

In its report, the Energy & Natural Environment Panel expresses the view that there are a number of fairly rapidly attainable "stepping stones" to energy sustainability which we must embark on immediately to create a breathing space, while long-term R&D prepares for more dramatic step-changes in the way we create and use energy and materials. Amongst the targets thus identified are the improvement and application of cleaner technologies; renewable energy sources and low carbon emission energy generation ("clean coal"); sustainable transport; and environmental clean-up and repair methods. The Panel calls for a reappraisal of nuclear power - an area where the problems in recent years have perhaps lain more with public perception than with the technology difficulties - and for the development of closed-loop production and consumption cycles, allied to reduced water use and less energy-intensive construction techniques. In the long term, products and production methods will need to use an order of magnitude less energy and materials, new energy bases that do not derive from fossil fuels need to be identified and products will need to use non-hazardous biodegradable materials.

The contribution to be made by physics to these areas cannot be overstated. Our increasing understanding of materials and the way that their use can contribute to energy efficiency is in no small part being derived from research in physics laboratories. Optoelectronics is already finding an application in high-efficiency lighting and new catalysts capable of improving the efficiency of chemical processing and creating cleaner cars are being designed. Plasmas that can clean noxious organic gases, reducing them to environmentally friendly products and even fuel sources, are under investigation. Energy generation and storage via the kind of experimental pumped storage systems in North Wales and the drive for increasingly light and energy efficient batteries suitable for use (for example) in electric vehicles, have long been on the physics research agenda. Much combustion research is currently aimed at decreasing our use of fossil fuels with an accompanying decrease in greenhouse gases and noxious emissions at source - thus removing the need for clean-up technologies.

The development of renewable energies such as wind and wave power, photovoltaic solar power, tidal power and hydrogen fuel cells requires a strong physics community with long-term research plans. Fusion research is already finding applications like an environmentally friendly bus (electrically driven by a small diesel engine that charges the batteries) and an improved understanding of plasmas that can be used to develop new technology for use in wind turbines.

The Energy & Natural Environment Panel points to the lack of a clear institutional framework able to “champion” key areas and calls for a set of “sustainability R&D” programmes, each working throughout the disciplines and sectors and funding high-profile programmes that are interdisciplinary and cross-sectoral. This, it believes, will create a continuing framework through which firms, universities, government, investors and regulators can effectively collaborate in key market and development areas. There should be a UK Sustainable Technologies Development Programme with participation from the Research Councils, the private sector and government. The Panel lists a number of areas in which it feels R&D should be a priority but particularly recommends three themes: strategies and technologies for the water-stressed world; low and close-to-zero emission power generation; and achieving step-changes in resource efficiency in products, their production and use.

The role that physics has to play in assessing the success or otherwise of our environmental activities must not be overlooked. Physicists have a wide range of techniques for studying the atmosphere and the chemical reactions that occur there. Monitoring and understanding the effect of pollutants is clearly a necessary preliminary to devising effective methods of control.



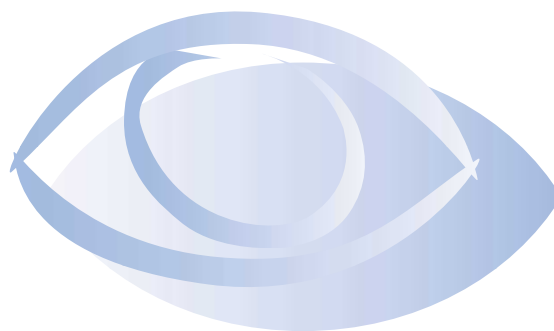
A Chemicals Renaissance

The Chemicals Panel's consultation recommendations report

Physics and chemistry have long had a close symbiotic relationship with much innovative research being carried out at the interstices between the two disciplines. In assessing the key strategic issues in chemistry which need to be addressed in the next twenty years, the Chemicals Panel inevitably identifies a number of concerns and opportunities that will be pertinent to physicists and in which physics research will play a pivotal role.

Like the Energy & Natural Environment Panel, the Chemicals Panel highlights the need for further research into battery technology, strong lightweight materials to create viable electric vehicles; hydrogen-based fuel cells are suggested as an alternative to the combustion engine. Photovoltaics systems, the Chemicals Panel points out, are currently largely based on relatively costly crystalline silicon semiconductor technology because of its proven performance, but a wide range of alternative materials, cell structures and manufacturing techniques are already under investigation. The Panel sees it as a priority to fund multidisciplinary research programmes to speed progress in this area. The DTI is particularly urged to encourage innovation and start-up companies in new energy technologies.

The application of miniaturised surface-engineered devices - the "lab on a chip" - is identified as being of particular interest to the pharmaceuticals industry. Here, physics plays an important role in both manufacturing such miniature devices and enabling their sensing capabilities. Sensors and miniaturisation are also of course vital factors in the burgeoning field of nanotechnology - labelled by the Chemicals Panel as "the driver of the next industrial revolution". The Panel calls on the government to identify "a nanotechnology strategy that matches the UK's scientific and technological strength", and to launch a programme that will inform and enthuse industry about the opportunities that will arise from nanotechnology.



UK Manufacturing: We can make it better

The Manufacturing 2020 Panel's consultation recommendations report

Physicists finding employment in manufacturing bring with them a whole range of transferable skills which make them well suited to designing, understanding and managing the complex interacting systems of a such a business. It is probably true, however, that many physicists finding themselves in a manufacturing environment are there to advise on ways of improving a process, solving a specific production problem or to engage in collaborative research aimed at bringing their research expertise to bear in a manufacturing situation.

Key therefore amongst the recommendations of the Manufacturing 2020 Panel are those pertaining to the applicability of research and technology transfer. The Panel calls on the DTI to stimulate mechanisms (processes, bodies or programmes) for further development of research results into implementation-ready products, technologies, applications, processes, skills and knowledge. It points out that UK manufacturing is currently living off the legacy of previous innovation, most notably because of the UK's low spend on R&D as a proportion of GDP. Physicists have been long recognised as innovators and the Panel believes that research providers and delivery systems must become more agile, responsive and approachable with research into innovative products, technology and business processes being dramatically stepped up to complement the UK's existing world-class science base. A limited-period appointment of a Chief Manufacturing Adviser to government from within industry could serve as a focus for such activity, the Panel suggests.

As part of the DTI's stimulation mechanisms, support for universities' third leg funding needs to be enhanced, the Panel says. There should be an active conduit for matching business needs and opportunities with demonstrated research results and capabilities in a way that would in particular benefit SMEs. The mechanisms for technology transfer from research establishment to companies needs to be improved, with the temporary transfer of people an ideal way forward.

To promote greater collaboration between research centres and between academic and industrial researchers, the Manufacturing 2020 Panel suggests that collaborative proposals for research funding should be favoured over single-centre proposals. The Panel also recommends revising the ways in which academic research is evaluated, by moving from primarily measuring the numbers of technical papers and citations to including applied measures such as patents, patent citations and industry-targeted publications.

Materials: Shaping our Society

The Materials Panel's consultation recommendations report

Understanding materials and the ways we can model them, use them and push their potential to the limit is inextricably linked with physics. In its report, the Materials Panel comprehensively reviews materials applications as different as semiconductors, biomaterials, polymers, aluminium, magnetic materials, wood, steel and glazing materials, with applications as diverse as nanotechnology, construction, packaging, sensors, textiles, energy storage and optical computing. The Panel extrapolates these to year 2020 scenarios: biomaterials that guide body tissue regeneration; miniature robotic "nanobots" to facilitate the use of minimally invasive surgery; microelectromechanical systems with applications ranging from vibration sensors in washing machines to micromirrors in large projection display systems; weight-saving aluminium framed aircraft; optoelectronic and semiconductor-based devices that will take the IT revolution to almost unimaginable heights; resealable food cans and zipped food pouches; and many more.

Physics will have much to contribute to these innovations but perhaps its most fundamental contribution will be skilled people. Many materials specialists come to the subject through physics, either encountered as part of the school science or design and technology curriculum in such a way as to engender an interest in studying materials at higher education level, or as an increasing specialisation once qualified as a professional physicist. The presence of able and enthusiastic physics teachers in schools is a vital component in maintaining a good supply of materials experts.

In its report, the Materials Panel calls for a coherent and integrated approach to delivering materials education from primary schools onwards, suggesting that a thorough survey of international best practice in materials education should be undertaken in the light of forthcoming changes in the way higher and continuing education will be delivered.

Other issues of a general nature identified by the Panel include the need for a unified materials support strategy that will stop the random dispersion of resources through different government departments. Attention should also be paid to how, with the decline in large corporate research laboratories in the UK, existing and new companies can have their materials research needs satisfied. The Panel proposes the creation of a one-stop Materials Research Centre to co-ordinate the national and local activities of research providers and to provide a brokerage service.

The Future of Financial Services

The Financial Services Panel's consultation recommendations report

"If motorways were the key to the last century, then broadband networks are key to the next", says the Financial Services Panel in its report. The Panel sees a clear future in which advances in computing and communications will reduce the advantages of large corporations over small. Institutions will segment their markets more finely, encouraging the growth of small, highly specialised firms, and the providers of financial services will increasingly use electronic means to reach their customers, maybe themselves becoming more "virtual" as they contract out all but a central operating core. Those who work in the sector will have to become highly adaptable and technology minded. As business becomes increasingly global, with customers purchasing from companies anywhere in the world, electronic invoicing and payment will become universal. PCs, mobile phones and other devices will permit instantaneous payments for any amount to any location.

Physicists have been much sought by the financial sector in recent years, using their problem-solving facility with mathematics and computing to model interest rates, financial derivatives and other important parameters on the global financial markets. Whilst these needs will continue, physics will also have much to offer by way of the sophisticated security and encryption techniques that are already emerging from research into quantum computing. (The security demands of e-commerce, together with needs such as secure packaging for unattended goods delivery, were also highlighted by the Retail & Consumer Services Panel).

As recognised innovators and entrepreneurs, physicists will also no doubt participate in the explosion of SMEs that the Financial Services Panel believes will occur in the next decade as revolutionary advances in computing and communications technologies take root. Many more SMEs are expected to start up in technology-intensive sectors, in part as a consequence of outsourcing by large companies. The Panel urges the government to review urgently the costs and benefits of ensuring that all SMEs have low-cost access to broadband internet services within the next five years. Universities are encouraged to explore mechanisms to accelerate the flow of technology into commercial ventures and the Panel particularly identifies a need for venture capital vehicles to address the needs of SMEs seeking funding below £1 million. The potential role of physicists both in developing the appropriate technology and in running technology-based SMEs is clear.



Let's Get Digital

The Information, Communications & Media Panel's consultation recommendations report

Underpinning all the Foresight reports is the expectation that enormous advances in information technology, electronics and communication (ITEC) technologies will change the way in which we live. The contributions that physics has made here are enormous and growing. While condensed matter physics has already led, for example, to semiconductors, superconductors, magnetic materials, plastics and polymers, we now see optical and laser physics supporting the optoelectronics behind high-bandwidth communications, low-temperature plasma physics making possible device fabrication and novel display technologies, and the particle physics data management expertise that produced the world-wide web creating the concept of computational "grids".

In its report the Information, Communications & Media Panel looks at ways of maximising the economic and social opportunities arising from these new digital technologies. Amongst the needs identified are a highly skilled and adaptable workforce, embedding digital and online use in all education provision at all levels, and universal broadband access (supported if necessary by public information initiatives). The creation of an appropriate fiscal policy for growth, aimed at encouraging and facilitating entrepreneurial activity via taxation and other policies, plus increased collaboration between academia and business, are identified as priorities.

A greater emphasis, and mechanisms to stimulate and reward, multidisciplinary research is required. The Panel draws attention to the potential shortfall in suitably trained people, in IT and the sciences underpinning it, through problems in school science delivery.

Action for Future Systems

The Defence, Aerospace & Systems Panel's consultation recommendations report

Defence, aerospace and systems are technology-intensive areas in which the UK has a strong and successful track record firmly rooted in fundamental research. Frequently, innovations driven by defence needs have found equally successful civilian applications; examples include navigation, control and guidance sensors; thermal imaging equipment; flat-panel liquid crystal displays; metal-organic precursors for semiconductor fabrication; and intruder detectors. Today, the defence and aerospace industries are less distinctly UK-owned and operated and are becoming increasingly global. To maintain a home for such global business, says the Defence, Aerospace & Systems Panel, the UK must provide a large and technically competent workforce, a high-quality educational infrastructure, good communications and e-commerce infrastructure, and an innovative environment.

Both the aerospace and defence sectors rely critically on the evolution and implementation of new technology to provide an effective competitive edge. Challenges identified by the Panel include the need to reduce fuel consumption and weight and to increase safety and reliability in the aerospace industry, whilst paying due regard to environmental considerations. In military applications, this must sit alongside enhanced performance and military effectiveness; in civilian applications the projected 5% annual increase in air traffic over the next two decades will force new approaches to the design and operation of aircraft and the systems that interface with them for air traffic control, airports and ground handling.

The Panel also highlights a new context for defence and security. The new information technologies available to the armed forces will have a major impact on the way future operations are conducted. Increasing numbers of core activities, capabilities and skills will no longer lie within the defence community and enhanced computational power suggests that unmanned services, including air vehicles and new

weapons systems with powerful decision capacities, will become viable. In parallel, new vulnerabilities are created. The effects of systems failure - either through an inability to keep them working or through hostile interference - must be guarded against. "New highly complex technologies imply new threats and increase the opportunities for asymmetric warfare", notes the Panel. "The implications of the new networked systems which drive and control the delivery of so many key services will need to be considered...cyber-threats are encouraged because the means to mount credible threats is widely and cheaply available."

Systems thinking will increasingly pervade all aspects of life in an increasingly global environment, the Panel says. It recommends the formation of a Systems thematic panel across all Foresight sectors to consider the implications of this. Systems needing investigation in which physics has a particular role to play include: the coupling of atmosphere to ocean surface to deep ocean to form a climate system; the coupling of industrial and transport systems to the atmospheric and climate systems; the coupling of electronic systems to molecular biological and cellular systems; and the coupling of vehicle systems more strongly to each other and to extended information systems. Developing a framework for common thinking should form the first key action of a Systems panel.

The Panel also notes that public support for research and technology in the defence and aerospace industries is vital. It is important that such research, which is often inherently long-term, is seen as relevant to the national good, bringing with it increases in wealth creation, broad economic prosperity and a successful manufacturing sector. A number of recent initiatives, such as the Defence and Aerospace Research Partnerships, the MoD Towers of Excellence programme and the National Defence Industry Technology Strategy are commended and, the Panel says, should continue.

Turning the Corner

The Crime Prevention Panel's consultation recommendations report

Developments in technology almost inevitably bring with them new opportunities for crime. New technology can, for instance, provide easier access to systems, premises, goods and information; it can remove geographical obstacles to crime; it can increase the scale of potential criminal rewards; and it can increase anonymity in a way that makes committing a crime more attractive. But while new technology could result in greater opportunities for crime, says the Crime Prevention Panel, we must deploy it to reduce those opportunities. That can be accomplished, for example, by directly applying it to crime problems, such as aiding detection by DNA analysis or increasing security through CCTV, or by designing secure products which reduce opportunities for theft or misuse.

The Panel calls for a dedicated funding stream to be established to focus science and technology attention to crime; considering this plan in detail will fall to its proposed new Science and Technology Task Force. There should also, it says, be a national strategy for e-crime, both against the individual and larger IT systems. Authentication information will become increasingly important in establishing the authenticity of goods and images and in proving the identity of individuals. The "chipping" of goods, tagging of offenders, protection of intellectual property and data, and the security of information within the criminal justice system are all identified as imminent needs. The Panel also proposes a programme to address crime at all stages of a product's life cycle and encourages manufacturers to build "crimeproofing" into products.

Physics clearly has much to offer in meeting these objectives. The Panel highlights the following areas in devising methods of proof and protection of identity and authenticity: biometrics, biomimetics, sensors, magnetic materials, smart materials, encryption,

genetics, digital signatures and physical and analytical chemical techniques. For forensic science and crime detection it lists: forensic IT, miniaturisation, nanotechnology, data fusion and data mining, fingerprints and other means of identification, sensors and analytical techniques. To meet personal and property security needs it points to: materials technology, including mechanical performance (relevant to ballistics and stab resistance) and thermal characteristics of fibres and materials, sensors, wearable technologies, tagging and tracking and intelligent alarms.

The Crime Prevention Panel has also produced a quick-hit "wishlist" of applications and activities which could be implemented in the short term:

- A single internet database of property to identify and trace stolen goods.
- A dipstick technology to offer protection against drinks spiked with drugs.
- A holistic approach, encouraging cross-discipline contacts possibly via a thematic network across professional institutions drawing on European funding.
- An international standing conference to consider the impact of new technology on crime.
- Funding for postgraduate courses that includes computer and network security.
- Increased importance for computer forensics in computing degree courses, to create a greater pool of people with this expertise.

The Age Shift - Priorities for action

The Ageing Population Panel's recommendations report

The UK's ageing population will bring with it fresh challenges for physics. A prime wish of many older people is to stay as healthy as possible and remain in their own homes for as long as possible. There will be great demand for technologies that facilitate this. As well as a whole range of practical devices to help us cope with the frailties of old age, technological support systems in the home that are linked into electronic networks will be much in demand. These are likely to include alarm systems that trigger when specific patterns (for example, turning on lights or shutting doors) are broken, plus easy-to use health check facilities that can routinely measure parameters like blood pressure, blood sugar, pulse rate or heart rhythms. Buildings, shopping facilities and leisure amenities of all kinds will need to be modified or designed with an older population in mind and new markets will open up for services and products that provide a better quality of life, especially for the frail and disabled. Government support for research relating to these needs - and especially for assistive technologies and their transfer from the universities to the business sector - will be needed, says the Ageing Population Panel.

For the first time, the older generation will be highly computer literate and this is likely to influence both leisure needs and employment issues. As the proportion of younger people decreases, labour and skill shortages, particularly in IT and science and technology areas, are likely to bring about new flexible working patterns for those who wish to continue employment into later life. The need for this older workforce to maintain its skills and expertise will make lifelong learning vital, the Panel notes.



Forward with Foresight

In May 2001, the Foresight steering group, which includes all thirteen panel chairs, will aim to produce a synthesis report looking at the rounded picture presented by the reports as a whole. The government has already announced a £15 million Foresight fund to take forward the priorities and it is clear that wise investments in the areas identified by the panels will pay dividends in terms of both quality of life and wealth creation. A healthcare system, for example, that can diagnose rapidly the onset of illness and provide effective treatment without lengthy hospitalisation, benefits both the individual and the employer. The Foresight fund is to focus on biomaterials, sustainable energy, nanotechnology and mobile wireless communications.

Foresight itself is to be reviewed by a panel chaired by the Chief Scientific Adviser with representatives from the Research Councils, the DTI and business. The review is to be completed by June 2001 and will look at the extent to which the current round of Foresight has met its objectives, whether there should be a further round and, if so, what form it should take. The Institute of Physics welcomes this review and will itself consider how the intersection of physics with Foresight can now best be expanded and enhanced to create both economic prosperity and the best possible quality of life in the future.

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