OSI Horizon Scanning Centre

and

The Foundation for
Science and Technology

Planning for Technological Change

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Executive Summary

Horizon scanning is not solely concerned with long term strategic change. Even in three years, new solutions may make existing approaches obsolete. Attempting to plan – and budget – 10 years ahead is even more clouded in uncertainty. The rate at which technology is changing poses a challenge for planners. Fixing budgets around today's operational processes and technologies may give some financial stability, but the risk is of being overtaken by events and by developments elsewhere.

The challenge lies in building sufficient flexibility into an organisation's structure and culture to take advantage of new opportunities – and respond to new threats. Incorporating this flexibility into departmental and organisational strategies is key to making best use of emerging technology developments.

In trying to discern paths by which organisations can better serve stakeholders in the future, it can be instructive to examine ways in which departments and businesses have already attempted to assimilate technological innovation and maximise the benefits both to them and their customers or clients.

At the same time, it is important to acknowledge that innovation carries a risk: a risk of failure and a risk of unexpected 'side-effects'. A key part of the process is the assessment of likely and unlikely collateral effects from a project – and an evaluation of the risks associated with entering what may be uncharted territory.

This report draws together examples where organisations have aspired to achieve the necessary organisational and cultural flexibility to make the most of emerging technologies. It also reports some of the challenges and unexpected outcomes that were encountered in the process. These approaches to the challenges of innovation can provide insights into how other organisations may adapt to change in the future.

The right choice of technology is not sufficient to ensure success. These case studies show how important it is to understand the human dimension – both organisational and cultural. Innovation may sometimes challenge accepted patterns of work or attitudes (11, 19). Embedded resistance to change can be just as damaging as the wrong technology choice – and arguably less readily corrected. The Defence Information Management study (18) shows how disadvantaged those who reject change can become compared to those who embrace it. This holds true for organisations as much as individuals.

A number of these studies illustrate the importance of engaging with others in new types of partnership and new ways of working (6, 7, 16). The potential benefits have sometimes been enough for competitors to join forces (8).

It is not the aim of this report to look at what innovations may become mainstream in the coming years or decades. Rather it shows how organisational and cultural change has been approached, in real situations, in the attempt to capture the benefits of technological change.

In a world where technology is changing so quickly, there will always be risk involved in planning ahead. Today's options may provide long term solutions (16, 20); equally, they may not. It is vital to develop the ability to identify the best options at any point in time, but also to judge when changes should be made and how best to achieve them. The case studies provide examples of how organisations in both public and private sectors have attempted to introduce that flexibility into their planning and operations.

Key Conclusions

1. Understand what are the drivers for change and the timescales.
2. Identify both the cultural and organisational issues.
3. Communicate with the staff who will have to make the technological innovations, externally with customers and also other stakeholders who may be affected (or fear they may be affected) by the change.
4. All change needs ownership by a champion for change.
5. Maintain flexibility in plans and budgets to respond to unexpected change.

The Case Studies

The studies in this document describe the challenges from technological changes introduced into a variety of organisations and companies. They also consider the impacts on the wider organisation, the new opportunities, possible stresses and the resulting changes.

Key messages

Change brings benefits to the innovator but also has risks and threats

Early change can give significant first-mover benefit (3). It can also mean committing funds to an uncertain outcome (1) where unexpected factors alter the dynamics of the development.

Change itself can lead to unexpected and sometimes undesirable side-effects. The Armed Forces' use of the Global Positioning System (GPS) has led to significant savings in materiel and manpower; indeed its introduction has exceeded original expectations. However, as the case study points out, a number of skills and systems in place before GPS have now been lost: in the event of GPS failure, the Armed Forces could be severely disadvantaged.

Choices can also exclude some other options. The pervasive use of GPS has meant that overlapping technologies may not receive investment. In the case of Sharp, alternative options were excluded in order to commit greater resources to the chosen goal: the decision to 'burn bridges' and cease production of certain products.

Sometimes change can be undertaken to reduce risk. BP wanted to better identify the potential of subsalt reserves in the Gulf of Mexico. To do this, it chose to develop its own seismic imaging resources rather then rely on outside contractors. Bringing in specialists to run Culture Online allowed DCMS much greater control over the outcomes of its projects through effectively 'insourcing' an 'intelligent customer' function.

In for the long term

GSK has found that "change is often not self-sustaining for a very long time". Many of the technologies being implemented also require long term investment, whether in money, or human resources or organisational commitment. New ways of working (10, 11) will take some time to become 'the norm'. Projects may take many years to come to fruition (3, 16, 20). For these projects to fulfil their promise, decisions have to be taken in the context of long term commitment.

Unlikely partnerships

Traditional ways of dealing with other departments, competitors or consumers may have to be re-assessed if maximum benefit is to be gained from a new technology. In some cases, this may even result in a change in structure from one organised by skill to a work team which brings together different disciplines (DCMS). In certain cases, success cannot be achieved by going it alone in the marketplace and collaboration with competitors or other sectoral organisations may be needed to ensure success (8, 16). In such cases, the involvement of an organisation seen to be independent can be a significant advantage to maintaining the partnership.

Leadership

Integrating change over the longer term requires continued focus and, normally, periodic refreshment of the objectives. For this, leadership is required. It can be the dramatic, top-level decision-making seen at Sharp which forces an organisation down a specified path. In Royal Dutch Shell, it meant that successive boards of directors had to re-commit to the project, and this could only be achieved by having a senior Champion who drove the programme over a long period.

Champions for change

New approaches may be tried out on a pilot basis within an existing structure in order to demonstrate/encourage change. On the other hand, departures from existing structures can release opportunity. Culture Online functions independently of the DCMS press office and of ministerial decisions, but is viewed as a model for the department and for other organisations. Giving seismic subsalt imaging the status of a Technology Leadership Area in BP (2) has enabled this group to promote changes in working elsewhere in the group. In GSK (11), changes in working practice have been led by small groups working alongside colleagues still working to more traditional practices.

Technological change must take account of non-technical dimensions

The introduction of GM crops into Europe at the end of the 1990s was originally perceived as a scientific and regulatory issue, with public reaction not being a great concern. In the event, the matter became one of substantial public concern, resulting in a complete re-appraisal of policy and the commitment of substantial departmental resources (1). The development of RFID tags has concentrated on technological and commercial aspects, but there is an awareness that full implementation of this technology will depend on addressing consumer perceptions, particularly of the privacy issues (8).

Communicating with stakeholders

Ensuring good communications with other interested parties can be vital to success. The strength of public reaction to the introduction of GM foods was not anticipated and this necessitated much greater engagement with the public at a later stage. The BioIndustry Assocation, on the other hand, took a strategic pro-active approach to engaging multiple interested parties in the run-up to changes in the Human Fertilisation and Embryology Act. This approach has produced continuing benefit in terms of creating opportunities for investment and innovation, and maintaining ongoing links established with other organisations. The development of interactive media such as the internet have also provided opportunities for more communication (10, 15).

The case studies

1. Marketing of GM foods – Department for Environment, Food and Rural Affairs

The introduction of GM foods produced unexpected results with a consequent increased workload for the department.

2. Advanced 4D seismic imaging – BP

This is a key area in reducing commercial risk for undersea drilling and BP has decided to develop it in-house.

3. Switching from CRT to LCD television screens – Sharp Corporation

By deciding in advance to cease production of CRT sets, Sharp were able to focus resources on a new marketplace.

4. The impact of GPS on the military – MOD Joint Doctrine and Concepts Centre

The Global Positioning System (GPS) had been extremely successful, exceeding the Armed Forces' expectations. But there are some disadvantages too.

5. Moving into data engine co-processing – ARM Ltd / ARM Belgium NV

ARM decided to acquire expertise in the search for a quicker route to market.

6. A one-stop-shop for corporate services – Department for Education and Skills

By the establishment of a simple desktop facility to book corporate services, DfES were able to secure significant efficiency gains.

7. Cell Nuclear Replacement – the BioIndustry Association

A pro-active communications strategy helped BIA achieve its campaign goals and led to continuing links with other stakeholders.

8. The use of RFID tags – The Monitor Group

To make RFID tags a commercial reality, standards had to be agreed between all the participants in the supply chain and the price had to be significantly reduced.

9. Designing the future with haptics – Arts and Humanities Research Council

Integrating creative and technical aspects of Computer Aided Design will enable ways of working better attuned to the needs of the design community.

10. Culture Online – Department of Culture, Media and Sport

Heightened consumer expectations have led the Department to develop an innovative process of commissioning arts and cultural heritage online projects.

11. Parallel experimentation in Chemical Development – GlaxoSmithKline

A change in approach to experimental methods and the use of statistical tools has led to better results but has been easier to implement at some sites than at others.

12. Developing manufacturing agility - ESRC

A switch to a team-based cell structure enabled a specialist forklift producer to accelerate product development lead-time.

13. DNA fingerprinting – Medical Research Council

This technology was the result of funding the best research, not of focussing on specific applications. Nevertheless, in 25 years it has transformed a wide range of disciplines, worldwide.

14. Internet technologies and business – Engineering and Physical Sciences Research Council

The internet has fundamentally changed the way businesses operate and has created a range of new business sectors.

15. Electronic publishing and the Web – Institute of Physics Publishing

Moving to electronic publishing is more than just a technological change.

16. The human genome project – the Wellcome Trust

The first 'big science' biomedical project needed a new partnership model to succeed.

17. Satellite data and the Met Office – the Met Office

Weather forecasting is becoming increasingly dependent on satellite technology which has generated significant economic and social benefits.

18. Defence information management – MOD Defence Academy

New methods of electronic information management are resulting in an increasing divide between those who embracing change and those resisting it.

19. DSpace@Cambridge - Cambridge University Library

The creation of a central repository of digital materials is raising questions about the extent of public access to academic materials.

20. Gas to liquids: a new clean energy source? – Shell International Exploration and Production

A 20-year development programme needs a champion at senior level to ensure continued commitment.

21. Ground storage of building heat energy – Ove Arup and Partners

A low-carbon energy source, already in use on the Continent, has been introduced into the UK.

22. Knowledge Transfer Networks ICT Platform - Innovation Team, Office of Science and Innovation, DTI

The DTI have developed a novel, integrated software platform to facilitate dialogue between researchers and end users. Interesting questions are raised about how people work together across a virtual platform and how such systems can be used to develop Government policy.

Case Study 1: Marketing of GM foods *Defra*

Key points

- public reaction was not anticipated;
- complete review of regulatory system was initiated;
- the public reaction resulted in changes in departmental resources and private sector investment.

The challenge

GM foods appeared on the market, both in North America and in Europe, in the mid 1990s. Within a matter of months the technological developments became a central issue of public policy, commanding massive media attention, and leading to a substantial campaign against GM foods directed principally by environmental and consumer-oriented NGOs. Although a regulatory regime had already been established in the European Union, regulators did not anticipate the public reaction to GM foods and crops.

The change

Following regulatory approval in 1996, GM Soya was first introduce into the UK market during 1997 and 1998. This was followed by the marketing of GM maize in Europe in 1998. The public debate was expanded following the publication of a controversial scientific study that claimed to link adverse health effects to GM foods in 1999. These events initiated a period of change within DETR and then Defra culminating in a Government announcement (neither for nor against) on GM policy in March 2004.

The impact

Within Europe there was a drive for a complete revision of the GM regulatory regime. Public and media reaction lead to a dramatic increase in correspondence to the department and parliamentary activity. The public impact focussed largely on GMOs used as food, despite the Government science focus on the potential environmental impacts of cultivation. GM plant development slowed down and the plant and biotech industries backed off development.

Organisational and cultural issues

In the lead-up to the Government policy announcement in March 2004 there were, in addition to the existing Farm Scale Evaluations (FSEs), significant resources committed to the GM Nation exercise, a GM Science Review and an economics/cost-benefit review. There was a consequent increase in the size of the departmental team dealing with the issue: from six to 17 at DETR (and later Defra) over a four year period.

In the following years a complete re-appraisal of the regulatory regime was initiated leading to changes in resource requirements.

Case Study 2:
Advanced 4D seismic imaging
BP

Key points

- accurate seismic imaging is a key technology which reduces investment risk;
- seismic imaging area is now a value-creating technology, not a purchased commodity;
- investment in this area is projected to sustain competitive advantage for BP;
- the company has taken ownership of a key technology in reducing investment risk and uncertainty.

The challenge

The largest challenge identified in 2003 was subsalt seismic imaging. Over 70 per cent of exploration and development resources in the Deep Water Gulf of Mexico are estimated to be fully or partially subsalt. The ability to reduce risk and uncertainty across the full life cycle of a project is directly correlated to the ability to create an accurate subsurface image.

The change

Historically, BP had depended on contractors to develop technology and had bought at lowest cost. Given the pressing business need facing BP with its portfolio of assets and the fiscal health of the seismic vendor community, it was decided to shift from regarding seismic as a commodity to one where it would be a value generating technology worthy of significant investment.

The impact

At the beginning of the project the company articulated its intellectual property stance along the following three elements and placed individual technologies into each category:

- Hold proprietary IP – build lasting competitive advantage by restricting competitor access to critical technologies and/or expertise;
- Be first adopter for technology – exploit a near-term (2-3 year) window of opportunity to deploy key technologies and lock-up critical contracted skills/ capacity;
- Accelerate commoditisation – build a viable market for new technologies and drive down unit costs through seed funding and consortiums with partners.

Organisational and cultural issues

Historically BP had regarded seismic as a commodity, and counted on the market/ vendors to develop new product to meet demand. This philosophy had been BP's stance for long enough to engrain that philosophy into corporate culture and also into long term planning assumptions.

BP changed this by designating Subsalt Seismic Imaging an in-house 'Technology Leadership Area'. A commitment to experiment at scale was necessary to unleash the ideas, creativity, and innovation of BP's talent base. The company made a significant intervention to accelerate the programme through focusing BP's fiscal and human resources on this problem.

In some countries know-how can be proprietary, while in others BP are contractually obligated to share it with all joint interest holders in a licence if the technology is deployed. This variation in international law requires considerable thought about where, how and in what order new technology is deployed globally.

The project has created a new atmosphere in both the technology and the asset teams, an atmosphere where individuals and teams feel they can accomplish what had before seemed impossible. This is serving as a blue print for other areas.

Case Study 3: Switching from CRT to LCD television screens
Sharp Corporation

Key points

- a strategy of 'burning bridges' was high risk, but encouraged staff commitment to the chosen development path;
- decisive leadership came from the very top of the organisation;
- focussing totally on the new technology gave significant first-mover advantage.

The challenge

In 1998 the great majority of televisions sold around the world were based on cathode ray tubes (CRT). Emerging technologies included plasma displays, rear projection and liquid crystal displays (LCD). Conventional wisdom at the time was that plasma displays would gradually become established as the technology of choice for large screens (30 inches and greater), but there was disagreement as to whether LCD could capture much of the smaller TV market.

The change

In the middle of this uncertainty, the company President declared that Sharp would stop making CRT televisions in 2005.

Sharp did not have its own CRT manufacturing facilities: moving to LCD gave the company a substantial advantage. Aggressively moving to LCD also accelerated the shift in the market away from CRT, giving Sharp a further advantage.

During the period 1998-2005, it gradually became clear that LCD televisions would take a substantial part of the TV market, including large sizes (up to 65 inches currently). By targeting larger sizes of LCD than were thought possible, the company has gained further advantage and taken market share from plasma display panels.

The impact

The decision by the company president had a big impact in several areas:

- research to improve the performance of LCD TV was accelerated (response time, viewing angle, contrast ratio, colour gamut, etc);
- a large investment was made in manufacturing facilities, first in large glass size LCD, then in the world's first integrated LCD TV plant;
- an external design consultant was employed to design the new type of TV;
- new advertising was put together.

Sharp has gained considerable first-mover advantage in LCD TV. It has been able to capture a 40 per cent market share. It has had the most cost-efficient manufacturing facilities. It has been first to market the larger sizes of LCD TV.

Organisational and cultural issues

At first many in the organisation resisted the new direction. Gradually everyone in the organisation came behind it. This accelerated when it became clear that CRT production would cease. This was equivalent to 'burning bridges' and people had no choice but to press on.

Case Study 4:
The impact of GPS on the military
MOD Joint Doctrine and Concepts Centre (JDCC)

Key points

- system has been highly successful, meeting and indeed exceeding original expectations;
- Armed Forces are heavily dependent on GPS, which introduces potential vulnerabilities;
- focus on GPS may work against investment in any partially overlapping systems.

The challenge

The ability to confirm the location of men and materiel, both the enemy's and one's own forces, provides significant and potentially decisive benefits in combat. The introduction of the Global Positioning System (GPS) does just this. However, there are potential disadvantages associated with the use of this technology too.

The change

The Global Positioning System (GPS) can be used for determining one's precise location and providing a highly accurate time reference almost anywhere on Earth or in Earth orbit. The principal uses of GPS by the military are: location awareness, targeting, logistic management, and communications and security.

The impact

Positive

GPS allows personnel to know their own location in all weathers, day or night. Force structures have been reduced on the assumption that an equivalent capability can now be delivered with less personnel and equipment.

Precision-guided munitions provide a greatly increased efficiency, significantly diminish collateral damage and reduce the potential for loss of local and international public support.

The acquisition of secure communications down to the lowest levels across the battlespace has increased tempo and reduced individual stress.

Negative

The pervasive adoption of GPS through the UK Armed Forces has potentially led to over-reliance. Many of the skills and systems in place before GPS have now been lost and could not be resurrected without considerable training and cost.

Users could make decisions based on impressive displays of friendly and enemy forces on a screen that may be inaccurate or may not portray the whole situation.

GPS, coupled with an effective communications system, allows commanders access to considerably more information than they had in the early 1980s – which risks overloading commanders with information.

Organisational and cultural issues

Until recently the UK Armed Forces have carried out only incremental changes to organisations and working practices as driven by developments in Information Communications Technology (including GPS). However, the MoD is now running a Network Enabled Capability (NEC) programme that is about the coherent integration of sensors, decision-makers, weapon systems and support capabilities to achieve the desired effect. The bottom line is that it will mean better-informed decisions and more timely actions leading to more precise effects and is thus shaping UK Defence's current and future force structures and requirements.

However, GPS has been a victim of its own success in that the Armed Forces now rely heavily upon it. This dependence has developed vulnerabilities the full impact of which were not perceived at the outset. Irreversible savings measures were implemented on the basis of savings from GPS and other ICT. Whilst those savings may have been logical when taken in isolation they have reduced resilience against the accidental or deliberate loss of GPS.

Case Study 5: Moving into data engine co-processing

ARM Ltd / ARM Belgium NV

Key points

- consumer demand for higher performance products required new technology;
- acquisition offered a faster route to market;
- ARM needed a flexible approach to properly evolve and integrate an effective business model from a strategic innovation acquisition.

The challenge

Higher levels of audio, image and video quality are being incorporated within the latest consumer products as companies seek to further differentiate their own. This has led to the development of new algorithms – the complex arithmetic and logical sequences that transform data. As a consequence, the required processing performance in many electronic devices has multiplied by several orders of magnitude.

While solutions developed by ARM's partners were able to meet data throughput requirements at acceptable power and area levels, designing dedicated logic for these complex algorithms was a cumbersome and time-consuming process.

The change

ARM realised it needed a radical change in order to continue delivering devices in shorter times and with more stringent power budgets. It needed something new.

Market research identified several start-ups developing potential new solutions. A purchase was cheaper than internal development and allowed a much earlier introduction of the new technology. So in 2003, ARM acquired a Belgian company, Adelante NV.

The impact

The first ARM OptimoDE product was launched commercially in late 2004. It is too early to say that the product will be a commercial success. The technology has been better adapted to the needs of the customers in a second release at the end of 2005.

Organisational and cultural issues

To make the acquisition work, ARM set up a small new division (the Data Engine Division) including all 25 employees in Belgium and several UK managers. The division was given a large degree of independence, but also quite detailed revenue and profitability objectives.

In order to have a major impact on ARM's future revenues and profits, it is better to give the product a longer period of smaller revenue growth and better tuning of the technology towards the customer needs. Therefore the former DED Business unit has been placed within the overall marketing group, with less focus on short term return and more focus on long term success.

Case Study 6:
A one-stop-shop for corporate services
Department for Education and Skills

Key points

- gaining senior support gave the project a much greater prospect of success;
- the rapid take-up meant traditional routes to services could be closed;
- using existing information and saving customer preferences made the system simpler and quicker to use, leading to a positive customer experience;
- thorough internal research and marketing was a key factor.

The challenge

One of three themes set out in the DfES e-business strategy of 2001 was the internal transformation of the Department, using IT to streamline processes and reduce bureaucracy. At that time, arranging a meeting with refreshments, travel and accommodation, for example, could involve several calls and considerable time spent by the organiser. The different services were provided through a series of helplines, websites and form-filling.

The change

The Department initiated the development of an innovative online booking system, designed to use technology to provide 'intelligent' and joined-up access to core support services.

The Services Zone provided a simple desktop facility which allowed people to book a range of corporate services quickly and efficiently, ensuring that everyone involved in providing that service was notified simultaneously.

The impact

There were significant efficiency gains within service teams as bookings were logged centrally.

Initial estimates of 40 per cent take-up were quickly surpassed. Within three months of launch, usage across all services exceeded 90 per cent, allowing more traditional routes to services to be closed.

Organisational and cultural issues

The project exposed the numerous and complicated levels of control and management which had developed over time and replaced them with a single, simple way of doing things. Many customers had developed their own unnecessarily complex systems for monitoring expenditure and approving requests. The service teams often had a number of systems in place – such as a different parking system for each of the four DfES sites. To convince customers of the value of the new procedures and encourage uptake, the project team developed a demonstrator and delivered a series of presentations, successfully gaining senior support.

The system used employee information and simple assumptions to personalise and speed-up the booking process. In effect, this meant that as much information as possible was already included when customers accessed the system, making first experience very positive. Preferences were saved and re-used by the system.

Management Information (MI) was instantly better following the introduction of The Services Zone, both for the people using the system and for the service providers. There was improved confidence in the ability of technology to make a positive impact.

Case Study 7: Cell Nuclear Replacement *BioIndustry Association*

Key points

- prospective legislation presented both a challenge and a threat;
- the BIA took a proactive stance on key strategic engagements;
- the Association established links with other stakeholders which have been maintained since;
- the campaign demonstrated the need for a strong communications function;
- early strategic consideration has enhanced potential health and investment outcomes.

The challenge

The Donaldson Enquiry in 2000 considered 'whether regulations need to be made under the Human Fertilisation and Embryology Act 1990 to extend the purposes for which the Human Fertilisation & Embryology Authority may issue licences for research using human embryos'.

The key issue for the UK bioscience sector was to ensure that those purposes were extended to include Cell Nuclear Replacement (CNR), or therapeutic cloning. In addition, it wanted to ensure a positive vote on such an extension in both Houses of Parliament.

The change

Failure to manage effectively the communications strategy risked the debate becoming dominated by single issue groups, with an associated risk to the BIA's members and bioscience and scientific research in general. The ultimate impact could have been to prevent research from taking place that has the potential to make a huge difference to many patients' lives.

What could have been interpreted as a threat was turned into an opportunity by the BIA. As well as ensuring that accurate facts about CNR were put forward, this development presented an opportunity for the BIA to communicate proactively on this issue, address issues of risk head on and highlight the UK's potential leading role in this field if legislation were amended in a proportionate and appropriate way.

Identification of other key stakeholders was vital, and on this occasion the patient group for Parkinson's Disease became an important partner. The campaign enabled the BIA to extend its links with the research community and other patient groups.

The impact

The BIA's primary objectives were achieved:

- the Government introduced legislation to change the regulations of the HFE Act to extend the purposes for which the HFEA may issue licenses for research using human embryos to allow therapeutic cloning; and
- both Houses of Parliament voted in favour of the regulations.

Organisational and cultural issues

The campaign proved useful in creating links with other key stakeholders that have remained in place in further campaigns. It also highlighted the necessity for an association dealing with what are often perceived to be controversial issues to have a strong communications function. Recognising the importance of this, since 2000 the BIA has increased its in-house public affairs from two to five individuals.

With many of the challenges to bioscience research coming from EU legislation, the Association is exploring, in conjunction with the DTI and under the auspices of the Bioscience Futures Forum, the extension of this approach to the establishment of a more formal cooperation network.

Case Study 8: The use of RFID tags
The Monitor Group

Key points

- success could only be achieved with the active collaboration of all the key players in the supply chain (open innovation);
- common standards were developed under the lead of an impartial, recognised authority and different disciplines had to work together;
- exhaustive financial analysis was carried out to justify the investment;
- downstream issues need to be explored regarding the views of the public.

The challenge

The widespread adoption of Radio Frequency Identification (RFID) tags is expected to ultimately replace the bar code. Each product will have its own unique identification code. In order to do this, however, two elements are essential:

- standards on radio frequencies, product mark-up language, etc, have to be agreed by all the participants in the supply chain;
- the costs of RFID chips have to be substantially reduced.

The change

The work started in earnest in 1999 with the founding of the MIT Auto ID Center in Cambridge, Massachusetts, USA (it is now UPC Global). A product mark-up language has now been created and agreed upon globally (the work of the MIT Auto ID Center). The cost of the chips has come down from over $1.00 to about 20 cents. It needs to be lower still, but expenditure can now be justified at case and pallet level.

The impact

Several retailers (WalMart, Metro, Walgreens) and top manufacturers are implementing this technology at selected distribution centres and in some test stores to monitor pallet and case movement through the supply chain (stock keeping unit – SKU – level tagging is not happening yet as the costs are too high).

Most importantly, the impact was industry-wide, not within one company. The entire supply chain, including competitors, had to agree upon standards, protocols, and, to some extent, common technologies to derive the benefits from this technology.

This is a transformational technology and has the potential to make huge productivity gains in the supply chain. The technology spans many industries: it has now spread into transport, financial, military, and many other sectors. Government can play an active role in getting these industries together to cross-pollinate ideas and application. The application to National Security has also been acknowledged.

Organisational and cultural issues

A high level of cooperation among all members of the supply chain, including competitors, was needed. The role of an impartial, recognised authority (in this case, MIT) was invaluable.

The first response by manufacturers and retailers was to carefully document the costs and how they could be lowered. Next, there was a focus on how to remove non-value-added costs in light of this new technology (e.g. reduction of retail help since inventory could be better managed, greater automation of manufacturing processes, etc). Then every element of the supply chain was unbundled and quantified – inventory costs, impact of theft, potential for incremental sales.

There is some concern about the impact of RFID on issues such as consumer privacy. Consumer benefit must be identified and communicated, to include anticipating any emotional issues such as privacy.

Case Study 9:
Designing the future with haptics
Arts and Humanities Research Council

Key points

- integrating creative and technical domains in Computer Aided Design;
- cutting the time for users to master CAD technology.

The challenge

Developing the skills for CAD can feel restrictive for many designers, and developing the technical abilities in this area takes an immense amount of time and practice – not always practical in fast-paced design industries.

Haptics is the study of human touch and how humans interact with the external environment using this sensory mode. In computing, using a force-feedback device, a sense of touch can be programmed-in and the body's sense of proprioception employed to inform the user about the position of the limbs in relation to the rest of the body and the space around. For applied artists and designers, spatial thinking and the sense of touch are integral to the process of creativity.

The change

An initial study in 2002 found that with the right back-up, haptic displays significantly enhance the user's experience. AHRC award holder Ann Marie Shillito of Edinburgh College of Art is working on a virtual system that will more closely replicate the experience of using a pen and paper, instead of a computer mouse, to create digital design images. This should enable artists and designers to fully exploit the potential of CAD, using haptic feedback.

The impact

Giving CAD users a direct, physical relationship with their data has the potential to shift their relationship with technology in radical ways. Allowing a more intuitive approach to working with a 3D environment has the potential to not only improve design practice but to avoid costly error.

Organisational and cultural issues

There can be a tendency to view technical (engineering or scientific) expertise as the only driver in developing new ways of working, which ignores the enormous contribution that the diverse domains of the arts and humanities community can make. This project showcases an extremely successful example of how different disciplines can work together – and learn from each other.

Case Study 10: Culture Online
Department of Culture, Media and Sport

Key points

- an entirely new model of working for the Department;
- team commissions without reference to ministers or the press office;
- team comprises specialists recruited from outside the Department;
- innovative procurement process which ensures control of the project till completion;
- solution developed in response to raised consumer expectations driven by new technology.

The challenge

The advent of broadband internet and other communications media offers the opportunity for arts and cultural heritage organisations to share materials online and interactively with new audiences.

DCMS was aware of the potential of these new technologies but also the lack of expertise within the department. There was also a general background of cost and time overruns on government-funded IT projects.

The change

DCMS set up Culture Online in 2002 with initial funding of £13.5m. Culture Online is an integrated commissioning team of some 20 specialists recruited from the worlds of TV, radio, online and print media, with expertise in project management, technology, communications, PR, finance and marketing. The team gets involved with the project editorially and maintains control through a strong focus on contract negotiation and deliverables, keeping back a proportion of funding until the project is delivered.

The impact

With its budget of £13.5 million, Culture Online is commissioning 20-30 projects that would not have happened otherwise. It works mostly with small companies in the creative industries – no large consultancies are involved. It has also issued guidelines on development, commissioning and procurement processes from which the DCMS and other government departments can benefit, and its approach to risk management was the subject of a positive National Audit Office (NAO) case study[1]. As part of each project it provides partner organisations with guidance on a variety of issues.

Within the arts and cultural heritage sectors the new funding opportunity offered by Culture Online has helped develop a more effective focus on new audiences.

Organisational and cultural issues

Culture Online uses a model of *strategic commissioning* (derived from production methods in industries such as TV) in which the commission team gets involved with the project editorially and maintains control, keeping back a proportion of funding until the project is delivered. This model requires all the key strategic thinking to be done up-front and shared, ensuring that all parties have a common vision.

This model was entirely new for DCMS and, unusually, Culture Online secured agreement to take individual commissioning decisions without reference to ministers. It was also given editorial independence from the Departmental press office.

Culture Online had to undertake extensive marketing and face-to-face outreach work to get interaction with hard-to-reach audiences.

The Culture Online commissioning process seems an effective model for bringing together projects involving complex technologies and small, diverse creative/cultural organisations, businesses and other working partners. This may have wider application in the creative and high-tech industries, particularly where they are engaged with social policy issues (e.g. technology to help the elderly stay in their own homes) which are not the normal province of the technology providers.

1. www.nao.org.uk/publications/nao_reports/03-04/03041078_casestudies.pdf

Case Study 11: Parallel experimentation in Chemical Development *GlaxoSmithKline*

Key points

- the change in approach has led to better data, and better manufacturing processes, in a shorter timeframe;
- champions were needed to lead the change;
- while global objectives can be set, there needs to be local flexibility in implementation;
- maintain focus: change needs sustaining.

The challenge

While some scientists within GSK Chemical Development had been carrying out multiple experiments in parallel, with automated and statistical tools for many years, the majority were continuing with an iterative, one-experiment-at-a-time methodology. The real value of these tools would only be realised when most chemists were using them on a routine basis. The challenge has been to implement a change in approach across five sites in three countries.

The change

Parallel experimentation approaches allow more data, of a better quality, to be collected on a chemical process in a shorter timeframe. Proper use of the tools has allowed different strategies for development of chemical processes to be explored. The information and the processes transferred to manufacturing are better. It is clear that the change has been easier to implement at some sites than others for a variety of reasons including previous experience and managerial support.

The impact

This technology is one of the key elements in the strategy for Chemical Development over the next three years. There is scope for further uptake of the change and plans are still progressing – currently 35 per cent of experiments are carried out in a parallel fashion (up from 25 per cent in the last 12 months) and a target of 50 per cent is believed to be realistic.

However, bottlenecks have become apparent in analytical throughput and there are some reservations about instrument reliability.

Organisational and cultural issues

To accomplish the change, cross-functional groups have been formally established on each site to champion the equipment and to be leaders in the use of statistical tools. These teams have clearly been successful and, although they coordinate with one another, they are independent.

A cross-functional, cross-site technology team developed the plans and objectives and has been responsible for leading the change. To allow the small group of experts to better influence their peers ‘by example’, the experts have been moved in to labs alongside their colleagues on some sites.

One of the main lessons has been to be clear about objectives on a global basis, but allow local flexibility in achieving them. Ensure that local progress is monitored by the global group and do not change focus too soon – change is often not self-sustaining without continuing reinforcement.

Case Study 12:
Developing manufacturing agility
Economic and Social Research Council
Brighton University

Key points

- team-based cell structure introduced to help innovate;
- focus on continuous improvement of product;
- new structure allows staff to learn new skills;
- accelerated product development lead-time.

The challenge

This company was established in 1969 as a result of a sudden demand to have modified forklift trucks operating in potentially hazardous environments. It offers customised diesel and electrically operated forklift trucks and equipment for offshore activities working under stringent regulations. By 1997, the company was looking for a mechanism which would enable them to make improvements in an increasingly competitive and unpredictable business environment.

The change

In 1997, new product development was an important topic for discussion. Or rather, the failure to deliver new products was the topic, as one manager commented: "*We haven't actually had a full new product developed in the last 10 years. There's no real discipline in the company for taking a new idea, developing it, testing it and handing it over to be manufactured.*"

The company identified three areas to effect change:

- the organisational structure was reconfigured from a divisional system divided according to discipline to a cellular, team-based structure;
- new product development was re-oriented to differentiated product lines, focussing on continuous improvement;
- the company expanded their facilities and changed the work layout, a new factory replacing the existing plant.

The impact

Results from the changes have been positive, particularly in accelerating product development lead-time. Products are semi-prototype and cannot be built on a flow line or on a conveyor belt. Meeting different specifications requires team members to adapt to different situations for each product. Teams have tried to standardise the repeatable processes while retaining the flexible processes for creative input. One product team has decreased lead-time significantly by standardising many of their activities.

Organisational and cultural issues

The company has retained many of the craft disciplines despite the breaking up of the technical divisions. The flexibility within each team and the overlap, especially in assembly activities such as mechanical, electrical and electronic technicians, allow people to move around and learn new skills.

The company has always based their performance indicators on financial measures. Since 1997 other measures were introduced, including customer-related indicators measuring on-time delivery and quality, as well as internal efficiency indicators such as quality per product.

Case Study 13: DNA Fingerprinting

Medical Research Council (Department of Genetics, University of Leicester)

Key points

- the fundamental discovery was unexpected and came from blue skies research;
- innovation in this case came from a policy of funding the best research, not focussing on specific applications;
- in 25 years, the technology has transformed a wide variety of disciplines, worldwide;
- large amounts of funding in different sectors have been re-directed as a result.

The challenge

Until the mid-80s, the technology that dominated biological identification was blood group and serological typing. This was seen by its practitioners as the ultimate technology in this area, though in hindsight the shortcomings are very clear. What were the alternatives?

The change

The crucial and entirely accidental breakthrough came in 1984 from studies of hypervariable minisatellites (so-called variable number tandem repeats or VNTRs). This was part of work initiated in 1997 to investigate genetic variability at the most fundamental level of all, namely variation in DNA itself. The notion of DNA fingerprinting and its applications only came to mind after the first DNA fingerprint had been accidentally produced. Patents were filed at the end of the year and in 1986 DNA profiling was first applied to a murder investigation, leading to the release of the prime suspect, the initiation of the first DNA-based manhunt and the apprehension of the true killer.

Cellmark Diagnostics was established in 1987 to provide a commercial vehicle for DNA fingerprinting technology.

The impact

DNA fingerprinting has transformed a wide range of disciplines, including police and forensic investigation, courtroom practice, military records and disaster management. In the UK, the Forensic Science Service has undergone major expansion, with very substantial new funding from the Home Office currently totalling over £300m, and a quantum shift to DNA testing and databasing. Commercial DNA typing companies have blossomed worldwide, providing access to the technology for paternity and immigration testing and for forensic casework, often for the defence, and creating major opportunities in an entirely novel business sector. Traditional blood group testing laboratories have almost entirely disappeared. New legislation has emerged, and entirely new areas of concern have been generated for civil liberties groups.

Organisational and cultural issues

Forensic laboratories worldwide have had to adapt to an entirely new science and technology that now dominates much of their activities, leading in some cases to massive restructuring of organisations and shifts in personnel. Interestingly, the culture of scientific excellence that originated with forensic DNA has now started to invade other areas of forensic science. Other responses range from the institutional (e.g. new legislation) to the personal. DNA testing has now directly touched the lives of perhaps 10 million people worldwide, often in a profound and life-changing way.

One fundamental driver of technological change is basic science and an academic environment that allows at least some degree of freedom of thought and enterprise not driven by applied goals. This environment can only be maintained through adequate funding from the research councils, and ultimately from Government, and a continued appreciation that blue skies research is an essential component of the UK's overall research portfolio.

Case Study 14:
Internet technologies and business
Engineering and Physical Sciences Research Council

Key points

- the internet has fundamentally changed the way businesses operate;
- organisations were forced to respond by a fiercely competitive global market;
- the internet has lowered costs dramatically;
- a range of new business sectors have been created;
- Major changes of this kind will always raise moral, ethical and political questions.

The challenge

The internet began in 1969 as an effort to provide fast communications for the US military scientists working on national security issues around the globe. Then, in 1989, Tim Berners-Lee, while working at the European Organisation for Nuclear Research (CERN), came up with the idea of the World Wide Web. In the late 1970s and 1980s, many UK researchers were studying network technologies and how best to connect networks together; this work laid the foundations for the internet technologies that are used by millions of people today.

The change

Commercialisation of the internet involved the development of competitive, private network services, and also the development of commercial products implementing the internet technology. In the early 1980s, dozens of vendors were incorporating TCP/IP into their products as an approach to improve networking with buyers.

Explosive internet growth occurred in the late 1990s and dramatically affected the evolution of computer networking. Broadband technology has enabled transmission of a large number of moving images or a vast quantity of data simultaneously.

The impact

The internet has had dramatic impact on business and fundamentally changed the way companies operate. This goes far beyond buying and selling, through the establishment of new electronic marketplaces, the creation of new distribution channels described as e-commerce and major changes into internal business processes and culture through faster more efficient communications. Complete industry structures such as entertainment, financial services, healthcare and publishing have been transformed as they aligned their organisations to take advantage of the continuous breakthroughs in network technology.

The internet has also impacted education by offering electronic delivery methods such as CD-ROMs, video conferencing, websites and e-mail and by providing faster access to information, virtual lectures, tutorials, online access to conferences through a range of e-learning programmes.

Organisational and cultural issues

Driven by a fiercely competitive global market, organisations were challenged to redesign their processes to adapt quickly to the new environment created by the internet. Now most medium to large companies have their own Home Page and use these pages to provide information and services to their customers.

The internet has helped both buyers and sellers to lower costs dramatically, helped form new supply and demand chains, take customer service into different groups, enter new markets, create additional revenue streams and redefine their business relationships.

Case Study 15:
Electronic publishing and the Web
Institute of Physics Publishing

Key points

- developing electronic publishing involved more than just a technological change, it needed a rethink of publishing concepts;
- there were risks associated with online publishing but potentially more in ignoring it;
- the nature of the internet means that a competitive edge can be short-lived;
- those entering the online world later were able to 'piggy-back' on the experience of the pioneers;
- it is easy to be a follower in ICT, there is more risk to first movers.

The challenge

As the internet, the Web and associated technologies rapidly evolved between 1994 and 1998, it quickly became clear that publishers who had ventured online were committing themselves to far more than they could have anticipated; those that did not were at risk of being left behind or swept away. Developing an electronic publishing capability was much more than a technological issue: it required new ways of thinking about reaching and delivering to customers (readers, users), different approaches to marketing and product development, and – freed from the shackles of ink-on-paper – a rethink of what the published article should and could be like.

The change

The company decided to experiment early, and from that grew a strong commitment to online publishing, backed with significant investments and organisational structures. The investment in electronic publishing at IoPP, including IT and staff costs, amounts to between £5 million and £10 million since 1994, representing about 5 per cent of business revenues during that period.

The impact

Despite being an early leader, the very nature of the internet meant that competitors could quickly replicate each other's offerings. The competitive edge therefore gradually eroded. For a small, charity-owned scholarly publisher,

taking on the mantle of an early technology adopter carried a large financial burden and risk.

Being early adopters and pioneers meant embarking on a largely self-taught and do-it-yourself approach to the technology required. In the last 3-5 years, the electronic publishing technology supply market has matured and consolidated, prices have reduced, and there is more choice of product. But because of the resources built up internally and the momentum of the DIY approach, IoPP have been slower to adopt outsourced solutions that they might have otherwise, had been a follower rather than a leader in electronic publishing.

Organisational and cultural issues

Initially online production resources comprised a small technical team dedicated largely to the journals publishing unit and drawn out of the IT department. As other parts of the business became more interested, initiatives became less technology-led and more publishing-led. Specific electronic publishing centres of expertise were gradually built into existing departments and the technical expertise became largely centralised again, merging with traditional IT.

Not every part of the organisation entered the new world of online at the same time or with the same gusto. Reluctance or resistance were driven by risk aversion, cultural inertia, or simple lack of perceived need. In the end, the 'slower' parts of the business were able to 'piggy-back' on the backs of the explorers and pioneers – those who had already invested in corporate infrastructure and expertise while forging new paths or learning from false trails.

Case Study 16:
The human genome project
The Wellcome Trust

Key points

- the first 'big science' biomedical project needed a new partnership model to work;
- the Trust had to be flexible enough to invest major funding in a single project;
- the HGP represented a significant, though calculated, risk;
- the Trust as an independent funder could play a unique leadership role in delivering a perceived public good.

The challenge

The rapid development of technologies for automated DNA sequencing and whole genome analysis made the proposition of sequencing the entire human genome a realistic goal. The launch of a private sector initiative to rapidly sequence the genome and potentially charge for access to the information resulted in the Trust and the other HGP funders injecting funding to accelerate sequencing efforts in 1998 to ensure that the genome was completed within the timeframe envisioned, and that the data was in the public domain.

The change

Through establishing and supporting the Wellcome Trust Sanger Institute in Hinxton, Cambridgeshire (which opened officially in 1993), the Wellcome Trust ensured that the UK played a leading role in the international Human Genome Project. The Sanger Institute was responsible for producing one third of the completed human genome sequence (the largest single contribution).

In addition to the sustained financial investment required to deliver the human genome sequence (over £200 million by 2001), the decision to establish the Sanger Institute represented a fundamental organisational shift, and entirely new way of working, for the Wellcome Trust.

The impact

The Human Genome Project was arguably the first example of a 'big science' project in the biomedical sciences – it provided a model for how scientists and funding agencies from a number of countries could collaborate and coordinate a massive international programme.

The availability of whole genome sequences has had a profound impact on biomedical research more broadly – greatly enhancing the ability of the scientific community to characterise how genes and their products underpin key biological processes.

The HGP also raised a series of significant ethical and social issues. The Trust has supported a range of activities to explore these through its Biomedical Ethics programme and wide range of public engagement activities.

Organisational and cultural issues

The vast majority of Wellcome Trust's charitable funding is vested through grants to universities and other research institutions. The Sanger Institute remains the Trust's only stand-alone, directly-funded institute (it is managed via a subsidiary). Developing and maintaining the Institute as one of the world's leading centres for genomics research has required a sustained financial commitment, representing a significant proportion of the Trust's total funding portfolio (currently around 15 per cent of its total annual spend of approximately £400 million).

The HGP provided a new model for how organisations could work in partnership both to overcome challenges that no single organisation could address alone, and to develop major resources for the benefit of the research community. Following its involvement in the HGP, the Trust has worked to broker a series of innovative partnerships with a range of other organisations.

The Trust, as an independent charity, took a leadership role on key policy issues, and worked with others to develop best practice standards for the benefit of the research community. Such independence and long-term funding would not be easy for government.

Case Study 17: Satellite data and the Met Office
The Met Office

Key points

- weather forecasting is becoming increasingly dependent on satellite technology;
- significant economic and social benefits have arisen from the advent of this technology;
- change has been gradual, over a number of years;
- satellite data has an input to policy making, particularly climate change.

The challenge

Public awareness of the value of weather forecasts is continually increasing, partly as a result of the increased media exposure of natural disasters, and also by the use of satellite image sequences and products to illustrate the official forecasts and warnings. Public expectation is also being raised in terms of the accuracy, type and range of forecasts that they would like to receive.

Over recent years, operational meteorology and climate research have continued to grow increasingly dependent on high quality Numerical Weather Prediction (NWP) models which in turn rely on steadily improving, sustained sources of data. Satellites have become the primary source of these data.

The change

The introduction of space technology into the Met Office has had an enormous impact on the quality and appearance of forecasts primarily due to the improved accuracy of NWP products.

Direct economic and social benefits can be associated with this improvement both in terms of the general benefits that accrue from accurate forecasting as well as specific benefits through forecasts tailored to support economic sectors (such a civil aviation, shipping, civil security, tourism, health…).

The impact

Today the Met Office is able to offer products and services that simply would not be possible without satellite data. As a vital input to NWP systems and a primary source of information for operational forecasters, it underpins much of what the Met Office (and the wider International Meteorological community) does. It also forms the basis for important research such as that carried out by the Hadley Climate Centre in order to support and inform Government policy.

Of course, satellite data does not come without significant cost. The European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) was founded in 1986. The Met Office, as member responsible for UK representation, is required to pay an annual contribution at a relative GNI level, which is currently 16.78 per cent of the total budget (UK contribution approximately 35 million Euro in 2006).

Organisational and cultural issues

As the satellite component has become more and more capable, this has led to many fundamental developments within the Met Office, including:

- changes in the ground-based observing system to ensure that it best complements the space component;
- reliance by forecasters on imagery and improved NWP products in order to carry out their day-to-day responsibilities;
- NWP models being developed in such a way as to make maximum use of both polar satellite data and products derived from geostationary satellite data;
- the availability of satellite datasets that span the last 30-years; now becoming useful for important climate research activities that are vital to inform Government policy;
- the establishment of the infrastructure to support the increasingly large data volumes being generated globally (primarily as a result of the growing satellite component).

Case Study 18:
Defence information management
MOD Defence Academy

Key points

- an increasing divide is developing between those embracing change and those rejecting it;
- training and education are essential to take best advantage of change;
- some existing education was outsourced in order to allow staff to focus on this project.

The challenge

Recent operational experience, together with the fact that the UK is introducing a Network Enabled Capability (NEC) strategy, has highlighted the need to improve the management of information within the MOD and the Armed Forces. This requires a large scale re-evaluation of the methods of managing and exploiting information in a fast-moving military environment.

The change

The underlying technological changes were gradually introduced from 1993 to 2003, in line with the revolution in communication, computing and information technologies. From a military perspective this included a series of developments; for example, the introduction of email at the lower end, up to the information management implications of unmanned air and remotely-operated vehicles in the achievement of military objectives at the higher level.

An intensive programme of lectures, exercises and visits has been developed for prospective Information Managers and Senior Information Officers. New policies are in the course of development with MOD Central Staff.

The impact

The opportunity is increasingly available to furnish military commanders with a more complete appreciation of the battle space: this brings with it the stress of multiple sources competing for attention and the need to be able to evaluate and prioritise these sources.

A major impact has been the need to introduce training so that these opportunities can be fully exploited. Although costs are incurred in delivering this training, they are not large as the Defence Academy chose to re-direct the work of existing staff, leading to intellectual commitment rather than major financial outlay.

Organisational and cultural issues

While it is important to keep up with emerging technologies, training and education facilities must run in parallel in order to take maximum advantage. The organisational response was for the MOD to commission the Defence Academy to address the shortfall in IM skills. Part of the project involved academic partner Cranfield University taking on existing training courses unrelated to IM from the Information Division of the Defence Academy. This released staff and resources to respond to the change.

The technology shift has highlighted the increasing divide between those who addressed and embraced its potential from the start, and those who did not – and who are progressively disadvantaged since the technological tools vital to the conduct of business are effectively obscured from them.

Case Study 19: DSpace@Cambridge
Cambridge University Library

Key points

- the links with MIT through the project have created opportunities for new research partnerships;
- the potential benefit of central services is being highlighted to a highly federated university;
- issues about access to the repository parallel the wider debate about Open Access publishing.

The challenge

While more and more materials are being created in digital form, the problem of how to store these items in the long term is becoming an issue for both public and private sector organisations. 'Digital assets' are at risk from a number of factors including: data corruption; file format and hardware obsolescence; as well as a mixture of complacency and ignorance among data owners (many of whom consider storage on a PC or back-up floppy as adequate for long term archiving).

Much of Cambridge University's materials are of long term value, not just for the university but also for the wider scholarly community and, potentially, for researchers in the private sector.

The change

Cambridge University Library (CUL) and Cambridge University Computing Service (CUCS) are engaged in a project to create a digital institutional repository – DSpace@Cambridge - as a central service. DSpace@Cambridge enables members of the university to submit selected digital materials to be managed by the repository.

The impact

Valuable materials in digital formats are being saved for both immediate and long term use. Researchers are able to use the repository as a means of meeting obligations imposed by funding bodies on making research outputs publicly available.

Organisational and cultural issues

The initial project was established as a collaboration with MIT Libraries, supported by funding from the Cambridge-MIT Institute. The link with MIT created opportunities for new library/computing service research partnerships.

The repository is highlighting, in a strongly federated university, the value of well-focussed central services.

Individual departments and research groups are creating new internal procedures for the routine deposit of digital materials into depository. It is interesting to note that different academic disciplines set different priorities for preservation – with arts/humanities typically taking a longer term view.

Academics are encouraged to employ Open Standard file formats (e.g. Open Office, PDF) in preference to commercial applications (e.g. Microsoft) when creating potentially archivable material, as the former present fewer preservation problems. There is an ongoing debate about the availability of materials to the wider public, which parallels the wider debate about Open Access publishing.

Case Study 20:
Gas to liquids – a new clean energy source?
Shell International Exploration and Production

Key points

- over a period of 20 years' development, a Champion at senior level was necessary to drive the project through leadership changes;
- the resulting business is the fastest-growing within Shell;
- an unexpected benefit was of being well-positioned to respond to calls for cleaner and lower-carbon fuels.

The challenge

Following the energy crisis in the early 1970s, Shell identified a need to diversify its energy resources – in particular with a view to lessening its dependence on the Middle East.

The change

The company took an old technology that turns coal, via synthesis gas, into a liquid hydrocarbon and applied it to other fuels such as biomass and gas. These liquids can be transported much more easily than solids or gas. The new forms of this technology took more than 20 years to develop.

The impact

A new Shell business, Gas and Power, was formed to drive the development and an $800 million pilot set up on Malaysia. A full scale plant is expected to come on stream in Qatar in 2009.

With global oil reserves now peaking, this technology is allowing Shell to focus more on gas: reserves are more evenly distributed across the globe than oil and will last longer.

Although not originally intended, this development has greatly affected Shell marketing. It has allowed the creation of 'cleaner' fuels such as V-Power and a number of synthetic, fit-for-purpose fuels and lube-oils.

It has also triggered new developments to leverage biomass as a carbon-neutral fuel of the future.

Organisational and cultural issues

The development has resulted in a business more focussed on gas than on oil. Shell Gas and Power is the fastest growing business in Shell.

The development of this technology took a very long time. Over that period, different boards of directors were in charge – and commitment to this process had to be elicited from, and owned by, successive boards. This could only be achieved with a Champion at senior level who could drive the project over a long period.

Case Study 21: Ground storage of building heat energy

Ove Arup and Partners

Key points

- the project called for a partnership between academic and commercial organisations;
- Government support was needed as a catalyst for the project;
- the project has helped to introduce a sustainable energy technology, already in use in Europe, to the UK.

The challenge

Ground storage of building heat energy has been used widely in parts of Europe where cheap, natural gas is not readily available and where the cost of energy is high.

Over the last two years, gas prices have increased in UK and there is a heightened awareness of the need to reduce carbon emissions. Ground heat storage has been identified by planners as a form of reusable energy.

The change

In 2002 Arup applied for, and won, a DTI Partner in Innovation (PII) award for a ground storage of heat project. This linked academics, consultants and contractors with the Environment Agency to develop methods for designing and constructing these systems in UK conditions.

The impact

It has enabled Arup to offer their clients up-to-date information on these systems. This is particularly useful at the current planning stage, when planners are very keen to have sustainability issues on the agenda.

Existing contacts with universities and the EA mean that Arup can develop the technology and explain to the client the risks and future developments that still need to be made to improve the technology.

Organisational and cultural issues

The organisation had to deal with a number of issues:

- technical – some of the systems are unproven in UK ground conditions, such as the chalk below London;
- commercial – because more work is needed to produce safe designs. There are risks that need to be explained to the client.
- staff training staff – this is important as new software is needed and has to be field-tested.

This area has become part of a sustainable energy business in Arup. It has provided a new business stream for the Geotechnical Engineering Group. Arup has invested about £50,000 per year to develop this business and technology in Europe.

Case Study 22: Knowledge Transfer Networks ICT Platform

Innovation Team, OSI, DTI

Key points

- the new virtual networks require a different mindset and skills;
- 'virtual' networks are less labour-intensive and so lower cost than 'real' networks;
- the networks bring together stakeholders from both within and outside Government;
- the approach offers a means to increase the opportunities for networking and hence assist policy making.

The challenge

The challenge was how to implement the Technology Strategy set out in the *Innovation White Paper* of December 2003 and the *10 Year Science and Innovation Framework.* Both of these stressed the importance of networks and innovation systems.

The change

The main technological change was to move away from a plethora of individual websites and develop the concept of an ICT platform. This uses economies of scale to purchase the underpinning software components upon which all Knowledge Transfer Networks sit (with unlimited usage licences): these provide easy linkage between networks as well as within them.

Participating SMEs can have the same access to information and global links as large firms, simply by joining the KTN and providing a profile of interests.

The initial investment in licences has been the main cost; the marginal cost of developing individual networks on the platform makes it very attractive to replicate and 17 have already been developed, with others in the pipeline.

Virtual networks require a different mindset and set of skills. The move to 'virtual' networks is not without its challenges.

The impact

The Department has the ability to access a much wider range of information and opinion and share it with others from the business/academic community. For example, without moving from desks, the Fuel Cells network was able to debate strategy with a wide range of stakeholders: academics with the EPSRC; business and researchers with the European Commission Director responsible for Fuel Cells and Hydrogen strategy (speaking from Brussels); and a group of RDAs regarding RDA interests and priorities. The system also enables civil servants to engage with the business/research networks more intensively and has been used to develop the medium term strategies for specific technology areas. Furthermore, it is enabling DTI civil servants to collaborate with counterparts in other departments on specific projects, e.g. in response to Parliamentary committees.

The opportunities for engagement are almost boundless.

Organisational and cultural issues

Government IT systems tend to develop cheap and secure means for internal exchange of information, while missing/preventing effective engagement outside the Department concerned. Extranets, on the lines of the KTN platform, could become a growing feature of Government knowledge acquisition and exchange for the benefit of policy making and the target audience. Just as ICT is rapidly transforming the service sector through disintermediation, the challenge of reduced headcount in central Government is necessitating a reconsideration of business models: the platform provides an interesting model of how Government can evolve to become intelligent enabler and facilitator, while acquiring all the information it needs to develop strategy/policy.