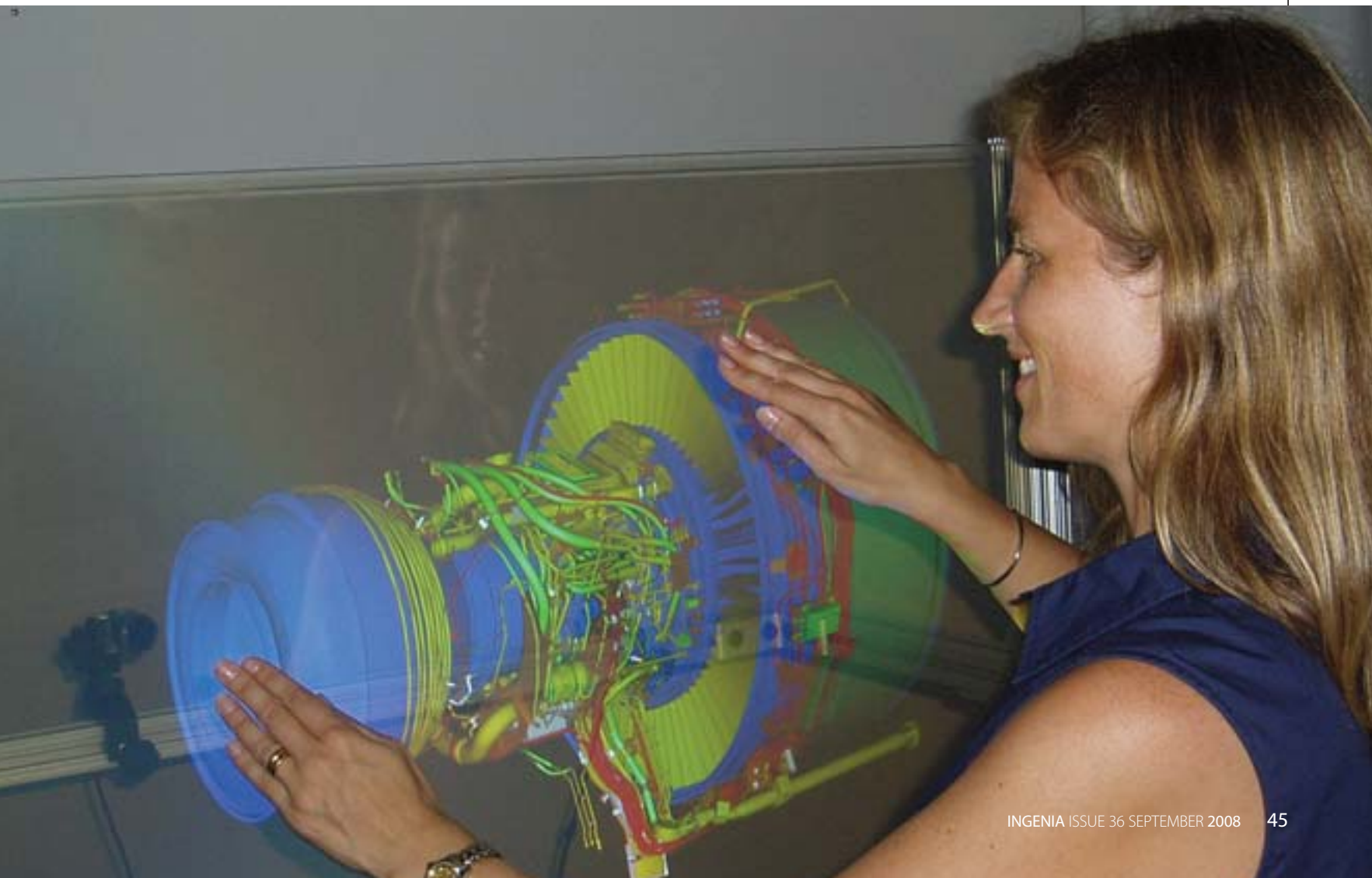


# INNOVATE WITH VISION

The convergence of digital technologies is opening the door to novel ways of managing the creation of new products and services. David Gann and Mark Dodgson argue that the new concept of innovation technology could change the innovation process and have as profound an impact on economic growth and social wellbeing as the development of machine tools in the 19th Century.

EON TouchLight makes it possible to interact with digital data without the use of head-mounted displays, shutter glasses or 'virtual reality gloves'. The technology combines the output of two video cameras behind a semi-transparent plane in front of the user. EON TouchLight allows people to use their bare hands to zoom, pan and rotate images, movies and high resolution interactive 3D products, such as this engine © EON Reality



To remain competitive, businesses have to be good at applying new ideas. To do this well, and to create new products and services, firms must develop innovation processes that take advantage of opportunities in science, technology and the marketplace. Innovation depends on input from many elements within companies including research, design, engineering, operations and marketing, for example. Innovation often also needs input from many external sources. Without effective coordination of all these inputs, the result can be a costly and wasteful process that fails to meet its objectives.

The convergence of various technologies – including eScience, simulation, modelling and virtual prototyping – provides a possible solution to the challenge of coordinating innovation processes. We refer to this new digital toolkit as ‘innovation technology’ or ‘IVT’.

### VISUALISATION

We can begin to get some idea of the power of IVT by looking at how it has already affected modern engineering. Recent improvements in technologies have significantly enhanced the ability to represent and visualise computerised results in a graphical way, enabling expert users to recognise patterns quickly and accurately. Visualisation also enables non-experts to understand the results of what are often highly complex mathematical equations. It provides new ways of communicating options and choices across diverse communities. Visualisation is usually far better than text-based media for communicating with decision-makers and involving them in innovation processes.

These tools already influence engineering design. Firms such as GE and Boeing make extensive use of visualisation

A full-height, backlit screen in the galley showroom for the 787 Dreamliner allows customers to view different galley configurations ‘virtually’. In this way, they can test and study the ergonomics of their chosen galley layouts © The Boeing Company



technologies to explore design options, cutting costs and reducing the time taken in traditional prototyping. Examples of the successful use of visualisation in innovation range from designing buildings, to making them safe in the event of a fire (see box to the right), exploring options in combinatorial chemistry in drug design, or even innovations in the public sector, such as London’s Congestion Charge. Visualisation also plays an important role in evaluating complex construction projects such as Heathrow’s Terminal 5 and the preparation for the London Olympics.

### MIXED REALITY

The tools needed for this work include technology developed by companies such as EON Reality. Based in Irvine, California, EON Reality is at the forefront of developing visualisation systems that allow data from real and virtual objects to be combined, creating virtual prototypes in ‘immersive’ studios with a high degree of detail.

These studios can include six-sided display rooms that immerse experts and users in the virtual environment, where they can manipulate data using Microsoft’s TouchLight technology to move 3D images by hand (see image on page 45). Examples of this type of ‘mixed reality’ environment include simulation of medical operations such as laparoscopic surgery, using digitally designed operating equipment combined with real data from MRI scans. With these systems, firms and their customers can experience products and services before they are produced in reality.

EON Reality’s capability is based on software that can take data from almost any engineering design system. The studios combine the best technologies from computer games with advanced engineering and design tools, including holographic imaging and touch-sensitive virtual models. Boeing used a fully immersive mixed-reality studio to help design the 787 Dreamliner.

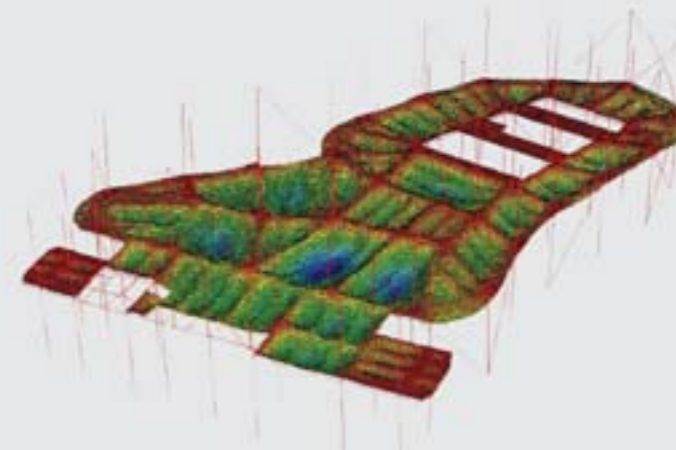
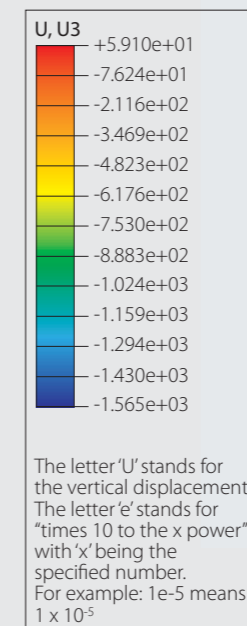
### CONVERGING TECHNOLOGIES

Visualisation using these new forms of computer graphics has also done much to change the shape of modern manufacturing. The development of computer aided

### FIRE IN BUILDINGS

Following the destruction of the Twin Towers in New York City, there has been an increase in the demand for engineers to verify that new and existing buildings would be safe in the event of a serious fire or disaster. In response, Arup, a design engineering consultancy, met these new challenges through an increased use of visualisation and simulation tools for fire engineering work.

These were needed to address key issues such as progressive structural collapse and simultaneous evacuation of tall buildings. Arup led the use of new approaches that utilise a suite of computational tools for designing buildings. With these techniques, engineers can work with architects, clients, regulators, fire authorities and insurers to assess whether a building is likely to provide adequate safety as well as meeting the other design objectives.



Advanced structural fire analysis of a tall externally braced frame steel and composite office building. This image illustrates the vertical displacements of the floor system during a severe post-flashover fire in the building. This analysis highlighted the robustness of the structure in fire and resulted in an optimised fire protection strategy for the building

design and manufacturing (CAD/CAM) in the 1970s improved coordination between engineering design and manufacture. Software gave design engineers tools to produce 3D CAD drawings that could deliver data to computer controlled machine tools and advanced flexible manufacturing systems. Using a common digital platform, design and production engineers integrated their work more effectively and improved product development and manufacturing processes.

Similar technological convergence between information and communication technologies – now commonly known as

The company’s new tools include advances in well-established techniques, such as finite element analysis (FEA) to check the integrity of a building’s structure in a fire. Arup also uses computational fluid dynamics (CFD) to model the flow of smoke within a building and how to control it. New simulation techniques also allow the designers to analyse the evacuation of people from buildings as well as evaluating people movement in normal circulation.

Visualisation techniques can combine results from these simulations, displaying them using graphics that allow non-technical stakeholders to better understand design options and achieve optimum design outcomes for clients.

ICT – combining computing with telephony, has led to significant productivity gains in business services.

Visualisation systems have the potential to extend the digital infrastructure that underpins the innovation process, and to build upon the developments of CAD/CAM and ‘artificial environments’. They allow innovators to look for, and experiment with, new ideas in ways that were previously unable to achieve. The capacity to display complex information relatively easily and cheaply was important for the Human Genome Project, for example.

In the aerospace sector, Rolls-Royce uses eScience or 'Grid technologies' to improve interaction between research teams. For example, in the company's Distributed Aircraft Maintenance Environment project, which developed real-time monitoring of jet engines, high-bandwidth computer networks connected engineers in different universities and parts of Rolls-Royce.

### SHARING PLATFORMS

eScience, or Grid technologies, have their basis in high volume data transmission, scientific computing and the internet. These technologies include software that allows teams working in different locations and in different parts of the R&D process to share data. This middleware is connectivity software that consists of a set of enabling services that allow multiple processes running on one or more machines to interact across a network.

Modelling, simulation and visualisation technologies evolved from CAD systems. They have benefited significantly from developments in the computer games and motion picture industries. Simulation enables design and development teams to explore options and test combinations of ideas in a virtual environment. This digital simulation process reduces the cost and time involved in combining different components and elements. It also enables more stakeholders, including customers and regulators, to become involved at earlier stages in the innovation of products and services.

Virtual and rapid prototyping have already proved their ability to save time and money. In the construction industry, virtual prototyping helps to connect architects, service engineers and end users. The consumer goods company P&G uses virtual and rapid prototyping to test whether disabled or elderly people can open new packaging containers, and how the design might appeal to particular market sectors.

Technological convergence may bring important benefits by improving the way innovation occurs in services – such as in designing better healthcare, energy, environmental or financial systems. Hitherto, companies have found it difficult to develop new services 'offline' from their use. In part, this is because the innovation process in services differs from that for products. Services are typically consumed as they are produced, making it difficult to prototype new versions and evaluate and test options before they are released on the market. Services therefore usually fail to go through the design and test stages found in new product development.

For this reason, new services are often launched before they are comprehensively tested. Visualising the potential use of new services in virtual prototyping environments offers an exciting way around this problem.

### CHALLENGES REMAIN

When considering how to implement innovation technologies, it is also important to take account of analytical skills and judgment based on craft knowledge. Existing knowledge and skills among users of these technologies are essential. Ill-informed use of the digital innovation toolkit can produce inaccurate results and can lead to catastrophic failure in the processes and outcomes of new product and service development projects. The value of modelling, for example, depends upon understanding the reliability of the data put into the models, the assumptions and simplifications involved in the model and the results that come out of the process.

Important challenges remain. Simulations rely on data in which computerised calculations can magnify small errors or misjudgements, leading both lay people and experts to make big mistakes. Professor John Burland, who developed modelling techniques at Imperial College London to prevent the collapse of the Leaning Tower of Pisa (*Ingenia* issue 23, June 2005), has expressed his concern in this regard. "Validation is extremely important," he says. "It's all very well to have your all-singing, all-dancing model, but how reliable is it? Do you have to calibrate it? A huge amount of my work involves being sceptical about the particular programmes we are using. We test the model against known cases. We test it against physics."

Validation of results is a particular challenge when simulating complex systems and services, where it is not always possible to calibrate models with real data. Visual results from virtual prototypes may appear slick and convincing – what some call "eye candy" – while hiding defects in the ways in which models are built and the potential errors in the data that underpins them.

### BIOGRAPHY – Professor David Gann and Professor Mark Dodgson

Professor David Gann is Head of Innovation and Entrepreneurship and holds the Chair in Innovation and Technology Management, Imperial College London, and is Group Innovation Executive at Laing O'Rourke plc. Professor Mark Dodgson is Director of the Technology and Innovation Management Centre at the University of Queensland Business School. Together they are part of the *Think Play Do Group*, a London-based innovation consulting, training and software company.

The value of these techniques depends upon the quality of questions they are asked to address, and having a clear understanding of the assumptions and simplifications built into the models and the results that they portray.

Innovation technology has the potential to unlock opportunities to engineer better systems and difficult to design services, whilst enhancing the coordination of innovation processes. Achieving this will require new management practices, that safe-guard against the validation problem; organisational structures enabling collaboration across disciplines and between firms; and skills to broker, interpret, translate and recombine knowledge in multi-disciplinary teams.

### AIDING ENGINEERS

Innovation technology can enhance the coordination of innovation processes and changes the practice of engineering. As this happens, engineers are likely to enjoy a wider and more strategic role as their capacity to visualise improves, together with convergence of the new digital toolkit for innovation. IvT has the potential to improve communications across professional, functional and organisational boundaries, allowing engineers to search for better answers to complex problems. As with CAD/CAM, the benefits accrue only when technological possibilities are aligned with

clear management objectives and supportive organisational structures and skills.

While visualisation and digital technologies have done much to improve the quality and productivity of parts of the innovation process, we have yet to see full convergence and integration of the various technologies that make up IvT. However, the concept presages a new era of faster, better and cheaper innovation. In the right hands, IvT should enable better interpretation and translation of data and information across organisational and professional boundaries.

To achieve the full benefits of IvT, companies and other innovators will have to create a new digital infrastructure for innovation. In doing so, they will open up huge opportunities to create better systems and services in areas such as healthcare, energy and the environment. Innovation technology may well have as profound an impact on economic growth and social wellbeing in today's knowledge economy as machine tools had on the industrial economy of the mid-19th Century.

- Further reference
- [www.eonreality.com](http://www.eonreality.com)
- [www.arup.com/fire](http://www.arup.com/fire)
- [www.laingorourke.com](http://www.laingorourke.com)

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### LAING O'ROURKE'S COLLABORATION CENTRE

Based on its successful partnership with BAA in building Heathrow's Terminal 5, Laing O'Rourke has developed a Collaboration Centre with two digital prototyping theatres.

These visualisation systems enable 3D and 4D modelling – the fourth dimension being time. These simulations enable the viewing of complex development and construction projects, from master-planning and regeneration schemes through to detailed structural, mechanical and electrical engineering including construction sequencing and cost planning. The ability to produce fly-through simulations has proven invaluable in demonstrating virtual prototypes to clients. Combining cost or resources/labour models to these simulations is often referred to as 5D in the construction field. And this has enabled better decision-making based on options for different designs.

A recent success in the use of the visualisation system and collaborative space was shown in the way the CLM team from three separate companies (Laing O'Rourke CH2MHill and Mace) mounted a successful bid to become programme managers for the 2012 Olympics.



Stereoscopic glasses enable participants to view 3D, 4D and 5D visualisations of many aspects of the design and delivery projects at the Laing O'Rourke Collaboration Centre