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# Introduction

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The IDEAS Factory is a unique concept in scientific thinking. It breaks down barriers and builds new relationships to create a world of endless possibilities. Intensive 'sandpit' workshops assemble the dynamic range of individuals and skills needed to attack real world problems from every angle. Groups and ideas are formed, reviewed and potentially funded within five days.

The result - ambitious, innovative research without boundaries and a legacy of new relationships and a new way of thinking that continues long after the factory gates have closed.

EPSRC's IDEAS Factory began life in 2004 with one aim - to provide a new dimension in problem solving.

An intense, five-day residential 'sandpit' workshop lies at the heart of the process. Isolated from everyday distractions and stripped of pre-conceptions, the group explore and deconstruct the issue before refocusing on emerging solutions. Ultimately, the group itself review the ideas and make the final funding decision.

Subjects can be born from a single issue, with each sandpit seeking to create research teams with the diverse skills needed for success. The process is guided by the people for which the chosen problem is an everyday reality.

Sandpits are also used to stimulate new research ideas or directions in emerging areas or reinvigorate existing disciplines.

New approaches to tackling gun crime, increasing airport and port security, improving independence for mental health patients and increasing UK productivity are just some of the issues that have passed through the factory.

The IDEAS Factory has made a real impact on the scientific landscape. It has stimulated new research and opened doors to exciting collaborations. Those who have experienced it continue to be influenced by its ethos of ambition and adventure.

*“The IDEAS Factory sandpit mechanism is unique and has already shown a universally positive impact for those attending. The sandpit has established independent and sustainable research communities; created an observable culture change amongst participants who are embracing creativity and originality; facilitated an increase in the capacity of multidisciplinary researchers and their interactions in the UK.”* - independent review panel.



# Inside the factory

## Meet the Staff

IDEAS Factory relies on the skill, passion and creativity of those involved. It is a process built on team dynamics - driving innovation and ideas through discussion, debate and interaction. Each sandpit is led by a director, supported by mentors and facilitators. Stakeholders, those with experience of the issue, provide valuable insight and, ultimately, teams of participants develop potential research proposals.

### Participants:

Participants are selected for each sandpit using an application process and each participant is assessed on the basis of the skills and expertise they can offer. The range of participants can be extremely diverse, from physical scientists and engineers to designers, social scientists, psychologists and healthcare specialists.

The ethos of the IDEAS Factory is that participants shape the process and the outputs. It is their responsibility to contribute fully and constructively and this includes making hard decisions about prioritisation of ideas and funding allocations.

*“Attending the IDEAS Factory was one of the most significant career influencing events I've attended. It has enabled me to work with excellent researchers in new and interesting areas as well as helping me to develop my research and project leadership skills, and extend my network of colleagues across disciplines and universities.”* - Emma Soane, Kingston Business School.

### Stakeholders:

People with real experience of the issue provide invaluable insight and a unique perspective.

Stakeholders often include industry representatives, government officials, charities, lobby groups or citizens' groups. Their input and knowledge helps participants explore the issue and shape potential ideas. This can include challenging presentations on the current state of play and can lead to future involvement with research groups.

### The director:

The director is fundamental to success. A director, from the academic or the business community, is appointed to each sandpit and it is their vision and leadership that shapes the process. Work starts about six months before a workshop is held, appointing mentors and ensuring the call for participants reaches those with the desired skills.

During the sandpit, the director, with support from mentors and facilitators, needs to maintain the group's focus on the key aim and ensure the intensive environment remains constructive. Post-sandpit, the director plays a key role in reviewing and monitoring projects.

*“I am very pleased at the outcome of this workshop. Cargo screening had already been the subject of considerable research effort, but serious operational needs remained unmet. We knew it would be a challenge to the academics to come up with some promising new ideas, but they did it!”*

- Stephen Barber, sector manager at the Home Office Scientific Development Branch, and Cargo Screening Sandpit director.

### Mentors:

A team of mentors work alongside the director in selecting the participants and providing objective advice, feedback and input at the sandpit. Selected for their knowledge and experience, their overall aim is to ensure the sandpit leads to high-quality innovative research. Like the director, mentors need the intellectual standing and impartiality to lead the group through this challenging experience.

### Facilitators:

While the director and mentors are responsible for the content of the sandpit, the facilitators are responsible for the process. They design the activities and schedule sessions to create an environment where innovative ideas can be formed, developed and accepted. In the intensive sandpit environment, facilitators need to constantly adapt schedules and activities to maintain the group's focus.

# The Production Process

## Diary of a Sandpit Cargo Screening

### Interact

Participants are encouraged to get to know each other through a range of activities, games and challenges. This stage of the sandpit gives people time to discuss skills, experiences and areas of interest. The sessions create an atmosphere where people feel confident in exploring diverse and unconventional ideas. Facilitators ensure groups and ideas are not formed too early.

### Mission Statement created

### Clarify

In this phase, the group focus on the specific issue of the sandpit. Through activities and interaction with invited stakeholders they debate the problems in detail to build a comprehensive picture of the situation. This stage can include site visits to give participants a clear understanding of specific issues. Mapping the problem in this way begins to highlight specific technology, knowledge and research gaps that could hold the key to future solutions.

### Problem Statement created

### Create

With a clear understanding of the issue, and helped by mentors and facilitators, the group begin to form ideas in response to the problem. Drawing on the discussions, experiences and site visits, smaller groups begin to form around the emerging ideas, self-selecting the skills and expertise needed for success.

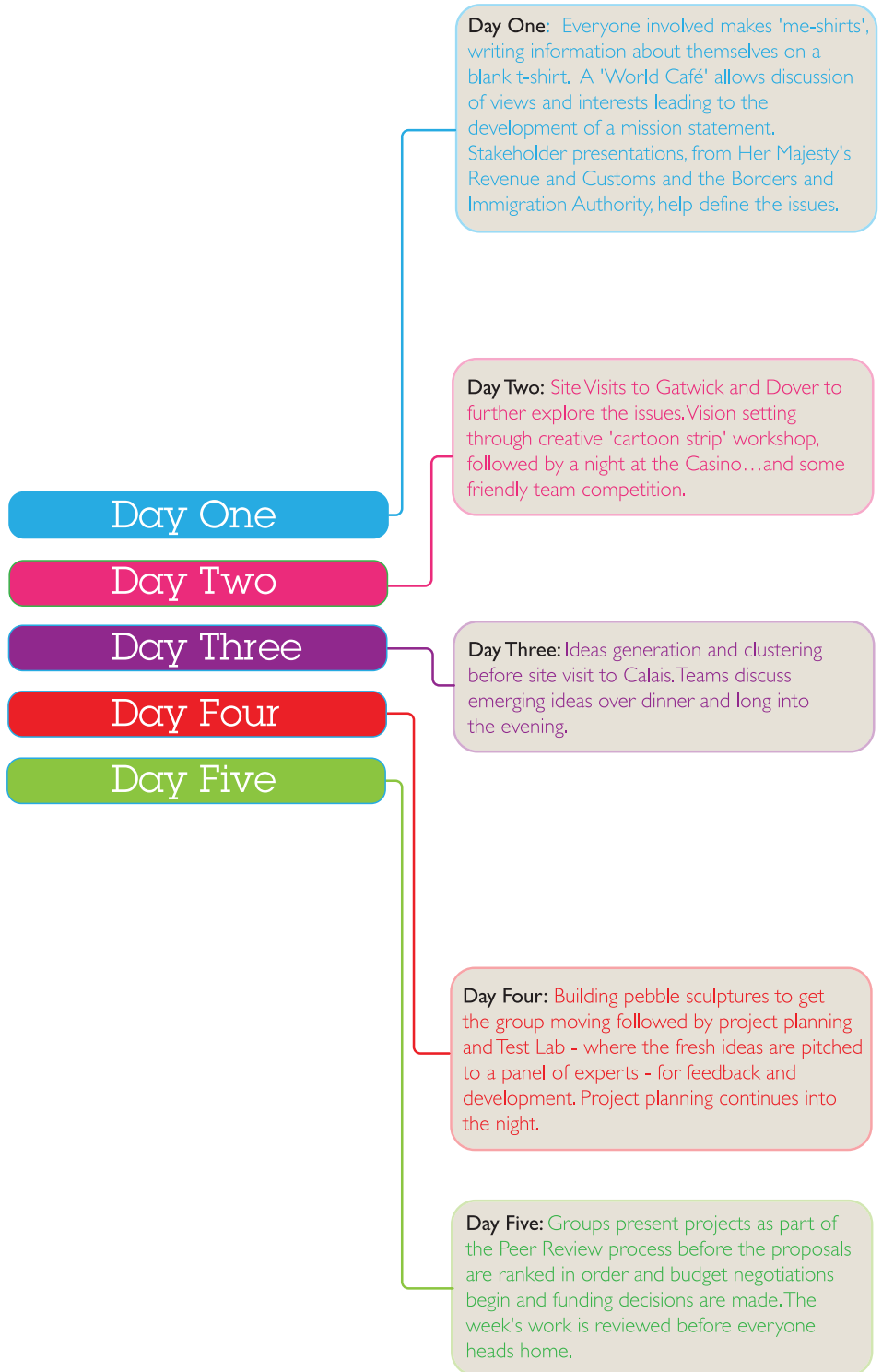
### Develop

Through a series of activities, the newly-formed research groups develop, test and refine their ideas. The proposals are repeatedly put under the microscope, through activities such as the 'test lab' pitching process, before being reworked and tested again.

At this stage, groups begin to look at funding issues such as the level of resources required.

### Implement

At the final stage proposals are short-listed and ranked in priority order by the group as a whole, before a final funding decision is made. The sandpit is reviewed before finally drawing to a close.



# The Showroom

Since its conception in 2004, EPSRC's IDEAS Factory has helped create innovative research addressing a wide-range of issues.

## Tackling Gun Crime

A team led by Nicholas Bowring of Manchester Metropolitan University (MMU) and involving the Metropolitan Police is developing a portable gun detector that could reduce serious crime in our cities.

The idea was formed at a sandpit in September 2005. Within a year the team had filed a patent for a new technique that uses microwaves to remotely determine the dimensions of metallic objects and spot a concealed gun-barrel.

*"The basic aims of the EPSRC/Home Office/Metropolitan Police sponsored sandpit on the prevention of gun crime were twofold," says Bowring. "They were to come up with ways to prevent, deter or detect gun crime and as such the sandpit was of interest to a wide range of people ranging from technologists through to social scientists."*

The project consortium consists of technologists from MMU, Newcastle University, Queen Mary University of London and the University of

Manchester. *"We were grouped together because we all had interesting ideas related to developing devices and technologies to detect and hence deter people carrying guns,"* says Bowring.

Gun detectors based on detecting the electromagnetic signature of a metal object in the microwave millimetre-wave region of the spectrum have been tried before, as too have longer wavelength detectors and terahertz imaging devices. But these systems are best deployed in airports and other transport hubs, rather than on the streets, explains Bowring.

His group is carrying out basic research that could lead to a new gun detector being deployed on UK streets.

*"Such a device would be easy to use, without requiring expert interpretation of complex images, and be small and discrete,"* Bowring adds.

The work has certainly been beneficial to the principal investigator, opening up an entirely new avenue of research that exploited untapped knowledge and experience developed in the field of microwave spectroscopy.

The networks developed as a result of the collaboration have led to collaborations with industry in the field of millimetre-wave detectors, offers of sponsorship for PhD students and other related grant income.

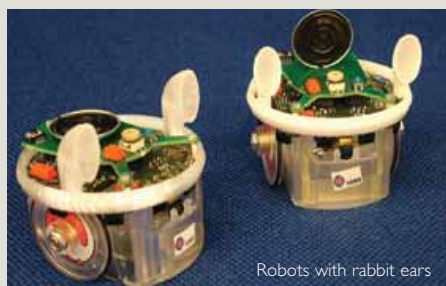


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Bowring-gun-1 (Gun shots by David Bradley)



## Evolving Robotic Culture



Robots with rabbit ears

*"How can culture emerge and evolve as a novel property in groups of social animals?"*

It is one of the most important questions of the twenty-first century, one which an IDEAS Factory project, started in September 2007, hopes to answer.

The Artificial Culture Lab aims to illuminate how behaviour becomes culturally ingrained in a quite radical way... by creating an artificial society of tiny robots.

The project brings together researchers from the fields of computer science, social science,

philosophy, theoretical biology, art history and cultural theory and robotics.

*"This project has given me the opportunity to work with an amazing team on the most exciting research project of my career,"* enthuses Alan Winfield of the robotics laboratory at the University of the West of England in Bristol. *"For this opportunity I am exceedingly grateful."* Before the sandpit, Winfield was already involved in one interdisciplinary project - a robotic art project called Mascarillons and was *"convinced that the key to creativity is to work with people outside your own discipline."*

He adds: *"The sandpit served to confirm and deepen that conviction. It has broadened my research horizons. The really important research questions transcend discipline boundaries."*

Winfield explains that the "artificial culture lab" consists of a horde of about sixty miniature robots organised initially into groups, or villages. The robots are programmed to interact and to imitate each other, although they are not perfect mimics, which leads to surprising behaviour. Might the robots start entertaining each other with flashing lights, for instance?

The team will then alter, or evolve, the robots'

neural network brains to make them better adapted to recognising and responding to any emerging behaviour. This cycle of behaviour and evolution will be alternated several times during the project, which Winfield anticipates will lead to novel robot behaviour.

The researchers hope these changes will reflect an emerging 'robot culture'. Although the robotic behaviour will be unlike any human activities - it will be purely symbolic - Winfield expects the experiment to reflect the processes but not the specifics, of human culture. *"In a sense, we will be using robots, not to understand robots, but like a microscope to study the evolution of human culture,"* he explains.

*"The project poses huge technical as well as philosophical difficulties,"* says Winfield. *"For instance what are the initial conditions, the prerequisites for culture? And once we have these can we program a group of robots to evolve culture?"*



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## The Psychological Impact of Disaster

The psychological effects of disasters - and the impact they have on people's lives and the decisions they make - will be investigated by a team of researchers brought together by the IDEAS Factory.

Occupational psychologist Emma Soane of the Kingston Business School, who leads the team, is particularly interested in personality and its effects on risk taking and decision making.

*"Attending the IDEAS Factory was one of the most significant career influencing events I've attended," she says. "It has enabled me to work with excellent researchers in new and interesting areas as well as helping me to develop my research and project leadership skills, and extend my network of colleagues across disciplines and universities."*

The project has progressed very well, moving on from a pilot study with 1,000 UK participants. The volunteers completed an online survey which led to several key findings and allowed the

researchers to assess how views change and how they affect choices in the face of uncertainty. Moreover, the study investigated how the framing of information affects the decisions people make in terms of costs and benefits.

Among the key findings of the pilot was that how information about a sensitive issue is presented to an individual has a significant impact on their behaviour.

The project might also be extended into the field of medical decision making, and Soane adds that she is currently in discussions with the medical director and doctors at a London NHS trust. *"The IDEAS Factory was crucial to the development of this project," says Soane, "It is hard to see how a collaboration like this could have developed without it."*

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## Improving Mental Health

One in ten people will suffer from a disabling anxiety disorder at some stage in their lives. But new research could help people take back control.

An IDEAS Factory sandpit brought together researchers from very different disciplines to develop new technology to improve lives.

Personalised Ambient Monitoring (PAM) will improve the health, independence and wellbeing of many psychiatric patients by monitoring their "activity signatures", measurements of behaviour which indicate a person's mental health state.

PAM will use a set of discreet sensors in a person's home, coupled to a computer system programmed to detect changes in activity signatures. These can then be used to issue automatic alerts to the patient, their family or their doctor, thus providing the capability to avert debilitating episodes.

The team includes biomedical signal processing expert Christopher James of the University of Southampton, John Crowe, who works in

biomedical instrumentation at the University of Nottingham, Evan Magill from the University of Stirling, Sally Brailsford in Operational Research, at Southampton's School of Management, and Roger James from the pharmaceutical industry.

*"The sandpit provided the opportunity for these people of different backgrounds to get together," explains James, "Incredibly, neither Brailsford nor myself were aware of each other's research despite being at the same university."*

*"Our aims are to provide an evaluation of ambient monitoring in a mental healthcare context," says James, "as well as to investigate the ability to simply plug in and turn on a low-cost, robust sensor set for use in the home."*

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### Sound Research in Urban Planning

The IDEAS Factory on Noise Futures - that brought together acoustic engineering experts, artists and social scientists - could revolutionize our attitudes to noise.

By moving away from the notion that environmental sound is negative noise and finding ways to incorporate positive soundscapes into planning, researchers hope to improve our everyday living, entertainment, shopping, and working conditions.

Other people's noise is usually undesirable but traditional noise reduction technology focuses on the negative rather than the positive soundscapes around us.

The researchers are using interdisciplinary studies throughout the three-year project, such as sonic art, website interviews and sound walks, as well as

laboratory experiments and brain scans on listeners, to determine how we perceive the soundscape around us and the effects it has.

They will, for instance, analyse the public response to aural art projects, which will feed data into scientific laboratory experiments. Conversely, the artists will use scientific results to create artefacts. An ongoing aspect of the project is its direct engagement with the public.

*"As public engagement is one of our aims, the project has been quite widely reported in the media," says team member Bill Davies of the University of Salford, "Highlights have been mentioned on BBC Radio and in The Observer newspaper as well as much excited discussion in other national newspapers and in blogs."*

*"As the project progresses, we will increase our dialogue with users including city planners and councils, to ensure that the results have the desired effect," says Davies.*

The IDEAS Factory itself has had considerable impact on the various team members. "Personally," says Davies, "I found it to be the most concentrated sustained creative experience in research that I've had to date." He adds that previous interdisciplinary research with social scientists has been enjoyable but the IDEAS Factory, enabled him to work with many more disciplines. "The experience of creating research with a team involving artists has been very exciting," he adds. "Having to explain one's ideas to completely different disciplines makes for real rigour."



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### Productivity Shopping

A novel collaboration between computer scientists, statisticians, psychologists and economists aims to improve relatively poor productivity in parts of the UK's service industries.

*"This project originated from the 'Closing the gap, crossing the levels' IDEAS Factory which was about improving the UK's productivity in novel ways," explains Aickelin.*

*"The project's strong multidisciplinary nature meant we could examine key management reasons for relatively poor productivity," says Aickelin. By focusing on management practices, the researchers hope*

to understand why there is a shortfall in UK productivity compared with the USA, a problem that applies even to US-owned companies operating in the UK, which outperform home-grown UK companies.

The team is incorporating variables from different levels of analysis, including national, sector, firm and workgroup variables into their model. The end result will be new insights into inventory management, staff training, information and communications technology, operational practices, empowerment, incentive pay schemes, team-based working and marketing practices that could be implemented to improve overall productivity.

In developing case studies for their model, the team worked with a major UK department store in its women's wear and TV-audio departments, in two different cities. One was performing 'well' and the other less so. *"Based on our data we could build a 'simulator' to analyse the problem."*

This allowed the team to adjust different variables, as one might in a life-simulation computer game to change, for instance, empowerment (e.g. which staff could give refunds and to what limits) and training (are a few specialists better than a

more comprehensively trained staff). *"The ground-breaking simulator is still under development"* says Aickelin. *"However, the results so far are quite realistic and incorporate such factors as 'word-of-mouth' between customers and other psychological variables, which emphasises the importance of multidisciplinary. As far as we know, this is the first 'retail simulator' with fairly detailed customers and staff," adds Aickelin.*

*"I always liked doing multidisciplinary research," says Aickelin, "The problem is that in everyday academic life it is difficult to do multidisciplinary work as one hardly ventures outside the building, let alone into the next building. That was the reason I applied to the IDEAS Factory," he adds.*

*"Without the IDEAS Factory there would never have been a project like this," adds Aickelin, "We have learned to appreciate how others do research and I'm sure this has led to better computer simulations, it's hard work, but the results are fantastic."*



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## Chemical Craftwork

Computer Scientist Natalio Krasnogor, of the University of Nottingham, hopes to understand complexity and being part of the Chemical Craftwork IDEAS Factory team has increased his chances of fulfilling his dream.

Investigating complex systems, such as synthetic computer-based lifeforms, could provide scientists with new insights into how complex natural systems such as organisms, climate, and communications networks behave. Finding ways to use and control these systems is key to understanding the flow of information and how it is processed, explains Krasnogor:

By building computational models that have life-like functions, Krasnogor and others hope to find clues as to what controls complex, non-linear behaviour:

*“My participation in the IDEAS Factory enabled me to substantially increase the level of interdisciplinarity in my work,” says Krasnogor. “Through my involvement in ChellNet, an umbrella network that encompasses ten sub-projects spanning three main research lines, I had the very unique opportunity to develop strong collaborative work with chemists, physicist and biologists.”*

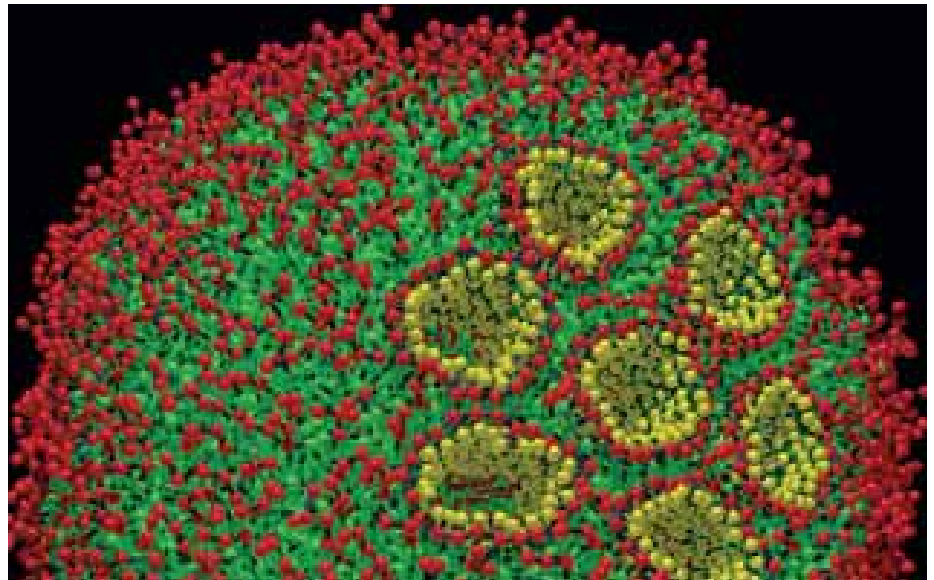
The research has already had a substantial impact, leading to a fundamental computational rethink about the way synthetic living systems are assessed. Indeed, the research provides a framework for answering profound questions about complex systems, such as what does it mean to be alive?

*“I am confident in saying that it would have been very difficult for me as a computer scientist to have the*

*opportunity to be so deeply immersed in this fascinating interdisciplinary research had it not been for the IDEAS Factory,” Krasnogor adds.*

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Krasnogor-vesicle



## A Magnetic Approach to Gun Crime



Film noir gun photo ( David Bradley)

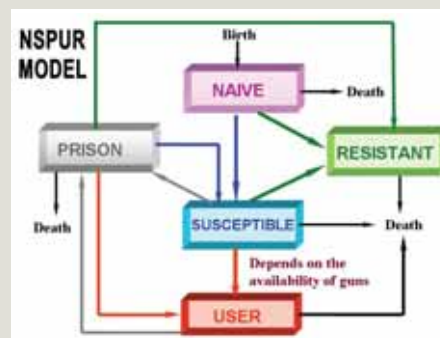
*“My involvement in two projects funded from the Gun Crime Sandpit has enlarged my already wide interdisciplinary interests,” says Kenton Morgan, of the University of Liverpool.*

*“Moreover, working with this team has improved understanding both in terms of language and science between mathematicians, biologists, social scientists and criminologists, which has led to an excellent team.”*

The MAGNET project, Modelling Analysis of Guncrime NETWORK, was funded by the IDEAS Factory and brought together experts from a wide range of disciplines in the social sciences and computer modelling. The researchers modelled gun crime in Manchester and tested three approaches that could be used by police to significantly reduce the number of incidents.

The three approaches were the epidemic, the social networks, and the cellular automata models. In the epidemic model, criminal behaviour spreads through contact. *“This model proved effective in indicating what effect different policies would have on gun crime,”* Morgan says.

In the social networks model, analysis of the contact structure of Manchester’s criminal network led to a new understanding of the development and structure of gangs. By combining this model with the epidemic model the researchers could find ways to prevent the spread of criminality.



The cellular automata approach simulates different scenarios to reveal their possible effects on crime patterns. The model takes local geographical information into account including buildings, schools, pavements, and street corners.

Using the epidemic model, the researchers have developed the current prototype model, which focuses on criminals rather than crime. *“We have shown this model can pre-test proposed interventions,”* explains Morgan. *“In particular, the model can give quantitative estimates of how long an intervention will take and its potential impact on reducing gun crime.”*

Worryingly, the model shows that without interventions, gun crime will continue to grow at a steady rate in Greater Manchester. However targeted interventions aimed at non-firearm offenders within the community and in prison can help to reduce the overall number of firearm offenders.

As part of the project, the researchers have established strong links with Greater Manchester Police, crime reduction partnerships and local community groups.

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Energy from Waste plant at SYSAV incineration plant in Malmö, Sweden (Photo by "jorchr" used under Wikipedia GDFL (GNU Free Documentation License))

## Hot House Consortium Tackling Climate Change

Strong convictions and a cut-throat approach to ideas and funding at the Green Chemical Technologies Sandpit gave rise to the C-Cycle consortium to tackle climate change.

The C-Cycle consortium, which includes researchers at the Universities of Sheffield, Newcastle, Nottingham, Warwick, Birmingham, Southampton, Oxford and the University of East Anglia, hopes to find ways to recycle carbon from waste facilities. This will bring carbon back into the fuel and chemicals supply chain using chemical catalysts and potentially cut total carbon dioxide emissions.

*"The consortium was strong in its convictions and negotiated to the end to secure funding," explains team leader Peter Styring of the University of Sheffield. "This hot house approach meant we all had to be very sure of our facts to make it work. The IDEAS Factory allowed us to forge close alliances but when funding was mentioned it got more cut-throat!"*

The need to capture and re-use carbon dioxide from burning fossil fuels in power stations is high on

the climate agenda. Carbon capture and storage is seen as one approach to combating rising greenhouse gas levels, but storage means the carbon is no longer available as a raw material for energy and manufacturing.

C-Cycle has exploited its members' expertise at the interface of chemical engineering and chemistry to address novel methods of carbon dioxide capture and activation, with the aim of converting activated carbon into new commodity chemicals. These materials might include organic cyclic carbonates and hydrocarbon fuels such as diesel, which can be used instead of oil in manufacturing and transport.

*"On a personal level, the concept helped me to move slightly outside the box," Styring enthuses, "employing existing skills but in new and exciting areas."* He also improved his negotiating skills and he developed several concepts that he went on to use in his successful application for an EPSRC Senior Media Fellowship and subsequently an additional Chair in Public Engagement.

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## Bridging the Global Digital Divide

The Rural e-Services project is developing sustainable systems for rural co-operatives in places like Madhya Pradesh, India, under the three year EPSRC funded project. It is looking at how farming co-operatives can learn to use information technologies to improve farming practices and profits. The outcomes from the project will be readily transferable from one location to another; for example from India to China.

The project is aimed at using innovative technology to bridge the gap between the technological haves and the have-nots. In many situations, such as rural communities in the developing world, current ICT fails to meet its potential simply because systems designed to support developed world demands are not matched to local needs and constraints. The challenge is to develop a new ICT model that is appropriate, effective and cost-effective.

Andy Dearden of Sheffield Hallam University is project manager and coordinator of participatory design elements, he said *"By working together with the community, we hope to produce systems that are usable, useful and deliver enough added-value to*

*make them affordable in their situation."* The team recently met with Shri Laxmi Kant, Minister for Mineral Resources, Culture and Public Relations in the state government of Madhya Pradesh to discuss the work.

The "Storybank" project involves building a way for people to capture and share their stories with each other using a new interface to a camera phone. The stories combine images and audio, and the system can be used by users who are not literate. The system has been deployed and is now being evaluated.

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## Mapping the Underworld

*"An extremely intensive underworld sandpit,"* - that's how the University of Nottingham's Gethin Roberts describes the IDEAS Factory sandpit aimed at mapping the underworld utility infrastructure our cities.

Mapping the telecommunications, electricity and gas supplies, and the fresh and waste water that flow beneath our streets could lead to more efficient services and repairs as well as a better response in times of emergency.

Roberts' area of expertise is in positioning systems and he headed a standalone project on the positioning aspects of the work. *"My project was to look at various positioning techniques applicable for surveying in built up areas"* Roberts explains.

The project exploits Global Positioning Systems (GPS) techniques and in particular, RTK GPS, which allows real-time positioning to be undertaken. This system is incredibly accurate down to a few centimetres in three dimensions. *"This is now an off-the-shelf technique,"* says Roberts. *"However, it doesn't work too well in built up areas, so we*

*are looking into alternative techniques or complementary techniques, such as Inertial Navigation Systems. Such systems will fill the gaps where tall buildings or a lack of satellite connection prevent GPS from working properly."*

The researchers could use ground-based transmitters that emulate GPS-type signals, called pseudolites. Roberts adds that this might be extended one step forward from this technology by using ground-based transmitters that operate at the radio frequencies used by Wi-Fi.

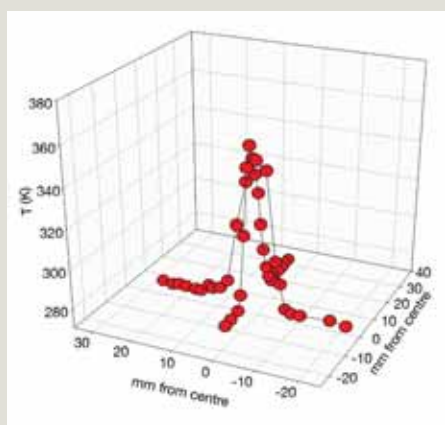
The researchers are using their simulation software and hardware to develop models of how all this new technology might be coordinated. Moreover, Roberts points out that they will be able to simulate the scenario that will emerge when the European Galileo system, the Chinese COMPASS system, and the Russian GLONASS systems are all fully operational around 2012. *"This approach means that instead of relying on 28 or so GPS satellites, we will have many more satellites to choose from,"* explains Roberts. The end product will be a system that will allow researchers to map accurately the complex hidden infrastructure beneath our feet.



Artists impression of Galileo satellites above the Earth. Credits: ESA/J.Huot.

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## Tiny 'tags' could help to solve and deter gun crime



Criminals who use firearms may find it much harder to evade justice in future, thanks to an ingenious new bullet tagging technology developed in the UK.

The tiny tags - just 30 microns in diameter and invisible to the naked eye - are designed to be coated onto gun cartridges. They then attach themselves to the hands or gloves of anyone handling the cartridge and are very difficult to wash off completely.

Crucially, some of these 'nanotags' also remain on the cartridge even after it has been fired. This should make it possible to establish a robust forensic link between a cartridge fired during a crime and whoever handled it.

To date it has been extremely hard to establish such a link because of the difficulty in retrieving fingerprints or significant amounts of DNA from cartridge surfaces, which are shiny and smooth. The nanotags, which are quite unlike anything previously used in the fight against gun crime, could therefore lead to a significant increase in successful convictions.

This breakthrough has been achieved by a team of chemists, engineers, management scientists, sociologists and nanotechnologists from Brighton, Brunel, Cranfield, Surrey and York Universities.

*"The tags primarily consist of naturally-occurring pollen, a substance that evolution has provided with extraordinary adhesive properties,"* says Professor Paul Sermon from the University of Surrey, who has led the research. *"It has been given a unique chemical signature by coating it with titanium oxide, zirconia, silica or a mixture of other oxides. The precise composition of this coating can be varied subtly from*

*one batch of cartridges to another, enabling a firm connection to be made between a particular fired cartridge and its user."*

In addition to this breakthrough, the team has also developed a method of trapping forensically-useful amounts of DNA on gun cartridges. It involves increasing the abrasive character of the cartridge case with micro-patterned pyramid textures, or adding an abrasive grit, held in place by a thin layer of resin, to the cartridge base.

*"The EPSRC sandpit was extremely effective and brought together engineers, chemists, management scientists and sociologists,"* says Sermon. *"All involved have benefited from the programme."*

*"Researchers and investigators at the universities within the consortium have benefited from participating in this interdisciplinary programme with its integrated chemistry, design, engineering, management and sociological components,"* he adds.

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