

Research

# Horizons

Pioneering research from the University of Cambridge

Issue 34

Spotlight  
Material culture

Feature  
Bionic bodies

Feature  
Carbon capture



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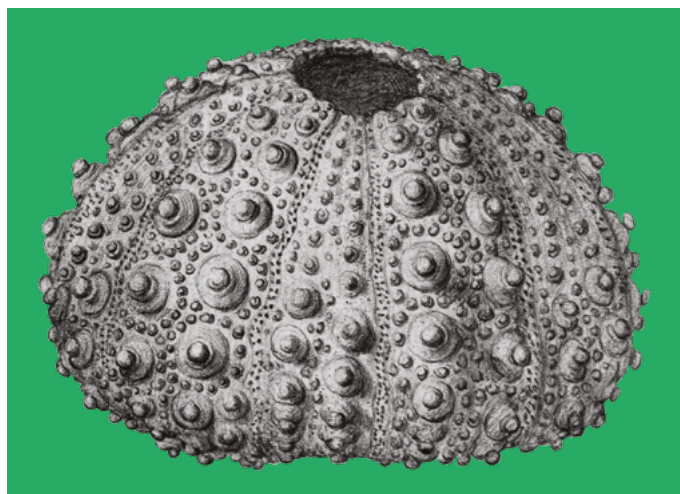
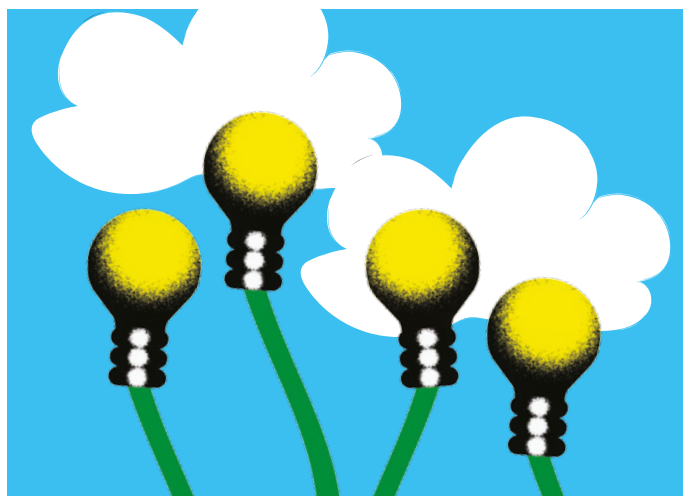
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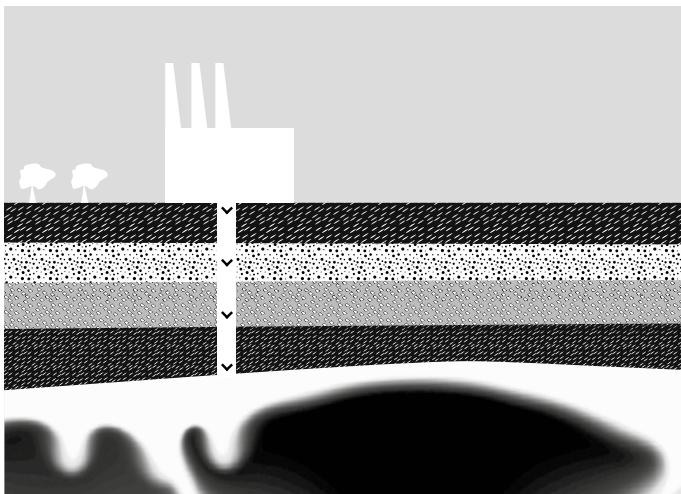
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## Welcome

The physical objects, materials and places that surround us are so much a part of our lives that aside from certain gadgets and favourite belongings we probably don't even notice them. And yet, understanding our material world and how we relate to it can reveal much about culture and humanity, past and present.

Studies of 'material culture' are emerging in arts, humanities and social science disciplines right across the University, and form the basis of our Spotlight focus. These studies are rooted in an understanding that objects are fundamental resources to understand our ancestors – and hence, research into material culture benefits from the depth and breadth of our museum collections. They are also grounded in an appreciation that contemporary issues are often material in nature: the scale of consumerism, the escalation of search algorithms designed "to give us what we want" and the toll of air-miles to deliver it.

Our front cover shows a painting that has recently been conserved and researched at the Hamilton Kerr Institute in Cambridge. It gives a wonderful foretaste of the vibrant and varied nature of the research on material culture covered in this issue.

We also feature five very different research areas, each with far-reaching consequences for society: techniques to detect cancer at its very earliest stages; women farmers in India and the need to increase food production; the rights of those who may not wish to be categorised as male or female; carbon capture and storage technologies; and social enterprise ventures that improve people's lives as well as create jobs, goods and services. All this plus ten pieces of Islamic art and a zoologist with a 20-year-old newt living in his kitchen.

An eclectic combination to enjoy.

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# News



## Cambridge's new Vice-Chancellor

Professor Stephen Toope is the 346th Vice-Chancellor of the University of Cambridge, succeeding Professor Sir Leszek Borysiewicz.

"In many ways, this day feels like a return to familiar ground," said Professor Toope at his inaugural address as Vice-Chancellor on 2 October 2017. "My time as a PhD student at Cambridge was personally rewarding and career-defining. What I learned then has served me well ever since. So I am thrilled in turn to serve an institution from which I gained so much."

Born in Montreal, Canada (1958), the new Vice-Chancellor studied history and literature at Harvard University, from where he graduated *magna cum laude* (1979), before earning degrees in common law and civil law at McGill University (1983), and a PhD from Trinity College, Cambridge (1987).

He was previously Director of the University of Toronto's Munk School of Global Affairs (2015–2017), and before that President and Vice-Chancellor of the



Image  
Professor Stephen Toope

University of British Columbia (2006–2014).

Addressing global issues the University can tackle through its world-leading research, he said: "I am convinced that the challenges today are more complex – and certainly affect all of us more immediately. Take, for instance, the urgent dilemmas posed by new information technologies. Or consider the problems of global food security. For the University of Cambridge, which sees it as part of its mission to actively confront issues like these, one of the greatest difficulties is that we must constantly be prepared to deal with newly emerging questions that we did not know had to be answered."

"We are not an excellent university because we are an ancient university," he continued. "We have become an ancient university because of our continued excellence. We must strive always to do more for learning itself and for the world we serve, and to do this in new ways that respond energetically to the social, political and economic conditions we face in our generation."



Credit: Marta Altes

## Helping children understand genetic illness

"Most days I'm like the other birds. Other days though, I'm not. And I have to be very brave."

*Avery*, a new children's book produced through a collaboration between the University of Cambridge and Anglia Ruskin University, tells the story of a young bird who is born to be different from other birds.

It's the brainchild of Professor Lucy Raymond, a rare disease expert in the Department of Medical Genetics, who wanted to create something for children and parents to share about their illness and about taking part in research.

"Being born with a genetic disease can be confusing and frightening, not only for a child, but also their parents and siblings," says Raymond, who leads IMAGINE ID, a research project funded by the Medical Research Council that looks at how a child's DNA affects development, particularly in relation to learning disorders. The study wants to answer a question parents often ask when their child has a genetic condition: what does this mean for my child?

"We created this book to help parents start what is often a difficult conversation with their child. It's to help the children make sense of what's happening to them and it's also to include siblings in what is happening to their brother or sister."

*Avery* is available to order online (<http://bit.ly/2xnvwjH>).

## News in brief

More information at  
[www.cam.ac.uk/research](http://www.cam.ac.uk/research)

### 19.09.17

Researchers awarded £2.5m to develop targeted treatment for patients with depression, anxiety and psychosis.

### 14.09.17

Archaeologists uncover an intact burial in a monumental Mycenaean tomb that dates to around 3,350 years ago.

## New professor of innovation

A new post will focus on helping young engineers to combine innovation with practicality when approaching design.

Dr Tim Minshall, who has been working in Cambridge's Institute for Manufacturing (IfM), has been appointed as the inaugural Dr John C. Taylor Professor of Innovation at the University of Cambridge.

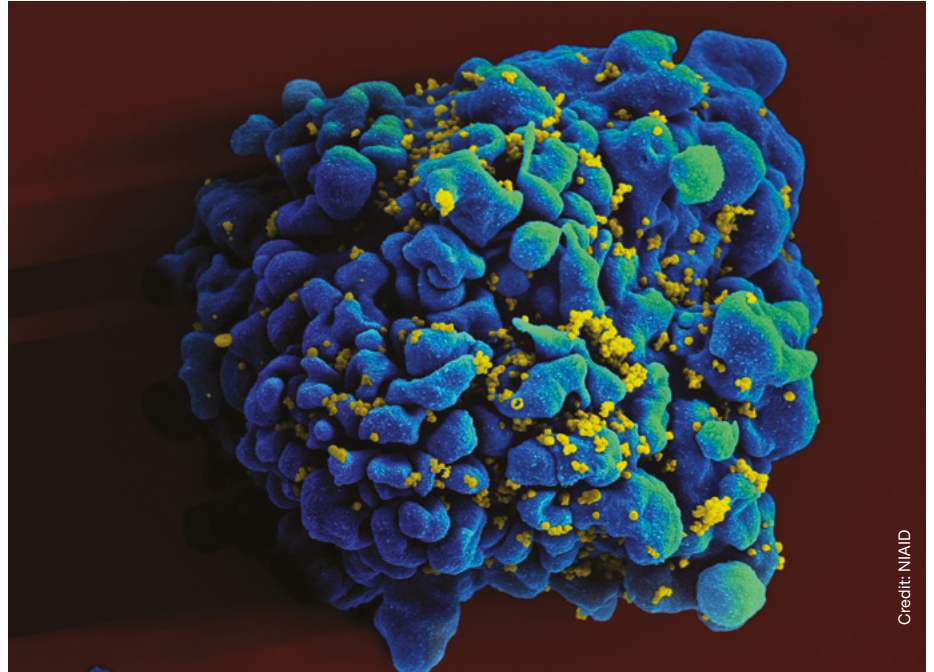
"It's an opportunity to address how we define and develop the innovation skills and capabilities of engineers so they can address economic and social needs: a challenge that has become critical for the UK given the current global economic and political context," he says about the new post.

"The UK has long been superb at invention – the creation of new ideas – but we need to develop a generation of engineers able to create and capture value from these new ideas, and provide these innovators with the capabilities to respond to future challenges and opportunities throughout their careers," he explains. "This requires us to take a much more joined-up, long-term view of technology, management and policy issues."

Professor Andy Neely, Pro-Vice-Chancellor for Enterprise and Business Relations at the University, adds: "We're working very hard to make sure that we end up with technologies that change the way the world works."

The new professorship has been made possible thanks to a generous donation of £2.5m from Cambridge alumnus Dr John C. Taylor OBE, one of the most successful British inventors of the past 50 years.

"You've got to have people who move the world forward: innovation is essential to trade, industry and the economy," says Taylor. "I trust that the new professor of innovation will help people actually create and do things that will improve the world."



Credit: NIAID

## HIV: longer lasting protection

**"We hope our discovery will unlock the paralysis in the field of HIV vaccine research."**

Scientists have known since 2009 how to make an HIV vaccine that lowers the rate of human infection, but long-lasting protection has proved impossible because of the short-lived nature of the immune response it generates.

Both the reason why and a potential solution have become clear thanks to research by Professor Jonathan Heeney from the Department of Veterinary Medicine and scientists in the UK, France, the USA and the Netherlands.

Anti-HIV vaccines target a protein on the outer coat of the virus, causing the body to generate antibodies that prevent the virus from entering cells and replicating. If the effects of the vaccine last long enough, the human body would develop antibodies that neutralise a large variety of HIV strains



Image  
HIV-infected T cell

and protect people from infection. However, the virus itself interferes with the immune response by preventing CD4 T-helper cells, the master regulators of the immune system, from working effectively.

The researchers have discovered the mechanism for this blockage and have modified the vaccine by adding a tiny protein that overcomes it and improves immune responses.

"For a vaccine to work, its effects need to be long lasting," says Heeney, whose research was funded by the National Institutes of Health (USA) and the Isaac Newton Trust, Cambridge. "It isn't practical to require people to come back every 6–12 months to be vaccinated. We hope our discovery will unlock the paralysis in the field of HIV vaccine research and enable us to move forward."

The team now hopes to secure funding to test their vaccine candidate in humans in the near future.

29.08.17

John Aston, Professor of Statistics in Cambridge, has been appointed as the Home Office's new Chief Scientific Adviser.

16.08.17

First UK experiment on policing domestic abuse finds fewer men reoffending when mandated to attend counselling sessions.

16.08.17

Researchers believe a bizarre 'Frankenstein's monster' dinosaur may be the missing link between two major dinosaur groups.

# THE SOCIAL ENTERPRISE GREENHOUSE

When it comes to starting social enterprises, Paul Tracey and Neil Stott would love “to see a thousand flowers bloom.” But doing good for society isn’t as straightforward as it sounds and even the best ideas can fail. Their research aims to understand the elements that are needed to help social ventures thrive.



Words  
Louise Walsh

**O**liver Armitage wants to make bionic limbs effective and affordable for amputees everywhere. Kate Nation wants to help young women gain confidence and self-esteem through work. Riaz Moola wants to tackle the educational inequalities he saw growing up in Africa by offering programming tuition online.

Oliver, Kate and Riaz are part of a movement of entrepreneurs that’s been growing rapidly in the UK since the mid-1990s. United by a passion for addressing deep-rooted societal problems, they aren’t looking to solve them with cash, instead they want to have a positive impact through business and enterprise.

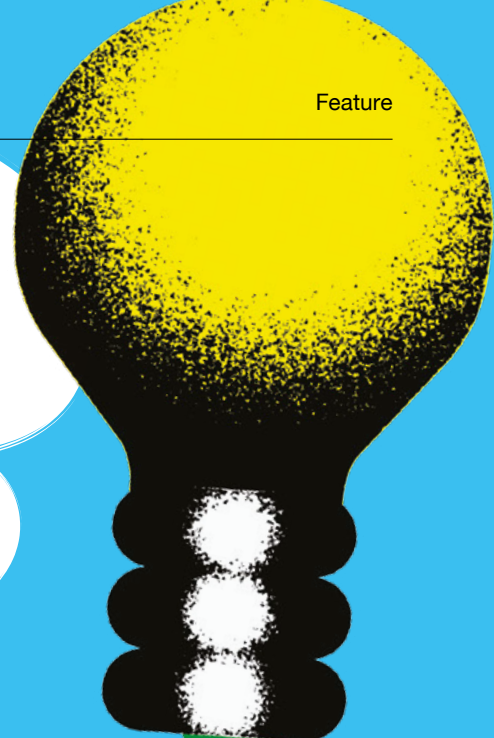
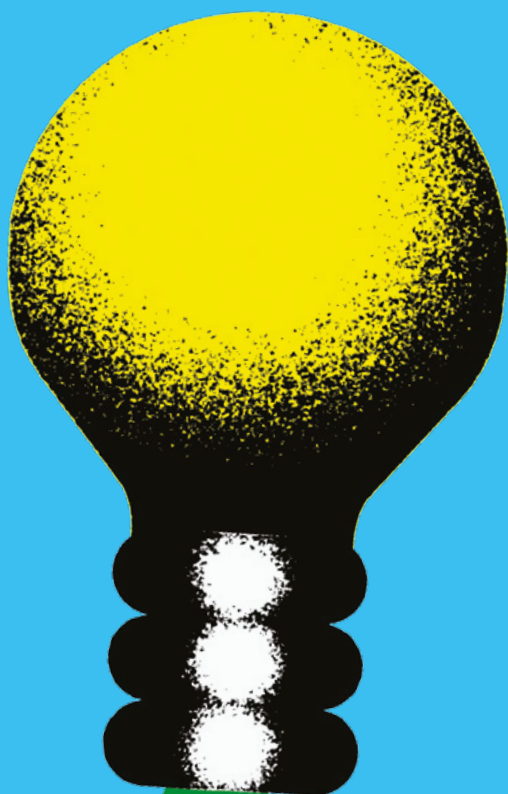
Social enterprises like the organisations that each of them runs (respectively Cambridge Bio-Augmentation Systems, Turtledove and Hyperion Development) are designed to improve people’s lives. According to the UK’s Department for International Trade, social enterprises also contribute £55 billion to the economy through jobs, goods, services and investing in local communities; no wonder it’s been said that “when a social enterprise profits, society profits.”

But, say Professor Paul Tracey and Dr Neil Stott, ensuring a social enterprise thrives is not always straightforward. “Doing good has increasingly been seen by government and others as the new game in town and investment and policies – including those launched by the UK government’s ‘Big Society’ in 2010 – have swiftly followed,” says Tracey, Professor of Innovation and Organisation at Cambridge Judge Business School.

“Social investment in the UK is growing by 30%, and a report last year suggested the UK is leading the way globally in effective policy around social enterprise and social investment.”

“This is of course excellent,” says Stott, who with Tracey co-directs the Cambridge Centre for Social Innovation. “But we felt that there were a few problems – that the rhetoric of success and the reality were a long way apart. Social enterprises are often started with great intentions but a lack of understanding about what’s needed to make them sustainable. Too many great ideas wither and die. Everyone – policy makers, academics, practitioners – think it’s a good thing per se. We wanted to lift up the stones and see what’s underneath.

“Even though we’d like to see a thousand flowers bloom – lots of people



being social entrepreneurs – if you want to make change in the world, having this passion is not enough,” adds Stott. “The challenges can be both immense and unique to any particular social venture.”

Stott cites Keystone Development Trust, a social enterprise he ran in a part of the UK that has experienced a significant influx of migrants. Keystone was one of the organisations in the area that offered a dedicated programme of support. What the organisers didn’t expect was that some members of the established local population, many of whom also benefited from Keystone’s activities, would ultimately stigmatise them.

In fact there was a positive outcome, he says, in that this withdrawal of support was compensated for by increased support from others who saw the organisation as representing a set of values they wanted to uphold.

Tracey and Stott realised that businesses could learn much from understanding both the failures and the successes of others, and so an integral part of the Cambridge Centre for Social Innovation’s work now revolves around an incubator – Cambridge Social Ventures – which supports social entrepreneurs to start and grow a social venture.

Initially funded with £1m from the government, Cambridge Social Ventures began life as Social Incubator East, a partnership between Cambridge Judge Business School, Allia, Foundation East and Keystone Development Trust, and has since become embedded in Cambridge Judge Business School. Nearly 100 early-stage and well-established social entrepreneurs – including Oliver, Kate and Riaz – have now come through a 12-month mentoring and support system, and a further 500 have been helped through weekend programmes.

“We’re not looking for entrepreneurs who happen to create benefit, as good as that is,” says Tracey. “We’re looking for people who are passionate about social change and are designing their venture for that purpose.

“We’re helping them with business advice, and we’re also studying them. We want to get a sense of motivation, ideas and practices, how – or if – social objectives are traded off with business objectives – and how all of this affects the way a social venture develops.”

They describe it as a greenhouse – where the ‘doing’ of social enterprise feeds both research in the Centre and teaching on a new Master’s course, which in turn is training future social innovators. “Our unofficial strapline is Think Teach Do,” says Stott.

“Once people have identified as a social entrepreneur and are suddenly in a room with others, they learn and they forge partnerships,” says Belinda Bell, Programme Director of Cambridge Social Ventures.

One example is Oliver Armitage and his team at Cambridge Bio-Augmentation Systems (see p. 8) working with John Willis and his charity, Power2Inspire, which encourages people of all ages and abilities to take up sport together.

Cambridge Bio-Augmentation Systems aims to make the most advanced bionic technology affordable and effective for anyone who needs it. After meeting Willis, who was born without fully formed arms or legs, Armitage and colleagues designed four different devices to attach to a prosthetic socket that would help him kayak, row and play archery and tennis as part of his successful challenge to take part in 34 Olympic and Paralympic sports. The designs for the devices are now freely available to download and print in 3D.

Tracey and Stott say this is ‘extrapreneurship’ in action – the creation of novel solutions by partnerships that come about through support mechanisms like Cambridge Social Ventures. They realised that a new framework was needed to describe how social ventures work in practice. While ‘extrapreneurship’ is the building of support networks like the incubator, ‘entrepreneurship’ is the creating and growing of a venture, and ‘intrapreneurship’ is the embedding of social objectives in the activities of established companies.

“There are many different approaches that individuals and organisations can take when addressing social problems, and these may have relatively little in common with each other,” says Tracey. “The result is researchers sometimes talk past each other and end up comparing apples with pears, which is a barrier to knowledge creation.”

Their research has also suggested that social entrepreneurship in isolation is not enough: “If you want to make real change you have to involve the corporate sector and the public sector in business,” explains Tracey. “The businesses that fail quickly are frequently operating at a small scale, in some of the most challenging areas of the country – places where regular businesses don’t flourish because people don’t have that much disposable income. Working with corporate and business sectors can provide security and sustainability.”

“We’re excited because there’s a real zeitgeist – right place, right time,” adds Stott. “Young people are as concerned today about making a difference as they are with making money. Social enterprises are taking off and we want to help them flourish.”

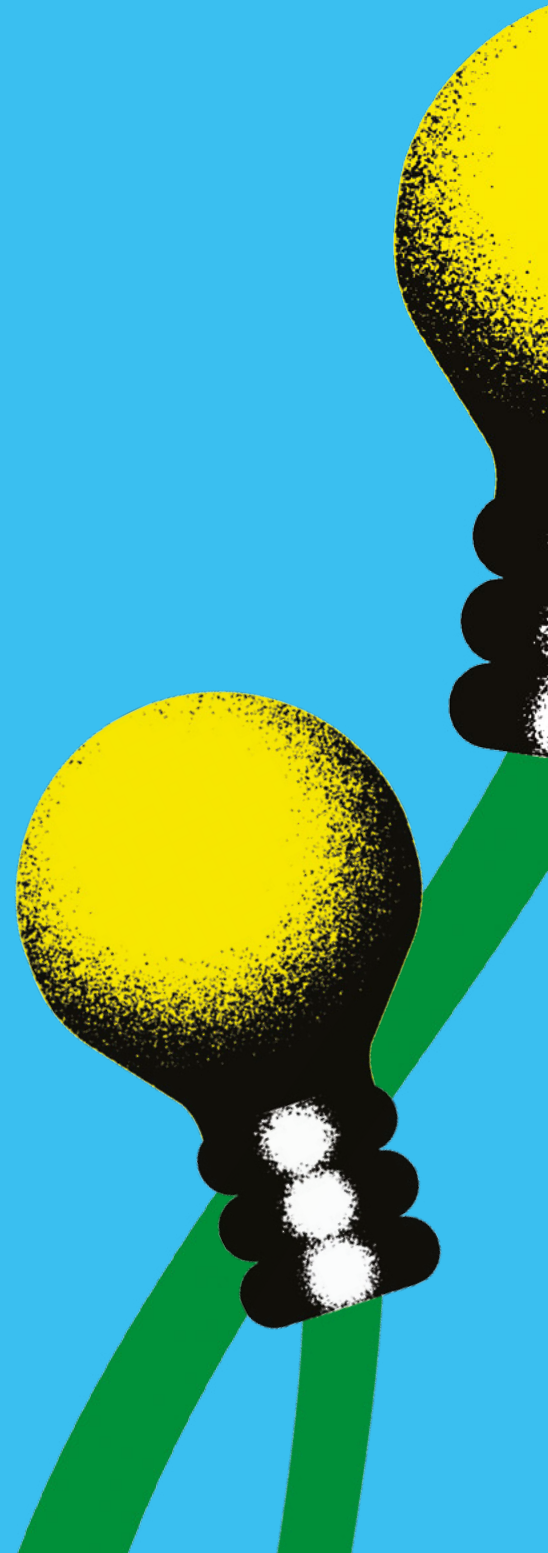
*Neil and Belinda recently won a Vice Chancellor’s Award for Public Engagement for their work in establishing Cambridge Social Ventures.*



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# BIONIC BODIES

**C**ambridge Bio-Augmentation Systems wants to redefine the limits of the human body.

“When the team showed me their plans, it dawned on me that this could change my life,” says James Young. “If I was offered a human arm and leg now I wouldn’t want it.”

Young is a double amputee and is describing when he first started working with the team of entrepreneurs, scientists, engineers and doctors behind Cambridge Bio-Augmentation Systems (CBAS).

CBAS is led by Cambridge alumni Oliver Armitage and Emil Hewage, who were undergraduates and postgraduates at the University. When they were engineering students, they discovered a mutual interest in how technology could be used to push the boundaries of what’s possible in healthcare.

“My first idea was to make the best prosthetic arm or leg. But what is the best?” says Armitage. “It’s a limb that’s attached so well that there is complete control, where the hand moves without deliberate thought, where the machinery listens to muscles tensing, where the sensory feedback is complete. That’s when I started thinking about the connector.”

The connector is an interface. It’s the boundary between man and machine that can enable an amputated limb to become fully functioning, or ‘bionic’. The vision at CBAS is to make the technology affordable and available to as many as possible, and the best way to do this for amputees, they believe, is to develop standardised interfaces on which to build prosthetic devices.

“Integrated bionics unlocks a cheaper and far more effective model for treating chronic conditions,” says Hewage. Amputees can suffer discomfort and limited functionality with conventional prostheses. Instead, CBAS is developing a permanent connection, a prosthetic interface device (PID), between

bionic devices and neural and soft-tissue systems within the body of any amputee. “It’s like a USB port,” he adds. “The user would ‘plug and play’ whatever limb or device they need. They could even print the add-ons using a 3D printer at home.”

The PID should not only lower the cost of artificial limbs by around 60% but also reduce the time-consuming adjusting and refitting of custom-made prostheses because any prosthetic limb can be designed to attach to the standardised interface. The implant also shifts the weight of the limb to the patient’s skeletal system, reducing uncomfortable friction.

“There are growing numbers of amputees globally,” adds Hewage. “Diabetes and cardiovascular disease cause a lot of planned amputations, and for patients with these conditions using this standardised approach reduces the cost.”

CBAS hopes for a first in-human use of a fully neurally connected implant for an amputee in 2018. Armitage explains that their aim is for two-way brain communication: “Full control of the arm or leg with the brain, with pinpoint accuracy, and full sensory feedback to the brain. We want it to be possible to do something as complex as writing.”

He and Hewage set up CBAS two years ago, at the same time that Hewage was working on his PhD in computational neuroscience in the Department of Engineering.

Ensuring that what they make is not only effective but also accessible and affordable was a goal from the start. “We’re not interested in building a single product for a single condition,” Armitage says. “We’ve seen the amazing things that can be done with amputees but it’s always a research study costing millions that benefits just one person. We want to have a larger impact.”

He describes this social enterprise aspect of CBAS as an ‘impact venture’.

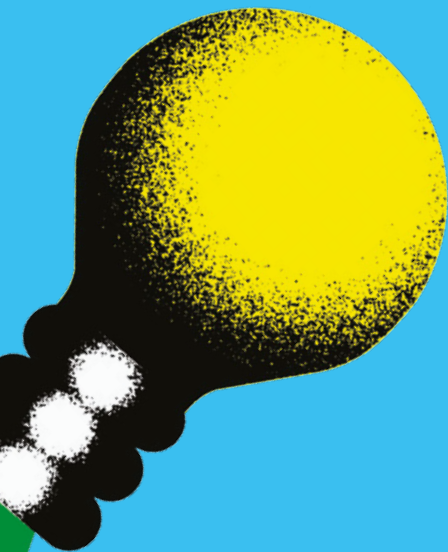


## “Evolution is a progression and we’re at a point in it. Let’s see where we go”

“Wanting to run a company and have an impact – they aren’t separate, they can’t be,” he explains. “If you have a piece of technology that you believe could have a huge positive impact on a large number of people, the only way to do this at scale is as a commercial venture.”

“Many chronic conditions depend on long-term use of pharmaceuticals or devices,” he adds. “We believe that innovative engineering could offer significant patient benefits in terms of avoiding side effects, increasing comfort and functionality, and reducing healthcare costs, whether it’s in the form of a smart pacemaker, insulin dispenser or prosthetic limb.”

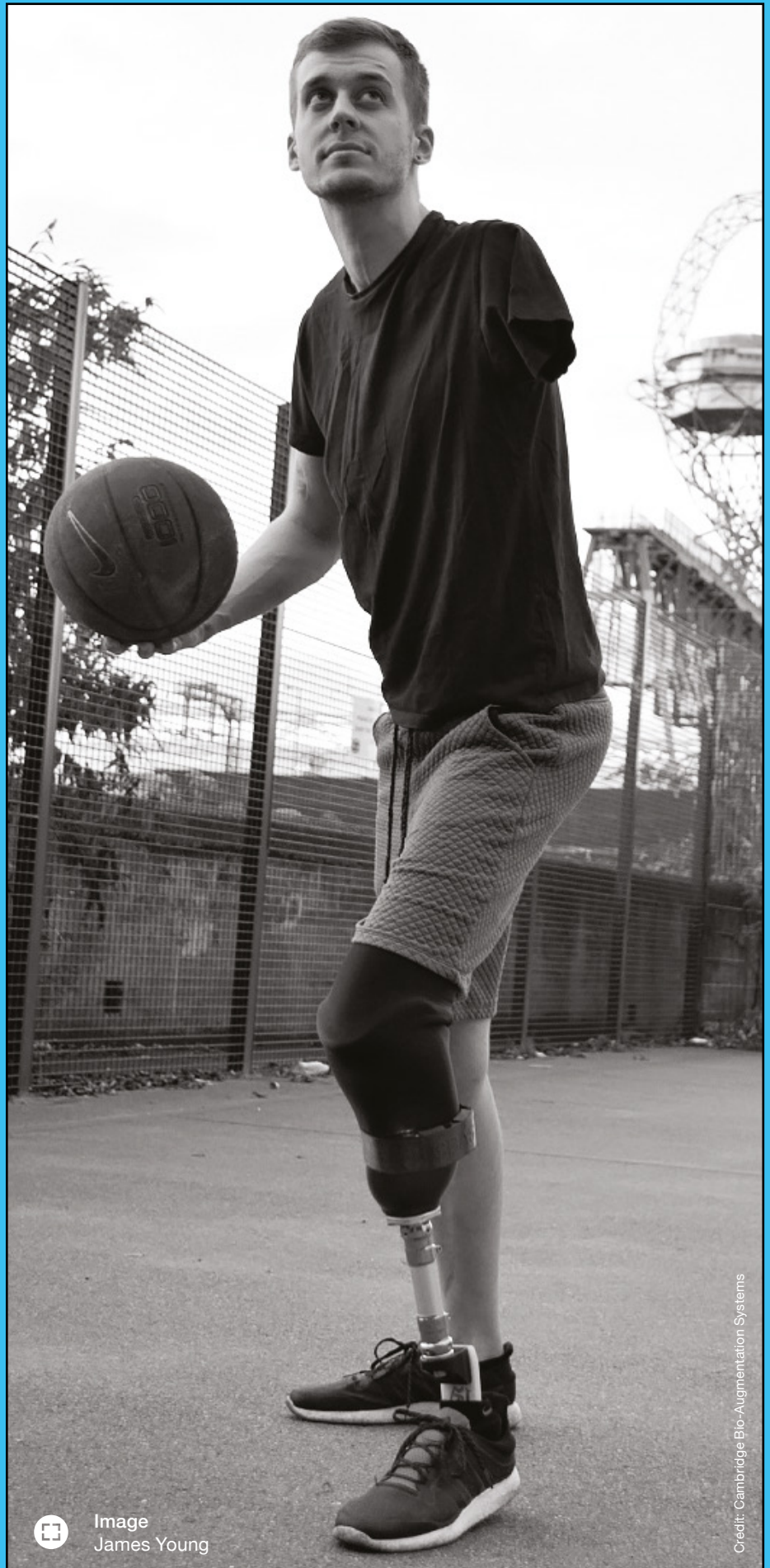
What drives Armitage, as it did during his PhD research in Cambridge on the engineering of biological systems, is the desire to understand how nature might work better with the aid of technology. “Evolution is a progression and we’re at a point in it,” he says. “Let’s see where we go.”



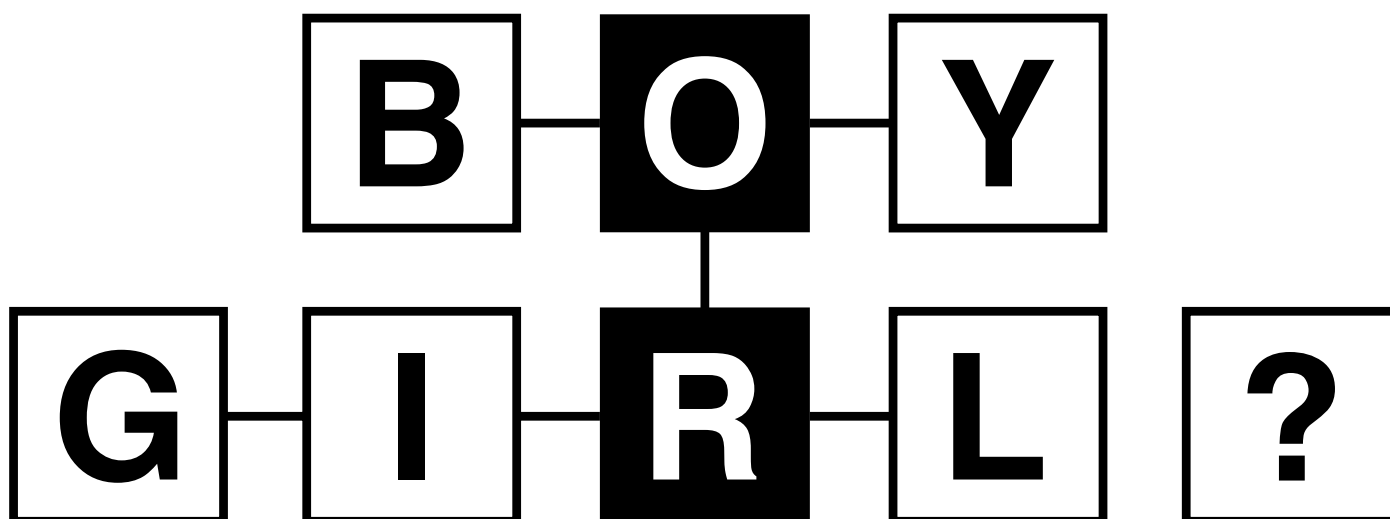
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**Words**  
 Louise Walsh



**Image**  
 James Young



**Boy or girl? This is one of the first questions all new parents are asked. In a small percentage of cases, the answer isn't straightforward: the child is intersex. In a highly gendered society, how does the law apply to people whose physiology doesn't fit the binary categories of male and female?**

**I**n England, Wales and Northern Ireland, the birth of a child must, by law, be registered within 42 days of the baby being born. To register the birth, the parents (or parent) must provide various pieces of information including the sex of the baby. But what happens if the child has been born with a reproductive or sexual anatomy that doesn't match the typical definitions of female or male?

Since 2013, it has been possible for children born in Germany to be legally recorded on their birth certificate (and later in life) as 'indeterminate'. While this remains controversial, especially among intersex groups who see it adding to

stigmatisation, it creates a legal gender status other than male or female.

Worldwide, a very small percentage of babies are born intersex – an umbrella term that covers a range of genetic variations that may be apparent at birth or emerge later in an individual's development. But, argues lawyer Dr Jens Scherpe, their relatively low number doesn't make these individuals any less important than those judged by society as 'normal' in terms of their physiology.

Scherpe carries out research within one of the most controversial and sensitive areas of family law – jurisprudence and gender. His introduction to the topic came when he was working at the Max

Planck Institute in his native Germany and was asked to carry out research into nationality and change of legal gender for a case heard by the Constitutional Court. He began talking to transgender people and learning about their experiences.

"Once you meet people directly affected by laws which discriminate against them, you begin to feel differently and I've become a passionate advocate for change in the law in this area. I began to question the way in which we seek to categorise people and apply labels. What right does the state have to classify people as male or female in official documents such as birth certificates and passports – and do we actually need gender categories?"

After completing a comparative project on the legal status of transgender people, Scherpe focused attention on the law as it relates to intersex people, a group whose voices are beginning to be heard more forcefully. Because intersex people are a minority and frequently face discrimination, they are often bracketed together with other groups as LGBTQI (lesbian, gay, bisexual, transgender, queer or questioning, and intersex). Each of these groups, however, is differently affected by the law as it applies to sex and gender.

With funding from the DAAD-University of Cambridge Research Hub for German Studies (see panel), Scherpe organised a workshop in 2016 on 'The Legal Status of Intersex Persons' as a forum to discuss some of the most pressing issues. It brought together participants from ten jurisdictions, including Germany which, as part of a wide-reaching human rights agenda, is making growing provision in the law for people who do not wish to be identified by the binary categories of male or female.

Germany has not been alone in making changes to the ways in which gender is recorded. Changes to the law have been mooted in several countries, including India and Nepal. In 2015, Malta took a lead in passing legislation allowing people to determine their own gender – and for parents, in certain cases, to postpone the marking of gender on a baby's birth certificate until the child's gender identity is confirmed.

While welcoming these changes, Scherpe says there is much more to be done to ensure that intersex individuals have the same rights, and are accorded the same respect, as the majority of the population.

One of the themes to emerge from the workshop is a growing concern that cosmetic (rather than medically necessary) surgery is carried out almost routinely. Intersex pressure groups argue that the medicalisation of intersex leads to violations of human rights and that corrective surgery can have devastating consequences.

"Most people strongly condemn the practice of female genital mutilation," says Scherpe. "But children born with genitalia that don't match what society regards to be male or female are routinely 'corrected' by invasive surgery, agreed by parents who fear the stigma attached to having a different child and who believe that their child will be seriously disadvantaged. Would we operate on a child who had red hair because we'd prefer them to have brown or fair hair – or change a child's eye colour from brown to blue?"

At the core of this debate is the view, still held by many medical professionals, that intersex is a 'disorder' rather than a 'difference'. Much of the argument surrounding intersex, and the issues it raises in a gendered world, centres on the use of language and how we choose to define ourselves. There is, for example, widespread debate about the definitions of the terms sex and gender in the highly competitive environment of world athletics.

"Because they're so intertwined with sense of self, and can appear so threatening to our boy/girl view of the world, these questions are understandably super-sensitive. Even the terminology used will be perceived as discriminatory by some. And you can be certain of abuse from those who disagree with you for even investigating the issues concerned. But neither of those things should deter us from seeking to improve the law," says Scherpe.

Not being part of the communities he writes about may be seen to add

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## “do we actually need gender categories?”

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credibility to his work; he has no self-interest in pursuing changes in the law relating to any of the groups he works with. On the other hand, his lack of personal experience of the extra challenges faced by minority communities means that he needs to listen to a great many people to find out how their lives intersect with the law.

He adds: "What matters to me is that as a society we have a duty to ensure that all our members are provided with a legal framework, free from discrimination and stigmatisation, within which they can live happy and healthy lives."



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**Words**  
Alex Buxton

### Studying Germany

**Jens Scherpe's work is one of over 30 projects that were funded last year through a research Hub in Cambridge which focuses on Germany.**

Historian Dr Hanna Weibe and theologian Dr Ruth Jackson are fascinated by how politics and religion worked together in Germany after the political upheaval of the Napoleonic Wars; Dr Simon Stoddart is interested in urbanism in Iron Age Germany; Dr David Trippett in how Wagner arrived at his theory of melody as a means of communication; and Dr Ksenia Gerasimova in why Germany chooses organic agriculture.

These and over 30 other projects have been supported through the €1m DAAD-University of Cambridge Research Hub for German Studies, with funds from the Foreign Ministry of the Federal Republic. "This money was given in recognition of the fact that Cambridge arguably now has the largest number of scholars working on Germany and German culture in the world outside Germany itself," says Professor Chris Young, who co-leads the Hub with Professor Chris Clark.

"Why study Germany?" asks Young. "Germany is widely regarded as a model economy that appears to be working when others are struggling. Understanding the country's economic and political importance, especially given the implications and impact of Brexit, is a golden opportunity for us and for Europe. How, for instance, has Germany coped with immigration or austerity? What facets of its history, culture, politics and theology have influenced the way that Germany is today?"

Through the breadth and depth of the research it supports, the Hub hopes to create a German-focused interface between the University and governmental bodies, both in the UK and in Germany, and be a nexus for the Anglo-German relationship.

"Germany has shaped the world in which we live and influenced the ways in which we think about, experience and seek to change it," adds Neil MacGregor, former Director of the British Museum, and patron of the Hub. "The gains in knowledge that [the Hub] will bring can only enrich and strengthen the ties that bind Germany and the world."

<http://www.daad.cam.ac.uk>

*“All this cancer talk is new to me,*

*but I do know there isn't a stage five”*

Aged just 36 years old when she died of cancer, Kate Gross (pictured) is an inspiration to us all. But it needn't have ended the way it did. Now, researchers in Cambridge – including her husband – are working to ensure that others receive their diagnoses much earlier, when their cancer can still be stopped.



Words  
Craig Brierley



Credit: With kind permission of Billy Boyle and William Collins

**I**t is October 2012. Kate Gross is a successful young woman for whom everything seems to be perfect. “My adorable twins are three, and their father Billy, is my soulmate, as well as the best-looking man I’ve ever kissed,” she wrote in her memoir, *Late Fragments*.

But Kate was about to learn that all was not, in fact, well. “Inside me a lump of cells has broken free of the rules and spawned a tumour which has blocked my

colon, crept through my lymph nodes and colonised my liver. Cancer is halfway to killing me, and I am completely oblivious to its presence.”

Kate was eventually diagnosed with stage four colon cancer. “All this cancer talk is new to me,” she added, “but I do know there isn’t a stage five.”

According to her husband, Billy Boyle, only 5% of people diagnosed with colon cancer at such a late stage survive. “Kate was not one of the lucky ones,” he says. His wife passed away on Christmas Day, 2014.

Boyle is determined that what happened to his wife should not happen to others: had his wife’s cancer been diagnosed at the earliest stage, she would have had a 95% chance of surviving, he says.

A decade earlier, Boyle had founded Owlstone, a spin-out from the Department of Engineering focused on developing chemical sensor technology. Using the same idea he had then, he has now spun out a second company, Owlstone Medical, to apply the technology for use as a ‘breathalyser’ for cancer. The breathalyser

works by detecting specific chemicals in the breath, metabolites – waste products – produced by tumours.

“We know that cancer has an altered metabolism, even at a very early stage,” says Boyle, “so the goal is to try and pick up these markers when the cancer is most treatable. We want to give doctors better tools for making a differential diagnosis, so if someone comes to them with abdominal problems, for example, they are better at working out what it’s likely to be.”

His company has recently begun a clinical trial, in collaboration with researchers at the Cancer Research UK (CRUK) Cambridge Cancer Centre and Cambridge University Hospitals. The trial will test whether the breathalyser can be used to non-invasively identify a wide range of cancers at a stage when more treatment options are available and the chances of surviving are much higher.

One of Boyle’s collaborators is Professor Rebecca Fitzgerald from the Medical Research Council (MRC) Cancer Unit, who is co-leader of Cambridge’s Early Detection Programme, supported by CRUK.

“People are beginning to talk of cancer as being a ‘chronic disease’,” she says, “and that is the case for some cancers, where we can keep them at bay. But most cancers are diagnosed late, and once cancer has spread to the lymph nodes or into the blood, it’s going to be an uphill battle to treat it.”

As many as one in five cancers are identified only when they present as an emergency, when the cancer is usually at an advanced stage. This might be because patients aren’t good at spotting the warning signs or understanding their risk, or there are delays in getting access to the appropriate diagnostic tests, or the tests themselves aren’t reliable enough or cost-effective enough to roll out across the NHS.

Fitzgerald is hoping to transform early detection of oesophageal cancer – cancer of the gullet. This is one of the cancers that has benefited little from recent advances in treatments, mainly because it’s usually caught too late. Patients with suspected oesophageal cancer have to undergo a gastroscopy – a camera down the gullet – which is unpleasant and not good at distinguishing between the often-benign ‘Barrett’s oesophagus’, a condition in which cells within the lining of the oesophagus begin to change shape, and malignant cells.

She has developed the Cytosponge-TFF3 test, a ‘pill on a string’ that dissolves to reveal a sponge; when withdrawn, the sponge scrapes off some cells from the gullet lining which can then be tested in the lab using a simple antibody test for Barrett’s. It has been shown to work, and is now undergoing a UK-wide trial

to compare its performance against the current endoscopy referral pathway, as well as its cost-effectiveness, ease of administration and whether it is acceptable for patients.

Fitzgerald’s co-lead in the Early Detection Programme is Dr Sarah Bohndiek from the Department of Physics, who is developing new imaging techniques for early detection and for monitoring the progress of cancers. This collaboration between a clinical researcher and a physicist typifies the Programme’s hugely interdisciplinary membership – around 250 researchers from 50 different departments in Cambridge, including clinicians, basic scientists, physicists, engineers, social scientists, and ethical and legal experts.

“I think this Programme couldn’t happen anywhere else,” says Bohndiek. “We have outstanding departments across all fields and an open-minded,

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**“In a normal world,  
I would have been  
granted decades to  
say all of this. Fat, old  
and wearing purple,  
I would have bored  
my children and my  
children’s children  
with stories of the  
world I had known”**

---

collaborative atmosphere that grows research from the bottom up.”

Such diversity is not without its challenges. “We learned early on that there was something of a language barrier, so we had to do some work to help the physicists and engineers understand some of the clinical issues around early diagnosis and what makes it difficult in different cancers, for example,” says Fitzgerald.

It was also important that researchers collaborated from the outset. “There’s no point developing a diagnostic that is so clever it’s never going to be affordable, or it’s going to take too long to do the test per patient,” she explains. “Unless you’re talking to a clinician from the outset, you might not see what the problems are until too late.”

The Programme has funded several ‘pump-priming’ projects to make these collaborations happen. These include a

much-needed new test for prostate cancer that could be carried out in a GP surgery, rather than a hospital, and a holographic endoscope capable of differentiating between benign and malignant tissue.

“We don’t expect that all of these projects will succeed, of course,” says Bohndiek. “If they did, then we’re not looking high risk enough.”

Ultimately, the Programme will be deemed successful if it leads to new ways of detecting cancer that are then rolled out across the NHS. For this to happen, it will be essential to build health economics into their Programme.

“Cancer treatment is incredibly expensive, especially with new targeted agents, chemotherapy, radiology, investigations, time in hospital, but if you can detect cancer sooner, the treatments get simpler,” says Fitzgerald. “But then of course, you’re testing more people, so the economics have to be worked out. You should be building this into your clinical trials.”

Fitzgerald expects that the economics “should stack up”, particularly if the tests are low tech and affordable and more thought is given to identifying and targeting those at greatest risk, either genetically or due to their lifestyles.

Cambridge is collaborating with the Canary Center at Stanford University and the Oregon Health & Science University Knight Cancer Institute, and Fitzgerald and Bohndiek have plans to set up an Early Detection Institute that will form an integral part of an ambitious new cancer research hospital being mooted for the Cambridge Biomedical Campus. But given the potential to save so many lives, it is perhaps surprising that there are so few centres worldwide focused on early detection.

“I am writing this book to share the sum of a life,” wrote Kate Gross. “In a normal world, I would have been granted decades to say all of this. Fat, old and wearing purple, I would have bored my children and my children’s children with stories of the world I had known.”

This is the future that Boyle, Fitzgerald and Bohndiek hope to provide for others unfortunate enough to receive a cancer diagnosis.

*‘Late Fragments’ (2014) is published by William Collins.*



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# Changing the face of Indian farming



Words  
Jacqueline Garget



Image  
Farmer from the Indian state of Bihar

**I**ndian agriculture is expected to feed a growing and increasingly urbanised population. But if everyone wants to move to towns and cities, who is left to farm the land?

The rains are less reliable. Sudden heat waves create challenging conditions for crops. Poor harvests result not only in debt, but also in malnutrition for smallholder farmers. Farming in India is not an attractive career option.

Many Indian farmers are turning their backs on the life altogether. The pull of the city, with the promise of better work and a better income, is drawing huge numbers of rural Indians away from the land.

Women in India have always been involved in farming, typically doing work between the traditionally 'male jobs' of sowing and harvesting, such as weeding and applying fertiliser. But they usually work land that belongs to their husbands' families, and when households become more impoverished they have to work harder yet still earn less than the men.

"It's becoming difficult to get a reliable income from agriculture in many parts of the Indian subcontinent," says Dr Shailaja Fennell, from the Centre of Development Studies. "It's quite common for the majority of younger family members to go to a town to look for work. In the last decade in regions like the Punjab – which benefited from the Green Revolution – even many of the young women are leaving the land, to study at school and college.

"So now the farming is left to the older women – the mothers and sometimes the grandmothers. They're in the difficult situation of having to make do in households where incomes are falling. In poorer states such as Odisha, this can lead to malnourishment, which has long-term effects on the children."

The record grain outputs of India's 'Green Revolution' in the 1970s and 1980s established the country as one of the world's largest agricultural producers, sustaining its booming population and boosting its economy. But the level of success varied from region to region,

and the continued overuse of water, fertilisers and pesticides, together with post-harvest crop losses, has put increasing pressure on natural resources. India's rapid population growth continues, and the UN estimates it will surpass China by 2022 to become the most populous country in the world. And more people means more mouths to feed.

Fennell is a co-investigator of TIGR<sup>2</sup>ESS: a new, large-scale, multi-partner project that has just been awarded £6.9m funding from the Global Challenges Research Fund (GCRF) by Research Councils UK to address this complex web of issues. Drawing together a formidable network of partners from research, industry, government and NGOs in the UK and India, the project aims to define the requirements for a second, more sustainable Green Revolution, and to deliver this through a suite of research programmes, training workshops and educational activities.

The funding forms part of the UK government's Official Development Assistance commitment, and partners from both countries will work together, with over 22 new researchers funded in both the UK and India.

"India is developing fast. A new approach is urgently needed to ensure a more resilient outcome for the future of the country's food production," says plant scientist Professor Howard Griffiths, who leads TIGR<sup>2</sup>ESS. "To be successful, we need to address the challenges in India today, from equality and sustainability in agriculture, to the problems associated with climate change."

The empowerment of women will be a key theme of this multifaceted project. Providing India's women with the skills and knowledge to contribute to improved food security for their country, and better nutrition for their families, will take various approaches. The UK–Indian partnership will set up 'nutrition kitchens' in Indian villages alongside existing health centres to run monthly cooking classes and provide nutrition-relevant education.

And in the field, workshops will educate female farmers to help them improve their farming practices.

"Some crops, like certain varieties of millet for example, are currently used only for animal feed," says Griffiths. "But they have a better nutrient balance and are more climate resilient than the preferred staples like wheat, so switching may partly be a question of education."

"In parallel, our research will be looking for ways to increase the value of these crops, to raise family incomes," adds Fennell. "These are very specific interventions that have huge potential impact. TIGR<sup>2</sup>ESS will bring together science and social science to drive interventions that actually work for Indian farmers and their communities."

TIGR<sup>2</sup>ESS will include fundamental research addressing crop productivity and water use in India, and will identify appropriate crops and farming practices for different climatic regions. It also includes a capacity-building programme of researcher exchanges between the UK and India to ensure skills development and build expertise for the longterm. And it will draw on expertise at Cambridge's Centre for Science and Policy with the aim of bringing about policy change in India, to ensure that it is not just the men who receive farming support.

"Recognising that an increasing number of India's smallholder farmers are women, we need to ensure that state resources and services, and knowledge, are equally accessible to them," says Dr V. Selvam, Executive Director of the M. S. Swaminathan Research Foundation in Chennai, one of the India-based project partners.

"The ultimate impact of TIGR<sup>2</sup>ESS will be to deliver sustainable practices and improved food security, whilst promoting equal opportunities and enhancing nutrition and health for rural communities across different regions and climatic zones in India," says Griffiths. "For Cambridge, this is an opportunity to build on our commitment to international scientific excellence and to translate this into real benefits for society through our partnership with India's Department of Biotechnology and institutions across India."

[www.globalfood.cam.ac.uk](http://www.globalfood.cam.ac.uk)



### Changing the way we eat, grow and distribute food

While TIGR<sup>2</sup>ESS focuses on improving India's food production, a £340m EU Innovation programme involving Cambridge aims to put Europe at the centre of a global revolution in food innovation and production.

Around 795 million people worldwide don't have access to enough food to meet their minimum daily energy requirements, while at least two billion consume too many calories but don't get the nutrients they need. Both the hungry and the overweight suffer the health consequences of poor diet.

And while our increasing population is creating a growing demand for food, 25% of what we already produce is going to waste. Add to this the changing climate affecting crop growing conditions, rapid urbanisation and the increasing demand for resource-intensive foods like meat – the net result is a food system that's increasingly under pressure.

Cambridge is one of several European universities and companies that last year won access to a £340m EU Innovation programme to change the way we eat, grow and distribute food.

The project, funded by the European Institute of Innovation and Technology (EIT) and called EIT Food, has ambitious aims to halve the amount of food waste in Europe within a decade, and to reduce ill health caused by diet by 2030.

"Sustainability is a top-level agenda which is engaging both global multinational food producers and academics," says Professor Howard Griffiths, who helped to lead Cambridge's involvement in EIT Food, a consortium of 55 partners from leading European businesses, research centres and universities across 13 countries.

"Our joint goal is in making the entire food system more resilient in the context of a changing climate, and improving health and nutrition for people across the world."

**"They're in the difficult situation of having to make do in households where incomes are falling"**



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# Going underground

An international collaboration between universities and industry will further develop carbon capture and storage technology – one of the best hopes for drastically reducing carbon emissions – so that it can be deployed in a wider range of sites around the world.



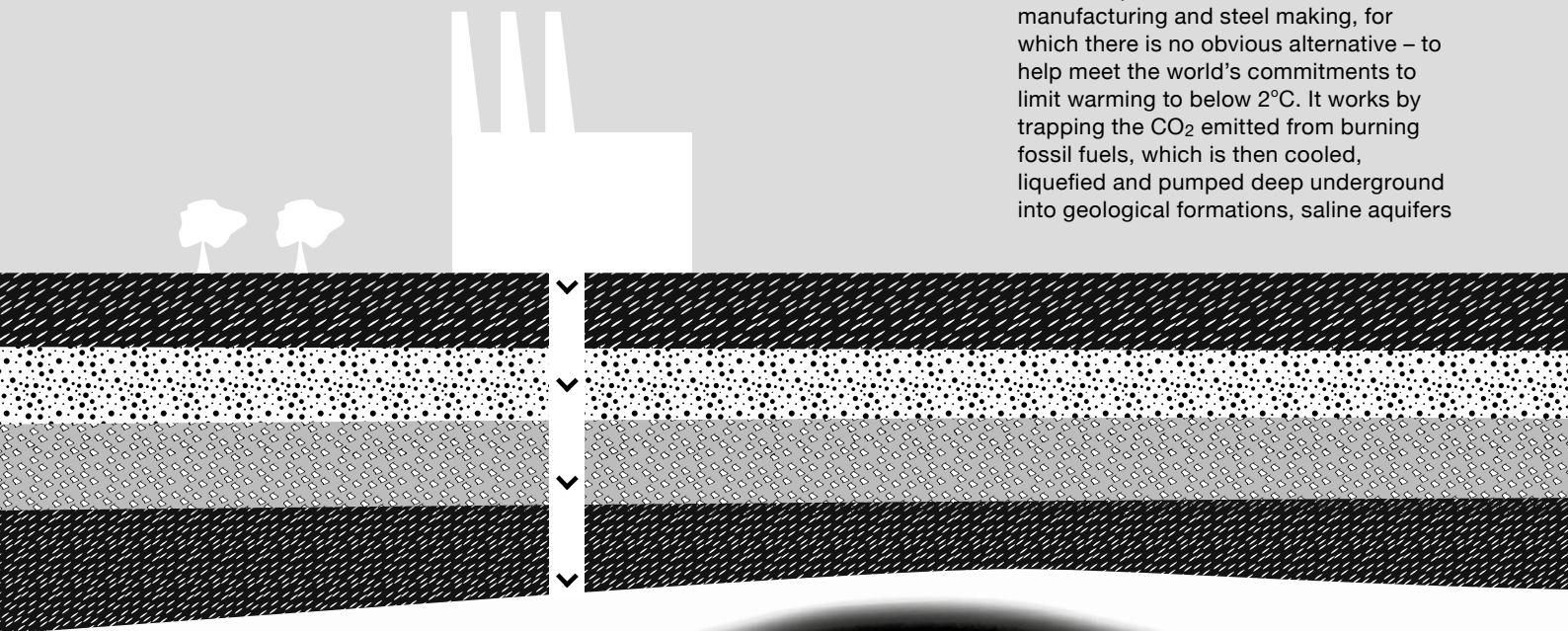
Words  
Sarah Collins

The world is not going carbon-free any time soon: that much is clear. Developed and developing countries alike rely on fossil fuels for transport, industry and power, all of which release CO<sub>2</sub> into the atmosphere. But as sea levels rise, ‘unprecedented’ weather events become commonplace and the polar ice caps melt, how can we balance our use of fossil fuels with the imperative to combat the catastrophic effects of climate change?

“Everything suggests that we won’t be able to stop burning carbon-based fuels, particularly in rapidly developing countries like India and China,” says Professor Mike Bickle of Cambridge’s Department of Earth Sciences. “Along with increasing use of renewable energy and improved energy efficiency, one way to cope with that is to use carbon capture and storage – and there is no technical reason why it can’t be deployed right now.”

Carbon capture and storage (CCS) is a promising and practical solution to drastically reducing carbon emissions, but it has had a stilted development pathway to date. In 2015, the UK government cancelled a £1 billion competition for CCS technology six months before it was due to be awarded, citing high costs. Just one year later, a high-level advisory group appointed by ministers recommended that establishing a CCS industry in the UK now could save the government and consumers billions per year from the cost of meeting climate change targets.

CCS is the only way of mitigating the 20% of CO<sub>2</sub> emissions from industrial processes – such as cement manufacturing and steel making, for which there is no obvious alternative – to help meet the world’s commitments to limit warming to below 2°C. It works by trapping the CO<sub>2</sub> emitted from burning fossil fuels, which is then cooled, liquefied and pumped deep underground into geological formations, saline aquifers





or disused oil and gas fields. Results from lab-based tests, and from working CCS sites such as Sleipner in the North Sea, suggest that carbon can be safely stored underground in this way for 10,000 years or more.

“The big companies understand the science of climate change, and they understand that we’ve got to invest in technologies like CCS now, before it’s too late,” says Dr Jerome Neufeld of Cambridge’s Department of Applied Mathematics and Theoretical Physics. “But it’s a tricky business running an industry where nobody is charging for carbon.”

“Everyone always wants the cheapest option, so without some form of carbon tax, it’s going to be difficult to get CCS off the ground at the scale that’s needed,” says Bickle. “But if you look at the cost of electricity produced from gas or coal with CCS added, it’s very similar to the cost of electricity from solar or wind. So if governments put a proper carbon charge in place, renewables and CCS would compete with each other on a relatively even playing field, and companies would have the economic incentive to invest in CCS.”

Bickle and Neufeld are following discussions about CCS closely because, along with collaborators from Stanford and Melbourne Universities, they have recently started a new CCS project with the support of BHP, one of the world’s largest mining and materials companies.

The three-year project will develop and improve methods for the long-term storage of CO<sub>2</sub>, and will test them at Otway in southern Australia, one of the largest CCS test sites in the world. Using a mix of theoretical modelling and small-, medium- and large-scale experiments, the researchers hope to significantly increase the types of sites where CCS is possible, including in China and developing economies.

In most current CCS schemes, CO<sub>2</sub> is stored in porous underground rock formations with a thick layer of

non-porous rock, such as shale, on top. The top layer provides extra insurance that the relatively light CO<sub>2</sub> will not escape.

The new research, which will support future large-scale CO<sub>2</sub> storage, will consider whether CO<sub>2</sub> could be effectively trapped without the top seal of impermeable rock, meaning that CCS could be deployed in a wider range of environments. Their research findings will be made publicly available to accelerate the broader deployment of CCS.

“We are seeing a growing acknowledgement from industry,

## “By not starting CCS now, we’re building false economies”

governments and society that to meet emissions reductions targets we are going to need to accelerate the use of this technology – we simply can’t do it quickly enough without CCS across both power generation and industry,” says BHP Vice President of Sustainability and Climate Change, Dr Fiona Wild. “We know CCS technology works and is proven. Our focus at BHP is on how we can help make sure the world has access to the information required to make it work at scale in a cost effective and timely way.”

During the project, Stanford researchers will measure the rate at which porous rock can trap CO<sub>2</sub> using small-scale experiments on rock samples at reservoir conditions, while the Cambridge researchers will be using larger analogue models, in the order of metres or tens of metres. The Melbourne-based researchers will use large-scale numerical simulations of complex geological settings.

“One of the things this collaboration will really open up is the ability to deploy CCS almost anywhere,” says Neufeld, who is also affiliated with Cambridge’s Department of Earth Sciences and the BP Institute. “We know that CO<sub>2</sub> can be safely trapped in porous rock with a seal of shale on top, but the early results from Otway have shown that even without the impenetrable seal, CO<sub>2</sub> can be trapped just as effectively.”

When CO<sub>2</sub> is pumped into underground saline aquifers, it is in a ‘super-critical’ phase: not quite a liquid and not quite a gas. The super-critical CO<sub>2</sub> is less dense than the salt water, and so has a tendency to run uphill, but it’s been found that surface tension between the salt water and the rock is quite effective at pinning the CO<sub>2</sub> in place so that it can’t escape. This phenomenon, known as capillary trapping, is also observed when water is held in a sponge.

“The results from Otway show that if you inject CO<sub>2</sub> into a heterogeneous reservoir, it will mix with the salt water and capillary trapping will pin it there quite effectively, so it opens up a much broader range of potential carbon storage sites,” says Bickle.

“However, we need to start deploying CCS now, and the biggest challenges we face are economics and policy. If these prevent us from doing anything until it’s too late, and we’re at a stage when we’d have to start capturing carbon directly from the atmosphere, it will be far more expensive. By not starting CCS now, we’re building false economies.”



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# Things

## A history of Islamic art in ten pieces

**T**hese treasures are part of a collection of Islamic art and manuscripts in Cambridge that stretches from the 7th to the 19th century and originates from a huge swathe of the Islamic world.

Enriched over centuries by the activities of scholars and benefactors, Cambridge's collection of Islamic artefacts is impressive by world standards: it comprises around 4,500 manuscripts in the University Library and over 12,000 objects in Cambridge's Fitzwilliam Museum originating from North Africa, Southern Spain, the Middle East, Central Asia and India.

The collection includes ceramics, glass, metalwork, calligraphy, manuscripts, paintings and a large collection of coins. Many items are exquisite and unique, such as a group of rare Qur'anic manuscripts in the University Library that are among the earliest fragments to survive from the beginnings of Islam.

"We have over a thousand years of history in these pieces," explains Marcus Fraser, Honorary Keeper of Islamic Manuscripts and Paintings at the Fitzwilliam Museum. "Collectively they make a huge contribution to understanding the history of the Islamic world through its art and culture."

The scale and breadth of the collections have meant that many pieces have yet to be fully catalogued and researched. Now funds are being raised to establish an Islamic Art at Cambridge programme to help give these historically important pieces recognition and generate research, teaching and public engagement.

"The programme will make a vital contribution to deepening our understanding of Islamic culture," explains Dr Deniz Turker, from the Department of History of Art. "Islamic art has from its roots been a product of regional and eventually global cultural exchange. It is precisely these cross-cultural roots and reach that we emphasise in our courses here at Cambridge."

*For more information about the Islamic Art at Cambridge programme, contact Emily Williams (emily.williams@admin.cam.ac.uk).*

1530–1535



1148

10th century



1355

1550



1620-1640



1571



16th century

1592-1594



9th century



Image selection by Marcus Fraser. Credit (clockwise from top left): Iznik blue and white bowl, Turkey, c. 1530-1535; Yusuf after bathing in the Nile, illustration from a manuscript of Yusuf va Zulaiykha by Abd al-Rahman Jami, Central Asia, c. 1550; dragon and qilin in combat, Isfahan School, Iran, c. 1620-1640; Nizami, Haft Paykar, copied by Babashah al-Isfahani, Iran, 1571; raid on Homs during the caliphate of Mustatin, illustrated leaf from Emperor Akbar's manuscript of the Tarikh-i Alfi, Northern India, c. 1592-1594; Qur'an folio in Kufic script on parchment, Near East or North Africa, c. 9th century; illuminated Qur'an manuscript, Iran or India, 16th century; glass mosque lamp with enamelled decoration, Egypt or Syria, c. 1355; Almoravid dinar, Spain, 1148; earthenware bowl painted in lustre, Iraq, 10th century. © Fitzwilliam Museum and Cambridge University Library/Digital Library <https://cudl.lib.cam.ac.uk>

**T**hings structure our lives. They enrich us, embellish us and express our hopes and fears. Here, to introduce our Spotlight on material culture, four academics from different disciplines explain why understanding how we interact with our material world can reveal unparalleled insights into what it is to be human.

From the tools we work with to the eyeglasses and dental implants that improve us, our bodies are shaped by the things we use. We express and understand our identities through clothing, cars and hobbies. We create daily routines and relate to each other through houses and workplaces. We imagine place, history and political regimens through sculptures and paintings.

Even when we think we are dealing with abstract information, the form it takes makes a huge difference. When printing liberated the written word from the limited circulation of handwritten manuscripts, the book and the newspaper became fundamental to religious and political changes, and helped create the modern world.

Studies of material culture focus upon things not just as material objects, but also on how they reflect our meanings and uses. Throughout the humanities and social sciences, there is a long tradition of thinking principally about meaning and human intention, but scholars are now realising the immense importance of material things in social life.

At the core of material culture studies is the question of how people and things interact. This is a simple, sweeping question, but one long overlooked, thanks to historically dominant philosophical traditions that focus narrowly on human intention. In fact, it's only in the past decade that scholars have posed the question of material agency – how things structure human lives and action.

Material culture studies have emerged as central in many disciplines across the University of Cambridge. In archaeology and history, scholars see material objects as fundamental sources for the human past, counterbalancing the discourse-oriented view that written texts give us. Should we use historical sources to see what people think they ate, or count their rubbish to find out what they really consumed? Combining the two gives us answers of unprecedented scope.

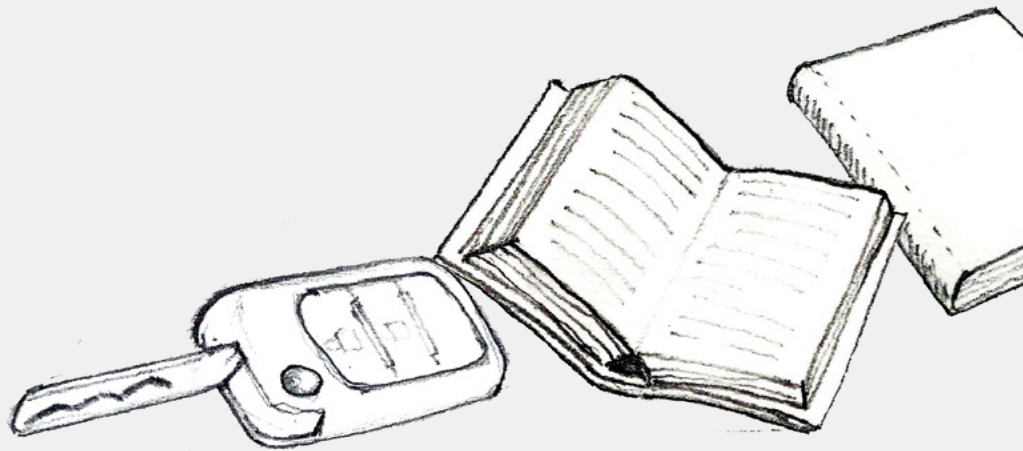
Geographers ask why it makes a difference whether workplaces are organised into separate offices or open-plan cubicles. Literary scholars draw attention to how experience and meaning are built around things, like Marcel Proust's remembering of things long past as a madeleine cake is dipped in tea; even books themselves are artefacts of

# Living in a Material World



## Words

John Robb  
Simon Goldhill  
Ulinka Rublack  
Nicholas Thomas



a singular and powerful kind. Likewise, studying anatomical models and astronomical instruments empowers an understanding of the history of science as a practical activity. And anthropologists explore the capacity of art to cross cultures and express the claims of indigenous peoples.

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## Most human dilemmas are material dilemmas in some way

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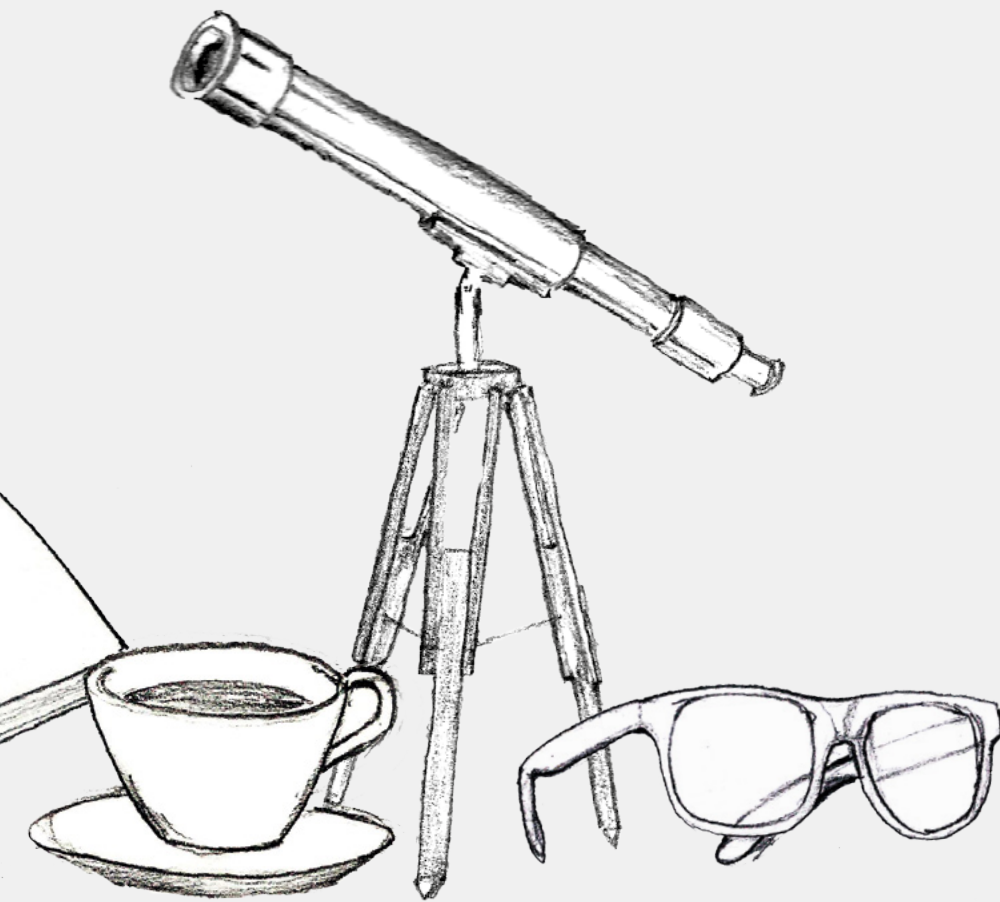
Material things are also at the heart of new fields such as heritage studies. Memory itself is material, as we've seen recently in the USA, where whether to keep or tear down statues of historic figures such as Confederate generals can polarise people.

Unlike most newly emerging fields in the sciences, material culture studies are grounded in a sprawling panoply of related approaches rather than in a

tightly focused paradigm. They come from a convergence of archaeology, anthropology, history, geography, literary studies, economics and many other disciplines, each with its own methods for approaching human–thing interactions.

As a result, the contributions in this issue of *Research Horizons* could easily be doubled or tripled. Scholars across the University are increasingly focusing upon material culture, from the Faculty of English's Centre for Material Texts (see p. 32) to the Department of Archaeology's Material Culture Laboratory (p. 30), from the Hamilton Kerr Institute's art conservation research (p. 26) to the Centre for Research in the Arts, Social Sciences and Humanities (CRASSH) and its interdisciplinary 'Things' seminar series (see panel).

The reasons for this interest are not hard to find. The University offers a rare combination of three essential foundations for the field. One is world-class strength in the humanities and social sciences, sustained by institutions like CRASSH, an essential venue for interdisciplinary collaboration. The second is the capacity for a huge range of scientific analyses of materials. The third is our immensely varied museum collections: the Fitzwilliam Museum's treasures; the Museum of



### Curious objects and CRASSH courses

You've had a difficult time lately. You're thinking that all this bad luck might be more than coincidence. You trim your nails, snip some hair and bend a couple of pins. You put them in a bottle with a dash of urine, heat it up and put it in a wall. That'll cure the bewitchment, you say to yourself.

Making a 'witch bottle' like this would be an entirely reasonable thing to do 400 years ago. It would also be reasonable to swallow a stone from a goat's stomach to counteract poisoning and hide an old shoe in a chimney breast to increase the chance of conceiving.

"All of these objects took on layers of meaning for their owners, and the fact these strong connections existed at all gives us glimpses of people's beliefs, hopes and lives," says Annie Thwaite, a PhD student in the Department of History and Philosophy of Science. She is also one of the convenors of a seminar series on 'Things' at the Centre for Research in the Arts, Social Sciences and Humanities (CRASSH).

"Material culture was a crucial part of medicine in the 17th century. Objects like witch bottles are often dismissed as 'folkish'. But by investigating the bottles' architectural and geographical situation, their material properties and processes, you start to look through the eyes of their owners. Fearful of supernatural intrusion into their homes and bodies, people would go to great efforts to use something they regarded as a legitimate element of early modern medical practice."

Charms and amulets, votives and potions, myths and magic will be discussed as this year's 'Things' seminars begins a new focus on imaginative objects.

"Like material culture studies, the seminar series is broad and varied," she explains. "We might just as easily examine the skills required to craft objects as the power of objects to become politicised."

"Things matter greatly to humans. We have short lives and our stuff outlives us. While we can't tell our own story, maybe they can."

[www.crassh.cam.ac.uk/programmes/things](http://www.crassh.cam.ac.uk/programmes/things)



**Words**  
Louise Walsh

Classical Archaeology's 19th-century cast gallery; the Museum of Archaeology and Anthropology's worldwide prehistoric, historic and ethnographic collections (p. 36); and many others. Where else can scholars interested in the material aspect of Victorian collecting study Darwin's original finches or Sedgwick's and Scilla's (p. 22) original fossils, boxes, labels, archives and all?

Whether it's work on historic costume (p. 28), South American craft production (p. 30), religion (p. 34) or the building of a 'Universal' library of books (p. 32), the study of material culture offers unparalleled insights into how humans form their identities, use their skills and create a sense of place and history.

But it is not only a descriptive and historical field. Most human dilemmas are material dilemmas in some way. Where did our desire for things come from and how did the economics of consumerism develop? How can we organise our daily lives to reduce our dependence on cars? Should we care where the objects we buy come from before they reach the supermarket shelves? How do repatriation claims grow out of the entangled histories of museum objects?

The shape of this new field is still emerging, but Cambridge research will be at the heart of it.



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**D**r Ken McNamara holds a book dated 1670, its edges curled and its pages mottled. “This is what helped to start a whole field of science that forever changed our understanding of the evolution of life,” he says. “This book; these drawings; the ideas it contained: in many ways they mark the beginning of palaeontology as a science.”

“Our understanding of past life on Earth is written in the fossil and geological records but, until Agostina Scilla and a small number of others began interpreting what they saw scientifically, the evidence had been wreathed in mythology and folklore.”

Scilla’s book is held in Cambridge’s Sedgwick Museum of Earth Sciences, where McNamara is Director. In itself the book is a fascinating and beautifully drawn account of one man’s passion to prove that fossils were the remains of

once-living things. But what makes this a unique piece is that it sits alongside not only Scilla’s original drawings, which are usually destroyed by the plate-making process for printing, but also all of the fossils he drew as he enthusiastically laid down his arguments.

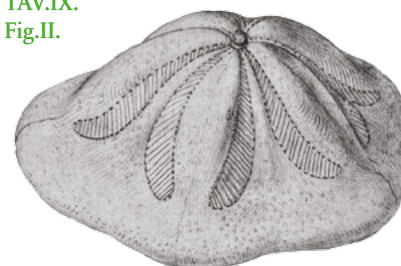
Today, almost 350 years after Scilla’s book was published, it’s hard to fathom that fossils would be anything other than the remains of living organisms. But, in the 1600s, few could imagine how plants and animals could be turned to stone. Instead, the strange and wonderful rocks that were occasionally unearthed from the ground were considered ‘sports of Nature’ – the planet having a bit of fun, trying to confuse us by creating ‘tongue stones’, ‘Maltese serpents’, ‘pearl bubbles’ and ‘thunderstones’.

Agostina Scilla (1629–1700), a Sicilian artist, believed otherwise. He began to collect and meticulously draw the fossils

he found while walking in the hills of Southern Italy. He noticed similarities between tongue stones and sharks’ teeth, and between Maltese serpents and the casings of marine worms. He noted that rocks that resembled bones also had spongy-looking textures, and that the perforations of thunderstones matched the shells of sea urchins that have lost their spines.

These weren’t examples of Nature behaving “with insufferable eccentricity”, he expounded, but the petrified bodies

TAV.IX.  
Fig.II.



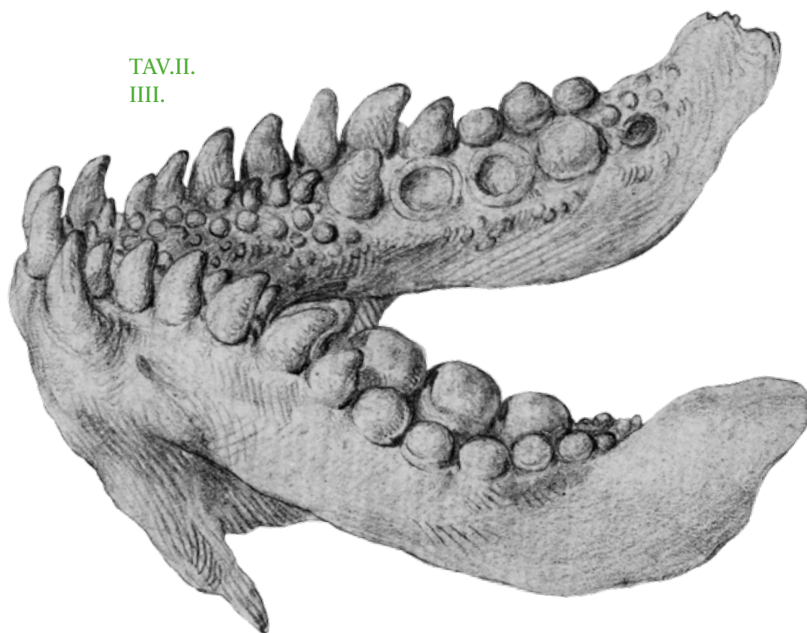
of sea creatures, ruined by time and the mighty weight of the Earth.

“What a hallucination to affirm that it was all due to chance, or to some subtle generative virtue composing Nature’s jokes and shutting them up in rocks! What piffle!” he declares in his book. “These shellfish lived in water and then rotted; a joke of time, not of Nature.”

Scilla’s book was barely noticed when it appeared in print in 1670. Two decades later, however, it had become a sought-after text, its polemic theories and accurate drawings chiming with those of other natural historians looking at the fossil record. Among them was Dr John Woodward (the subject of a book McNamara is writing), who eventually bought all of Scilla’s drawings and fossils and donated them to the University of Cambridge in 1728.

McNamara explains that Scilla’s emphasis on observational science still underpins palaeontology: “Understanding the evolution of life comes from understanding the objects. This is what

TAV.II.  
III.



#### Image

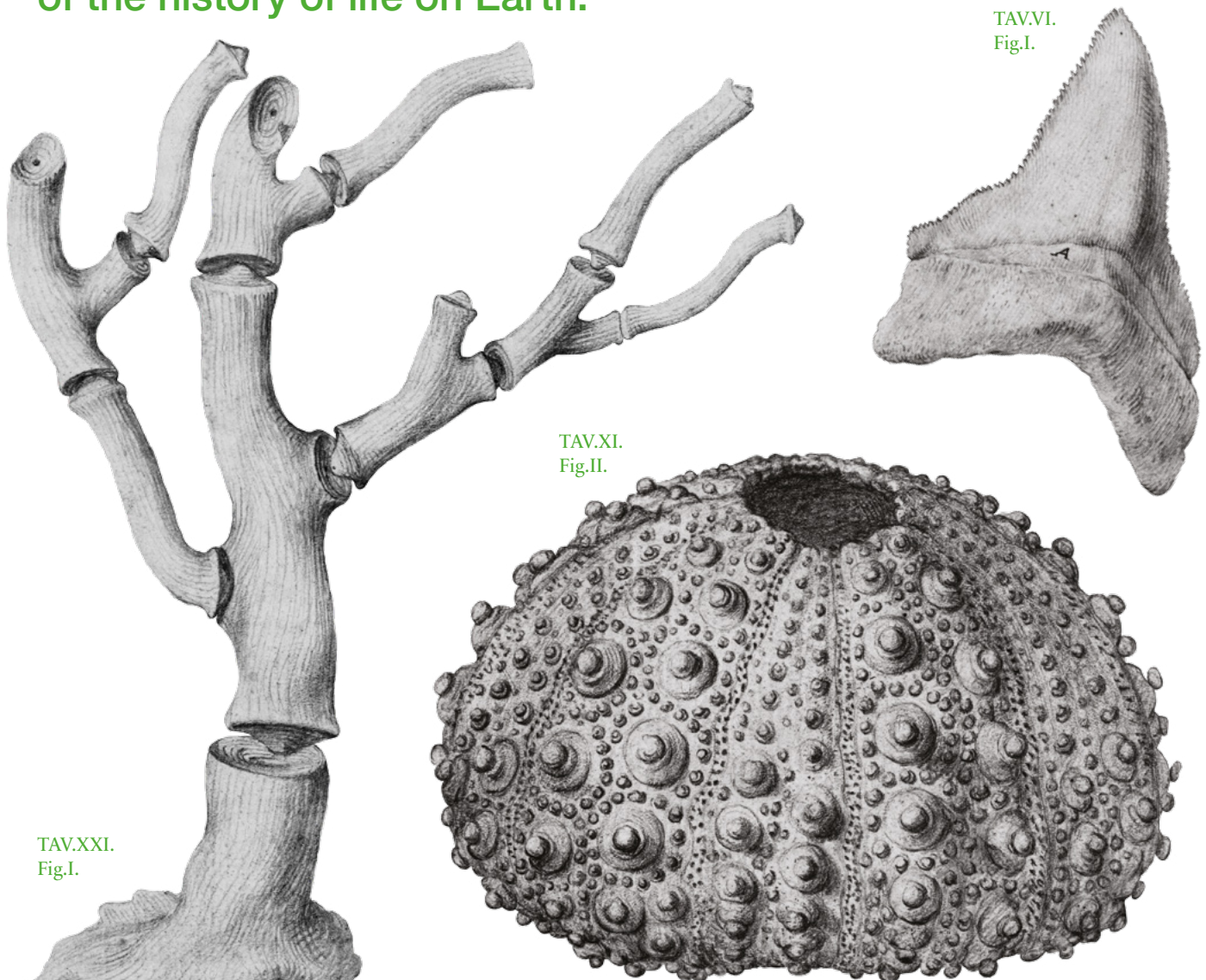
Agostina Scilla’s fossils and drawings “in many ways mark the beginning of palaeontology as a science”

**“A joke of time,  
not of Nature”**  
The object and the image



Words  
Louise Walsh

Over 300 fossils collected in the 17th century by Agostino Scilla, together with his meticulous drawings and the book he wrote, all survive in Cambridge's Sedgwick Museum of Earth Sciences. Today, they are helping historians and Earth scientists to unravel the very beginnings of our understanding of the history of life on Earth.



TAV.XXI.  
Fig.I.

TAV.XI.  
Fig.II.

TAV.VI.  
Fig.I.

I've done for the past 40 years. We collect fossils and rocks, we interpret them, and we use them to understand past biodiversity, climates and environments."

Now Scilla's book, drawings and fossils are helping Earth scientists like McNamara and historians like Professor Sachiko Kusakawa to understand this complex relationship between seeing, handling, visualising and interpreting.

"Science is supremely visual," says Kusakawa. "An integral part of modern scientific endeavour involves making visible the structures and processes that are normally invisible to the human eye. We might therefore think of scientific

observation as so specialised it has nothing to do with art. But the activity of drawing was a key element in how people in the past trained their way of looking and understanding."

Kusakawa is interested in understanding where this all began – how images and drawings were used to express early scientific ideas, to pursue and preserve knowledge and to disseminate findings.

She explains that Scilla's collection of fossils and drawings gives us unique insight into this process. But what did Scilla see when he held the fossils up to the light, looking for indentations,

perforations and the faintest of lines that might hold clues? When Kusakawa and colleagues tried to replicate the process, they made a surprising discovery.

"We tried to draw the objects and then compared them with Scilla's own drawings. We found he couldn't have seen the object in the way he drew if he'd looked from only one angle. He slightly adjusted the drawing to include areas that would be hidden from one viewpoint – he's combined multiple views into one drawing. Scilla seems to have realised the importance of the third dimension."

Of course being able to see the fossils from all angles is just as important

today. Dan Pemberton, the Collections Manager at the Sedgwick Museum, has been leading a project to create a 'virtual' Scilla collection using a variety of imaging techniques including 3D modelling.

The visualisations are part of an online resource that the Museum is creating, with funding from Arts Council England, to allow users to explore virtual drawers, choose and rotate individual fossils, see Scilla's drawings and read what he had to say about them. Scilla's book has also been translated from Italian to English for the first time since publication and is available as a free eBook (edited by Dan Pemberton and Rosemary Williams).

"The resource gives us a 21st-century experience of historical objects," says Kusakawa. "They help us to appreciate how complex observational drawing might be and how it assists and shapes our understanding. Drawing can be a means of knowing."

Examining Scilla's collection is one strand of Kusakawa's work. She also leads a larger project to work through the archive of the Royal Society of London to find and catalogue all the images it amassed during a 50-year period after its beginnings in 1660.

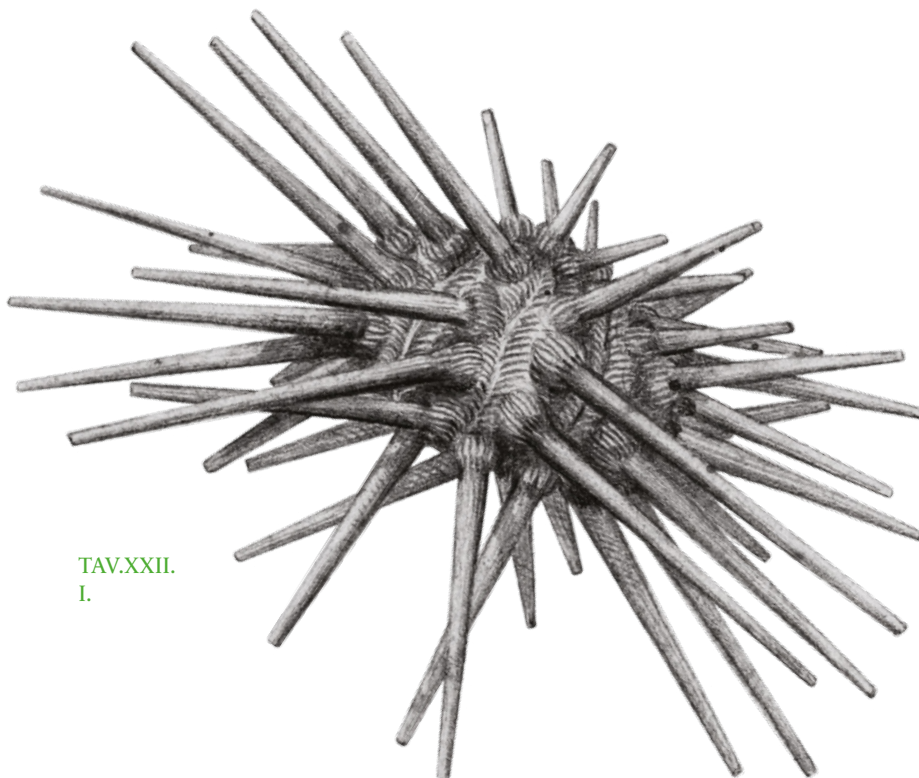
The Royal Society was an important institution for early modern science, dedicated to the collective investigation of Nature, and Scilla's work was of great interest to its members. With funding from the Arts and Humanities Research Council, Kusakawa's team hopes to provide the first comprehensive account of the complex and ingenious ways in which diagrams and drawings shaped knowledge about the natural world.

Scilla may well have approved of the historians' and Earth scientists' hopes to shed light on the role of the object and the image in the history of scientific observation. He knew the crucial importance of accurate drawings to convince anyone who doubted his theories, and he understood the power of images over words: "I shall never, for any reason, cease to want information about things to be conveyed through my eyes, not my ears or my intellect."

I

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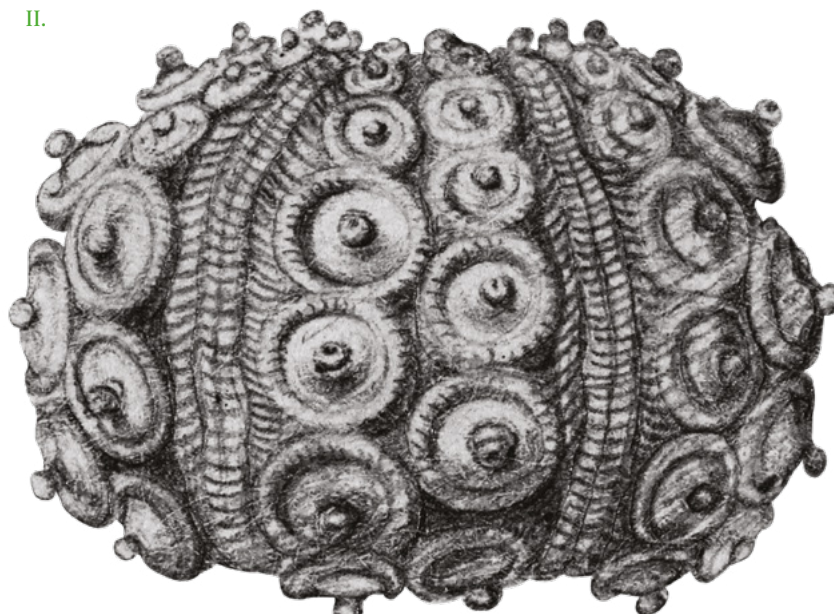


TAV.XXII.  
I.



TAV.XVI.

TAV.XXII.  
II.







# Curiosities, curses and the epitaph of a fading lobster

**A** microcosm of the early-modern world, the *Paston Treasure* is a 300-year-old celebration of the riches amassed by Sir Robert Paston's family in the home he held most precious. It's also their collective epitaph. Conservation scientist Dr Spike Bucklow has uncovered the many layers of the painting's fascinating story.

As the first brush strokes obliterated the carefully drawn chalk outlines, and patches of colour started to grow and resemble the texture of silk, skin, silver and shell, Sir Robert Paston must have been a contented man. Here were his most-treasured possessions being brought to life by his chosen artist. The chaos of the world around him could be put to one side as he settled in to watch his great vision emerge.

But even as the objects took form, the 300-year-old fortune that had brought them together was slipping away. By the time of Sir Robert's death aged 51 in 1683, many of his family's treasures had been sold and shipped off and, within just two generations, the Paston family had completely died out.

In 2005, the painting arrived in the conservation studio of the Hamilton Kerr Institute (HKI), a department of Cambridge's Fitzwilliam Museum. Dr Spike Bucklow was immediately captivated: "The painting was peculiar – incoherent yet careful, a jumble of oddities. The more I looked, the more I felt that none of it made sense."

The painting depicts a fraction of Sir Robert's 'cabinet of curiosities', which numbered over 600 items at Oxnead, his home in Norfolk. Most were acquired by Sir Robert's father, William, who lived well, spent extravagantly and brought back colourful tales and exquisite rarities from his Grand Tours in the early 17th century. Such material collections were used not only to demonstrate wealth but also to share knowledge of strangely different cultures.

Some of these riches have now been traced in a research project involving Bucklow and led by the Yale Center for British Art and Norwich Castle in Norfolk, where the painting now hangs. The treasures are being brought together again for a joint exhibition in January 2018 in

Yale and then in Norwich, at the same time Bucklow's book on the Paston Treasure is due to be published.

But what led Sir Robert to choose these particular objects? It's a strange and eclectic mix to say the least: a lobster, an hourglass, a globe, a death sonnet, the latest fashion in clocks, seven decorative shells and sundry musical instruments, not to mention a girl, a servant, a monkey, a parrot, an abundance of ripe fruits, and all with the luxurious folds of a theatrical red cloth as a backdrop.

"For Sir Robert, the value he placed on his possessions was linked with the difficulty of their acquisition. His cabinet of curiosities allowed him and his friends to luxuriate in the fabulous richness brought by globalisation in a world that could still be the stuff of fables," explains Bucklow.

After Bucklow and colleagues at the HKI had finished conserving the 1.65m by 2m painting, he began to research both the

masterpiece and the life and times of Sir Robert and his treasures. He was helped in his analysis by state-of-the-art X-ray fluorescence (macro-XRF) spectroscopy techniques – a non-invasive method for imaging, layer by microscopic layer.

Everything he found pointed towards this being Sir Robert's own carefully planned creation. "He may not have held the paintbrush, and actually we're not really sure who did, but he certainly directed the whole operation," says Bucklow. "In fact, the painter may well have regretted taking on the commission, given the level of enthusiastic interference by his patron!"

First, there is the composition. Bucklow explains that it's highly unlikely any competent artist would arrange the items in such a bizarre 'scrapbook' or 'photoshopped' manner, ignoring the standard conventions of single-point perspective. The oddness is accentuated by the light shining on the girl coming from a different direction, perhaps suggesting she was copied from a painting.

Then, there is the case of the fading lobster. Sir Robert was a man who liked materials – he was an early member of the Royal Society, and a strong believer in the 'philosopher's stone' and the promise of turning base metals into gold (if only he could one day perfect his alchemical skills). Bucklow believes the once-bright vermilion red lobster is the unintended outcome of his experimentation in pigment recipes.



“The colour has faded spectacularly. Vermillion is known to be unstable but it’s rarely as bad as we see here,” explains Bucklow. “The lobster’s vermillion must be an alchemical mishap.”

Bucklow has now identified around 20 different pigments in the painting and worked out the order that each item was painted from how they overlap. The picture largely emerged in a ‘colour-by-numbers’ fashion – all the greens, for instance, were painted at the same time. Some items were painted over, including a large silver platter and a girl with blue eyes, a red-laced bodice and ribbons in her hair.

“We cannot know who she was or why she was painted over but the disappearance of the platter is physical evidence of goods flowing out of Oxnead,” adds Bucklow. “Perhaps Sir Robert didn’t want to be reminded of his losses.”

Sir Robert lived in a time of great change: England was recovering from civil war and adjusting to the restoration while London suffered plague and then fire.

“One of the deeply satisfying things about making the painting would have been its orderly growth, a moment of respite in a chaotic world. Life outside Oxnead was buffeted by unpredictability. Making the painting was a very different

experience. Unlike most other aspects of his life, Sir Robert was in control of every single detail.”

But the Paston fortunes were soon to spiral downwards. Sir Robert suffered money worries, repeated business failures and ill health. He may even have believed that a curse laid on one of Sir Robert’s unscrupulous forebears by the Prior of Bromholme was finally playing itself out: ‘since you are this cruel and inexorable to us... you shall henceforth always have one of your family a fool, till it is become poor.’

“Sir Robert would have seen the painting as a mirror of his world. The suffocating busy-ness and apparent confusion echo a world that was neither coherent nor orderly. The painting’s subject matter was a celebration of family and wealth but its bizarre composition was a brave acknowledgement of the world’s unstable nature.”

It is these “many unruly threads” of meaning that Bucklow was inspired to gather together when he first saw the painting awaiting its conservation. It’s also what fascinates him today about the material culture of art.

“When you look at a painting what do you really see? You can think of it simply as an image, or you can think

of it as a material object that happens to project an image whilst containing layers of economic, philosophical and religious meanings. I quite like that about paintings.”

*Spike Bucklow’s book ‘The Anatomy of Riches’ will be published by Reaktion Books in 2018.*

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**P** Words  
Louise Walsh

**I** Image  
Detail from the  
*Paston Treasure*



# A feather in your cap

## *Inside the symbolic universe of Renaissance Europe*

**T**oday, feathers are an extravagant accessory in fashion; 500 years ago, however, they were used to constitute culture, artistry, good health and even courage in battle. This unlikely material is now part of a project that promises to tell us more not only about what happened in the past, but also about how it felt to be there.

Later, an eyewitness recalled that officials thought the Duchess had fainted at the sight of blood trickling from her husband's mouth. Only the Archduke himself seemed to realise that she, too, had been hit. "Sophie dear! Don't die! Stay alive for our children!" Franz Ferdinand pleaded. Then, "he seemed to sag down himself," the witness remembered. "His plumed general's hat... fell off; many of its green feathers were found all over the car floor."

The assassination of Archduke Franz Ferdinand on 28 June 1914, had such seismic repercussions in precipitating the First World War that it is easy to disregard the curious little detail of feathers on the floor. In such context, they seem trivial. Rewind a few moments more, to the famous final photograph of the couple leaving Sarajevo town hall, and the plumage sprouting from the Archduke's hat looks positively absurd; as if amid all the other mortal perils of that day – the bomb that narrowly missed his car, the bullets from a semi-automatic – he somehow also sustained a direct hit from a large bird.

Today, we generally associate feathers with women's fashion, and a peculiarly ostentatious brand at that, reserved for Royal Ascot, high-society weddings and hen parties. Among men, wearing feathers is typically seen as provocatively effete – the domain of drag queens, or ageing, eyelinered devotees of the Manic Street Preachers.

Yet a cursory glance at military history shows that Franz Ferdinand was far from

alone in his penchant for plumage. The Bersaglieri of the Italian Army, for example, still wear capercaillie feathers in their hats, while British fusiliers have a clipped plume called a hackle. Cavaliers in the English Civil War adorned their hats with ostrich feathers.

"Historically, feathers were an incredibly expressive accessory for men," observes Cambridge historian Professor Ulinka Rublack. "Nobody has really looked at why this was the case. That's a story that I want to tell."

Rublack is beginning to study the use of featherwork in early modern fashion as part of a project called 'Materialized Identities', a collaboration between the Universities of Cambridge, Basel and Bern, and funded by the Swiss National Science Foundation.

To the outsider, its preoccupations (her co-researchers are studying gold, glass and veils) might seem surprising. Yet such materials are not just mute artefacts; they sustained significant economies, craft expertise and, she says, "entered into rich dialogue with the humans who processed and used them". Critically, they elicited emotions, moods and attitudes for both the wearer and the viewer. In this sense, they belonged to the 'symbolic universe' of communities long since dead. If we can understand such resonances, we come closer to knowing more about how it felt to be a part of that world.

Rublack has spotted that something unusual started to happen with feathers during the 16th century. In 1500, they were barely worn at all; 100 years later they had

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**Something unusual started to happen with feathers during the 16th century**

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**Image**  
Hendrick Goltzius, soldier, c. 1580

become an indispensable accessory for the Renaissance hipster set on achieving a 'gallant' look.

In prosperous trading centres, the locals started sporting hats bedecked with feathers from parrots, cranes and swallows. Headgear was manufactured so that feathers could be inserted more easily. By 1573, Plantin's Flemish–French dictionary was even obliged to offer words to describe people who chose not to wear them, recommending such verbiage as: 'the featherless' and 'unfeathered'.

Featherworking became big business. From Prague and Nuremberg to Paris and Madrid, people started to make a living from decorating feathers for clothing. Impressive efforts went into dyeing them. A 1548 recipe recommends using ashes,

lead monoxide and river water to create a 'very beautiful' black, for example.

Why this happened will become clearer as the project develops. One crucial driver, however, was exploration – the discovery of new lands, especially in South America. Compared with many of the other species that early European colonists encountered, exotic birds could be captured, transported and kept with relative ease. Europe experienced a sudden 'bird-craze', as birds such as parrots became a relatively common sight on the continent's largest markets.

Given the link with new territories and conquest, ruling elites wore feathers partly to express their power and reach. But there were also more complex reasons. In 1599, for example, Duke Frederick of Württemberg held a display at his court at which he personally appeared as 'Lady America', wearing a costume covered in exotic feathers. This was not just a symbol of power, but of cultural connectedness, Rublack suggests: "The message seems to be that he was embracing the global in a duchy that was quite insular and territorial."

Nor were feathers worn by the powerful alone. In 1530, a legislative assembly at Augsburg imposed restrictions on peasants and burghers adopting what it clearly felt should be an elite fashion. The measure did not last, perhaps because health manuals of the era recommended feathers as protecting the wearer from 'bad' air – cold, miasma, damp or excessive heat – all of which were regarded as hazardous. During the 1550s, Eleanor of Toledo had hats made from peacock feathers to protect her from the rain.

Gradually, feathers came to indicate that the wearer was healthy, civilised and cultured. Artists and musicians took to wearing them as a mark of subtlety and style. "They have a certain tactility that was seen to signal an artistic nature," Rublack says.

Like most fads, this enthusiasm eventually wore off. By the mid-17th century, feathers were out of style, with one striking exception. Within the armies of Europe what was now becoming a 'feminine' fashion choice elsewhere remained an essential part of military costume.

Rublack thinks that there may have been several reasons for this strange contradiction. "It's associated with the notion of graceful warfaring," she says. "This was a period when there were no standing armies and it was hard to draft soldiers. One solution was to aestheticise the military, to make it seem graceful and powerful, rather than simply about killing." Feathers became associated with the idea of an art of warfare.

They were also already a part of military garb among both native American peoples and those living in lands ruled by the Ottomans. Rublack believes that just as some of these cultures treated birds as gods, and therefore saw feathers as having a protective quality, European soldiers saw



L'assassinio a Sarajevo dell'arciduca Francesco Ferdinando erede del trono d'Austria, e di sua moglie.  
(Disegno di A. Beltrame).

them as imparting noble passions, bravery and valiance.

In time, her research may therefore reveal a tension about the ongoing use of feathers in this unlikely context. "It has to do with a notion of masculinity achieved both through brutal killing, and the proper conduct of war as art," she says. But, as she also notes, she is perhaps the first historian to have spotted the curious emotional resonance of feathers in military fashion at all. All this shows a sea-change in methodologies: historians now chart the ways in which our identities are shaped through deep connections with 'stuff'. Further work is needed to understand how far these notions persisted by 1914 when, in his final moments, Franz Ferdinand left feathers scattered across the car floor.



#### Image

An Italian paper depicts the assassination of the feather-hatted Archduke Franz Ferdinand



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**Words**  
Tom Kirk

[www.materializedidentities.com](http://www.materializedidentities.com)

## The social life of

# FRAGMENTS



**T**he town of Borgatta was built in the Argentinean Andes sometime in the tenth century.

It grew to a community of several hundred residential compounds before being abandoned around 1450 when the Inka Empire claimed the region. In the ruins, archaeologist Dr Elizabeth DeMarrais has been hunting for signs of pre-Inka elites.

Her interests lie in the dynamics of social groups in the past – how did society work? Were there ‘pecking orders’ or hierarchies? When did the ‘politics’ of daily existence begin to characterise human societies, from the ancient to our own? The excavation of Borgatta, which she led, was to yield some surprising results.

“It’s a big site, with a population that would have numbered in the low thousands,” she explains. “We therefore expected to find evidence of leaders, of

rich and poor – as in our own society. But we were surprised to see only limited social differentiation in the materials we uncovered.”

She studies the fragments – the archaeology of daily life – that societies left behind. “We thought we’d see socio-economic differences reflected in diet through remains of animal bones, or in dwelling locations, or in material accumulation,” she explains.

The team found evidence of craft production occurring across the entire settlement. But no specialists could be identified: no equivalent of a blacksmith’s workshop, or a dedicated weaver or a

kiln technician. And no wealthy elites with stockpiles of luxury goods. Yet things were being made in most houses in town – things that defied easy classification.

“Think of the feather cloaks of Hawaiian chiefs, or the swords of Bronze Age warriors,” adds DeMarrais. “These were objects of wealth and power, commissioned from specialist technicians for elites who controlled production and often also trade. This commodification is typical in hierarchical societies.

“In Borgatta, however, we found evidence of nonspecialist ‘multicrafting’ right across the community: with each household using expedient bone and stone toolkits to create a range of objects – from baskets to cooking pots, spindle whorls to wooden bowls – in their own idiosyncratic styles.”

Each residence produced its own items. Household members shared skills and mixed media – creating distinctive artistry in the process.

“Archaeologists like to classify, and the diversity of the Borgatta materials was initially frustrating. However, ideas from social theory helped us think about the significance of this variation, including contexts of production and social roles,” says DeMarrais.

The approach to making things in Borgatta has led her to believe that its people depended upon “a different kind of social glue” – one based on individual relationships, rather than ordered by social rank.

“Objects were gifted on a personal basis to build connections, rather than being funnelled up to a leader who represented the group.” She describes this as a ‘heterarchy’: a society ordered along the lines of decentralised networks and shared power.

“Heterarchy was described in the 1940s as a means of understanding the structure of the human brain: ordered but not hierarchically organised. In a human society, it highlights a structure where different individuals may take precedence in key activities – religion, trade, politics – but there is a fluidity to power relations that resists top-down rule.

“One can think of it as a form of confederacy – similar in some respects to the governance of Cambridge colleges, for example,” says DeMarrais.

Artefacts tell the story of this laterally ordered society. Distinctive clay urns with painted motifs showing serpents, frogs and birds, as well as human facial features, were found to contain the skeletal remains of young infants.

The urns were buried under the floors of houses. DeMarrais suggests that the funeral rites of babies involved displaying urns in the community as part of an extended process of mourning, before they were returned to the residences.

Some urns had the rim extending above the floor, to allow ongoing access to the contents. “In the Andes, mortuary practices involved extended interaction with remains that sustained a sense of connection between the living and the dead.”

The decorated urns were the most striking pieces of material culture excavated

at Borgatta. Adults were simply buried in groups of three or four outside the home, while other children were interred in old cooking pots called ‘ollas’.

Why were the burial vessels of certain infants so distinctive? “The emotions around such premature loss may have been intense. But emotion is also culturally constructed. Would our grief be the same as their grief?” asks DeMarrais.

“These urns may have been intended to evoke emotions. In the absence of centralised authority, we would expect that rituals involving display of objects and the inculcation of shared emotions were an important means of social cohesion.”

There is little standardisation of the urns. Borgatta artisans exercised considerable freedom, says DeMarrais, combining design elements in novel ways. “Each urn, with its individual qualities, may

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## “a different kind of social glue”

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have referenced the unique infant interred inside. But the diversity of motifs also reflects the localised character of social ties within a heterarchical society.”

The shape of some painted urn motifs hinted at design constraints faced by weavers, supporting the ‘multi-crafters’ idea. “We think this similarity suggests that patterns first appeared on textile, and were then transferred to the urns by individuals with experience in both crafts.”

The things observed in Borgatta suggest the lives of artisans in this heterarchy were more varied and creative, given the diversity of social roles objects had to play. The things of the Inka Empire, however, were made by specialist artisans whose skill level was high, but who were tightly constrained by the state in their artistic expression.

Neither society had a writing system, so material culture was vital for communication. And for the Inkas,

a central aim was expressing power through an identifiable ‘brand’.

“The Inkas had rules about who could wear and own what, according to status. Inka objects and architecture were immediately recognisable – like a Coca-Cola bottle in our world. This is, in part, how the Inkas managed to integrate roughly 12 million people across 80 ethnic groups without a writing system.”

Whereas Inkas had specialists who worked to formulae, each object made in Borgatta may well have had numerous ‘authors’ through multicrafting in household workshops. DeMarrais envisions a workshop environment similar to a tech start-up’s open-plan office: “people with different skill-sets pitch ideas and collaborate to create new products to adapt to a changing world”.

The Department of Archaeology’s Material Culture Laboratory, which DeMarrais runs with her colleague Professor John Robb, takes a ‘Borgattan approach’. Researchers working on artefacts from Ancient Egypt to Anglo-Saxon England come together to conduct comparative analyses, and debate how ‘things’ mediated social relations in the past.

“We ask why humans put their energy into particular objects,” explains DeMarrais. “We look for commonalities – from religion to bureaucracies – as well as differences. We ask what happens when you look at an object through a different theoretical lens, whether economic, political, ideological or ontological.”

“What you find – as Elizabeth’s work shows beautifully – is that social life works materially,” says Robb. “Whether it is a government trying to exert its authority, villagers organising their lives to meet their own needs, or individuals remembering and feeling emotions about their own history, things are the medium of the whole process.”

“In the end,” adds DeMarrais, “it’s about squeezing as much information as we can from things people have left behind to build a picture of human lives across time. As an archaeologist you have to accept you will never have the definitive answers. We work with fragments.”

**Researchers are using social theories to interpret objects unearthed in the Andes to tell new stories of societies lacking hierarchical leadership in the time before the Inka Empire.**



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**Words**  
Fred Lewsey

# The man who tried to read all the books in the world



Words  
Louise Walsh



**O**ne man's quest to create a library of everything, 500 years before Google Books was conceived, foreshadowed the challenges of 'big data' and our reliance on search algorithms to make sense of it all.

129,864,880. That's the number of books in the world, according to an estimate by Google Books, which since its launch in 2005 has been trying to scan them all, convert them to searchable text using optical character recognition and then make them publicly available online. Although Google Books' hopes have been slowed by wrangles over copyright and fair use, if it succeeds it could become the largest online body of human knowledge ever available.

Half a millennium earlier in Seville, Spain, Hernando Colón (1488–1539) had the same ambitious aim: to create a library that would be universal in a way never before imagined because it would contain everything. And Colón really did try to collect everything: from precious manuscripts to books by unknown authors, from flimsy pamphlets to tavern posters, from weighty tomes to throwaway ephemera.

Colón's bibliomania took him back and forth across Europe for three decades. According to Dr Edward Wilson-Lee, from the Faculty of English and the Centre for Material Texts, he bought 700 books in Nuremberg over Christmas in 1521, before passing on to Mainz where he bought a thousand more in the course of a month. In a single year in 1530, he visited Rome, Bologna, Modena, Parma, Turin, Milan, Venice,

Padua, Innsbruck, Augsburg, Constance, Basle, Fribourg, Cologne, Maastricht, Antwerp, Paris, Poitiers and Burgos, voraciously buying all he could lay his hands on.

Wilson-Lee has been working with Dr José María Pérez Fernández from the

accompanying his father on explorations of the new world and wrote the first biography of Columbus; he was also a ground-breaking mapmaker and gathered unparalleled collections of music, images and plants.

"Colón had an extraordinary memory and an obsession with lists," says Wilson-Lee, whose research on Colón was funded by the British Academy. "Each time he bought a book, he would meticulously record where and when he bought it, how much it cost and the rate of currency exchange that day. Sometimes he noted where he was when he read it, what he thought of the book and if he'd met the author. As pieces of material culture, each is a fascinating account of how one man related to, used and was changed by books."

This almost obsessive activity makes what now remains of his library – the Biblioteca Colombina, housed in a wing of Seville Cathedral – an incredibly important material resource to explore book history, travel and intellectual networks. "When pieced together," he adds, "they give an account of one of the most extraordinary lives in a period filled with entrancing characters."

Wilson-Lee describes Colón as having lived at the time of an "event horizon" of exponential change, in the same way that the advent of the internet has been for us today; only in Colón's case it was the move from written manuscript to printed book.

"It simply became impossible for one man to read everything," says Wilson-Lee. "Maybe in his youth, it would have been possible – there would have been few

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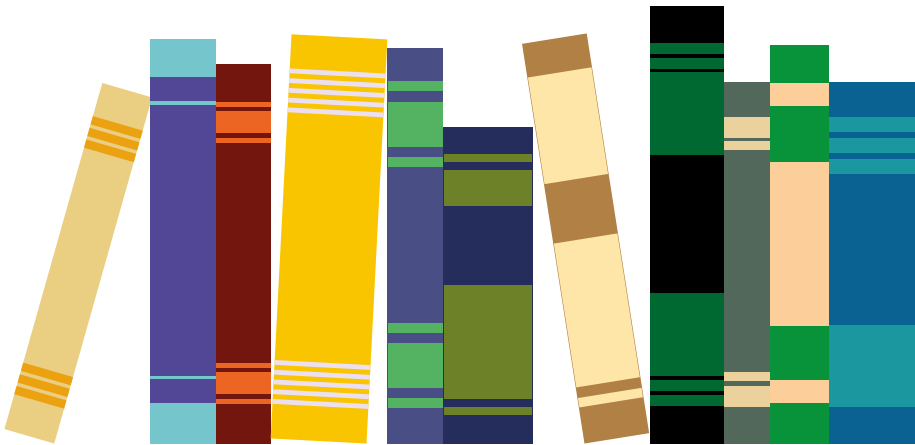
**“In some respects, the Biblioteca Hernandina was the world's first search engine”**

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Universidad de Granada to research the life of Colón, the natural son of the great Italian navigator Christopher Columbus. In addition to creating his library, Colón







enough printed books. But as his library grew, he realised he needed to employ readers to work through each book and provide him with a summary – in effect the forerunner of the *Reader's Digest*.”

As Colón's vision of amassing all knowledge grew, so did something else: the need to add structure to the information he gathered. “It was one of the first ‘big data’ challenges,” says Wilson-Lee. “You might have the information but how do you make sense of it all?”

“One of the fascinating aspects about the library is that it shows that sometimes the way in which knowledge becomes divided up is not in response to some kind of grand abstract reasoning, some kind of Eureka moment, it's sometimes in response to a practical problem. In this case, ‘I've got 15,000 books, where do I put them?’” On a shelf seems reasonable, but even in this respect Colón was pioneering, says Wilson-Lee.

“In essence, he invents the modern bookshelf: row upon row of books standing upright on their spines, stacked in specially designed wooden cases.”

And a material problem of how to store things very quickly turns into an intellectual problem of which things belong together. It forces certain decisions. “As



anyone who has walked through a library will know, order is everything,” explains Wilson-Lee. “The ways in which books can be ordered multiplies rapidly as the collection grows, and each of these orders shows the universe in a slightly different light – do you order alphabetically, by size or by subject?”

“Hernando was acutely aware of this. He referred to unordered, or ‘unmapped’, collections as ‘dead’.”

He wanted his library not only to have everything but also to “provide a set of propositions about how the universe fits together,” he adds. “He viewed the Universal Library as the intellectual counterpart – the brain – to the world empire that Spain was aiming for in the 16th century. It was a fitting extension to his father's grand ambitions to explore the globe.”

One of Colón's innovations to make sense of his library was a vast compendium of book summaries, called the *Libro de Epitomes*. To create this, he set a team of *sumistas* – digesters of the thousands of books in the library – to work distilling each volume, leading towards his ultimate vision that all the knowledge in the world could be boiled down into just a few volumes: one for medicine, one for grammar, and so on.

Another was a blueprint for the Library using ten thousand scraps of paper bearing hieroglyphic symbols. “Each of the myriad ways they could be put together suggested a different path through the library, just as a different set of search terms on the internet will bring up different information. In some respects, the Biblioteca Hernandina, as it was then called, was the world's first search engine.”

How these systems worked will be uncovered in books that Wilson-Lee and Pérez Fernández are writing about the man and his library, and also about how his accomplishments resonate with our own fast-changing networked world.

“For all that he died nearly five centuries ago, Hernando's discovery

of the world around him bears striking, sometimes uncanny, resemblance to the world that we are discovering today,” says Wilson-Lee. “The digital revolution has increased the amount of information available but how do you discern what's useful from what's useless? We are wholly reliant on search algorithms to order the internet for us. Hernando was just as aware that how you choose to categorise and rank information has immense consequences. It's easy for us to forget this sometimes – to sleepwalk our way into knowledge collection and distribution.”

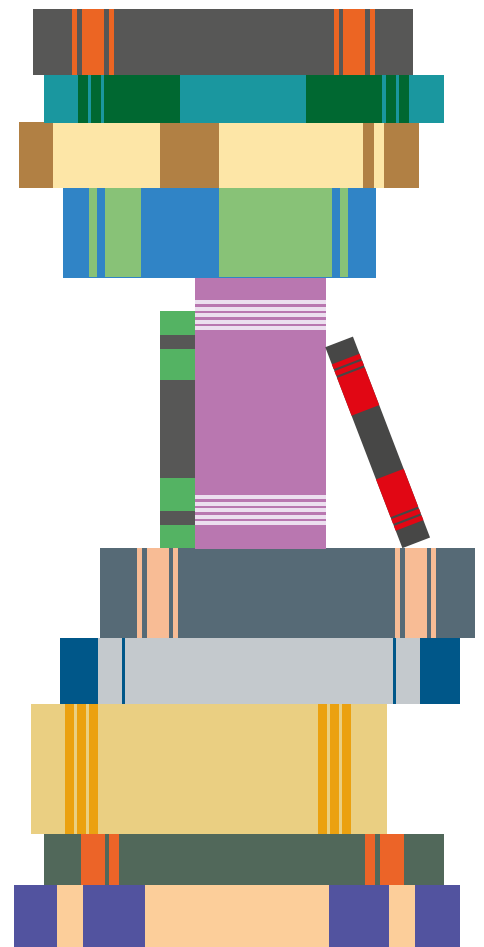
Today, just over 3,000 books of Colón's library remain. Until now, the life of this extraordinary man has largely escaped notice; it's taken another revolution to grasp how visionary he was in recognising the power of tools to order the world of information.

*Edward Wilson-Lee's biography of Hernando Colón, 'The Catalogue of Shipwrecked Books' will be published by HarperCollins in 2018, and the study of the library, co-authored with José María Pérez Fernández, will be published later by Yale University Press.*



#### Dr Edward Wilson-Lee

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# Animating objects: What material culture can tell us about domestic devotions



Words  
Alex Buxton



Image  
This down-to-earth, glazed terracotta figurine of the Virgin could act as the focus of family prayers in a modest home

**R**ustic figurines of a resigned-looking Virgin clutching her child may have no obvious literary or artistic merit to us today. But understanding what they meant to the spiritual lives of their owners can offer a glimpse of the human hopes and fears that people have, for centuries, invested in inanimate objects.

It's an enduring irony of history that the most commonplace objects from the past are those least represented in today's museum collections. The more precious and expensive an object, the more likely it is to have survived. As a result, our perceptions are skewed towards items

that belonged to the rich and powerful – objects that were perhaps rarely handled.

During *Madonnas and Miracles*, a recent exhibition of religious material culture at the Fitzwilliam Museum, one of the most 'stopped at' items of the objects on show was an exquisite rock crystal rosary. It was clearly crafted for an individual of outstanding wealth and status. Each bead features a scene from the New Testament; the drawings are incised into a layer of gold. Not surprisingly, the rosary is today one of the treasures held by the Palazzo Madama Museum in Turin.

But also attracting attention was a much less eye-catching slip of paper



printed on both sides with prayers in Latin. This *breve* would have been sold cheaply on the streets of Italian cities. Its frayed edges suggest that it was folded and worn close to the skin in the belief that the prayers would protect the wearer from a host of disasters – from earthquake to plague. Thousands of *brevi* were produced, and carried as talismans against misfortune, but few have survived.

In 2013, three Cambridge academics from different fields of scholarship came together to throw fresh light on the ways in which Renaissance Italians worshipped within the privacy of the home. Historian and Professor Mary Laven, literary specialist Dr Abigail Brundin and art historian Professor Deborah Howard were determined to explore material culture from modest as well as wealthy households through their ambitious research project, *Domestic Devotions: the Place of Piety in the Italian Domestic Home 1400–1600*, funded by the European Research Council.

During the research, which informed *Madonnas and Miracles* and a forthcoming book, the three stepped out of the ‘golden triangle’ of Florence, Rome and Venice, the major hubs of cultural activity in the Renaissance, to look at material culture from further afield – in Naples, the Marche and the Venetian mainland. In doing so, their study makes an important contribution to our understanding of domestic religious practice across the Italian peninsula.

The Renaissance is often seen as a secular, less religious age in which interest in antiquity encouraged a more rational way of seeing the world. But the evidence from material culture paints a different picture. “The wealth of devotional images and artefacts that we have discovered in Renaissance homes encourages us to view the period 1400–1600 as a time of spiritual revitalisation,” says Laven.

Household inventories show how even a relatively modest family could create a special place for prayer and meditation by setting objects such as a crucifix, candlesticks, holy books and rosaries on a table or kneeling stool. As a reminder of divine protection, religious pictures or statues might be found almost anywhere in or around the house.

“Acts of devotion, from routine prayers to extraordinary religious experiences, such as miracles and visions, frequently took place in the home and were shaped to meet the demands of domestic life with all its ups and downs – from birth to death,” adds Laven. “The tight bond between the domestic and the devotional can be seen in the material culture of the period – in paintings, ceramics and more. These objects tell us how closely daily life intersected with religious belief.”

Young women often asked the Virgin Mary for intercession during childbirth. Representations of the Madonna embracing her healthy son were a feature of many bedchambers – and not just those of the wealthy. The Fitzwilliam Museum holds an example of a rustic terracotta figure of a solemn-looking Madonna and Christ child who is portrayed holding his mother’s naked breast. This rare object exemplifies the type of lower-end production available to less well-off consumers.

Household objects acted as reminders to Renaissance parents of their duties, and the Holy Family was a powerful model of how a devout family should live. An early 16th-century maiolica inkstand in the Fitzwilliam collection, for instance, takes the form of a nativity scene: the infant Christ lies before an adoring Mary and Joseph while a cow and ass look over a stable door, their placidity testament to the wonder of the moment.

In Renaissance paintings, the Madonna appears as an ideal mother and educator – a compelling role model.

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## “Shaped to meet the demands of domestic life with all its ups and downs”

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“A painting of Virgin and child with John the Baptist by Pinturicchio, held by the Fitzwilliam, is a wonderful example,” says Howard. “It shows the Madonna teaching the young Jesus to read. Seated on her lap and encircled by her arms, he is perfectly absorbed in a book. Meanwhile, a boyish and pious John the Baptist provides a model for devotion by young children.”

Everyday objects could literally incorporate the sacred. An earthenware bowl in the Fitzwilliam Museum decorated with an image of the Madonna of Loreto bears around its rim the inscription: CON POL. DI S. CASA. This abbreviated Italian text tells us that the clay from which it was made contains dust (*polvere*) from the ‘holy house’ of the Virgin Mary, supposedly carried from Nazareth to Italy in the 13th century. Behind the Madonna is an outline of the Santa Casa with its tiled roof and bell tower.

At a time when much of the population was illiterate, owning devotional texts was important for surprisingly large swathes of the population. Even when closed, or

unread, they exuded beauty and spiritual value within the domestic sphere. Brundin explains: “Sacred words, by their very presence, could provide protection. Some authors even advised writing the words of certain psalms on the walls to keep the family safe and as a reminder to pray regularly.”

Texts can offer clues to their owners. Cambridge University Library holds a stunning hand-illustrated printed copy of the *Meditation on the Life of Christ*. Hand-written notes in its margins show that in 1528 it was given to a nun, Sister Alexia, by her uncle. Alexia’s annotations indicate that she read the work closely. She even added manicules (pointing fingers) next to passages of particular importance. The book was later owned by another nun, Teofila, whose own reading would have been guided by Alexia’s marks.

Objects accrue deeply personal meanings that are impossible to unravel fully. Careful investigation across disciplines can, however, offer a glimpse of the very human and very fragile hopes and fears embodied by objects, as Brundin explains: “A humble scrap of paper marked with a cross or a brief prayer, of no obvious artistic or literary merit, comes alive when we’re able to marry it with an archival record in which a devotee explains what it means to them.”

*‘The Sacred Home in Renaissance Italy’ by Abigail Brundin, Deborah Howard and Professor Mary Laven will be published by Oxford University Press in 2018.*

[domesticdevotions.lib.cam.ac.uk](http://domesticdevotions.lib.cam.ac.uk)



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# Two million years of human stories

**E**very object in the Museum of Archaeology and Anthropology tells not just one but many stories. The Museum's collections chronicle two million years of human history, revealing the diversity of human life over millennia and the ongoing dynamism of world cultures in the present. Many individual artefacts reflect histories and cultures that are contested.

One of the overarching mottos and principles of the Museum is "Look. Look again." Spread over three floors, with ground-breaking exhibitions and one million objects in its stores, the Museum presents endless opportunities for visitors and researchers to look, then look again.

Among its collections are objects that speak to us of love and loss, conflict and war, and life and death. These objects of material culture communicate to us in many different ways – if we learn how to observe and listen to the myriad stories they have to tell.

But what is the place and purpose of ethnographic museums in the UK in the 21st century? As time marches us further and further away from Britain's

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**“The web of information that might lie behind a single object of encounter ensures they resonate to this day”**

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own contentious history of exploration and the Empire, can and should we be comfortable with such repositories – born from an imperial legacy that painted a quarter of the globe red?

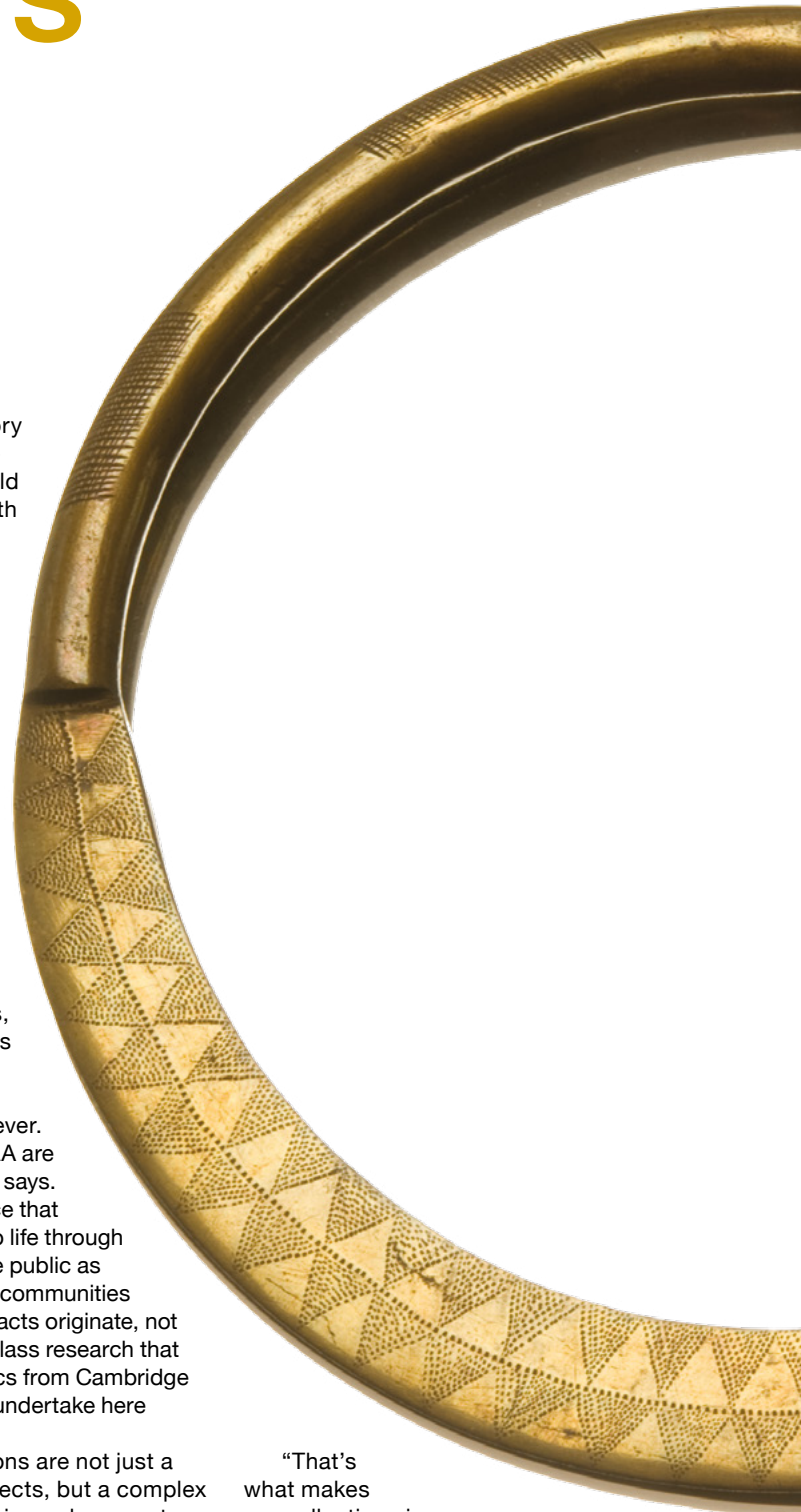
For Professor Nicholas Thomas, Director of the Museum of Archaeology and Anthropology (MAA), the answers are clear. He believes that at a time when questions of cultural and religious differences are highly contentious, the renewal of displays that stimulate cross-cultural curiosity are more important than ever.

“The objects in MAA are not ‘dead’ objects,” he says. “The Museum is a place that brings its collections to life through its interactions with the public as well as the indigenous communities from which these artefacts originate, not to mention the world-class research that scholars and academics from Cambridge and around the globe undertake here every day.

“Museum collections are not just a mass gathering of objects, but a complex set of relationships, things, documents, images and people. Each collection is a tangled formation of material culture and human intention. We're dealing not with lifeless data, but with people's interests in making, using, collecting, interpreting, classifying and reclaiming things.

“That's what makes our collections in particular so rich; it's the web of information that might lie behind a single object of encounter that ensures such objects resonate to this day.”

MAA's collections are extraordinary for a museum of its size. Fewer than 1%





### Image

Necklet worn by a royal bodyguard, gifted in 1902 by Apolo Kagwa, Katikiro of Uganda



hailing from the Pacific, including the world's most important collection from the first voyage of Captain James Cook.

Cook's three voyages of 1768–1780 were formative for the histories of exploration, anthropology, natural history and the Empire, and marked a new epoch in contacts between Europeans and indigenous peoples across the Pacific Islands and around the Pacific Rim.

Bequeathed by Cook's patron Lord Sandwich to Trinity College in Cambridge and transferred to MAA during the early 20th century, the collection is probably the first extensive, systematically made ethnographic collection from any part of the world.

Recent projects have included research published in the leading archaeological journal *Antiquity* on the origins and history of a unique and enigmatic sculpture from the Cook collection.

The carving, which features two double humanoid figures and a quadruped, is one of the Museum's best-known objects and was long attributed to the Austral Islands in French Polynesia.

However, wood isotope analysis reveals that it is in fact from Tahiti, and carbon dating suggests that the work was 50–80 years old by the time Cook acquired it, changing our understanding of Oceania's art history.

Probably an element of a gateway into a sacred precinct, the carving was most likely preserved as a relic before being presented to the explorer. Its gifting implies the wish to build relationships with visitors who were perceived as powerful partners at that time.

It is often assumed that artefacts in ethnographic collections were appropriated from the communities that created them. Although some objects were indeed looted, many collections were created more collaboratively through trade and deliberate gift-giving.

MAA also holds important material from Uganda, brought to Cambridge

primarily by the prominent missionary and ethnographer John Roscoe. Roscoe's donations were supplemented by artefacts such as the necklet shown here. Worn by a royal bodyguard, it was gifted in 1902 by Apolo Kagwa, Katikiro (Prime Minister) of Uganda and the author of important anthropological studies, who travelled to England for the coronation of Edward VII.

Sixty years later, Abu Mayanja, a Cambridge law graduate and Minister for Education in the newly independent nation, asked the University to return certain sacred objects, which were repatriated, and remain on display in the Uganda Museum today.

"I think we see the repatriation question as an opportunity to open up a dialogue – rather than a threat," adds Thomas. "MAA has a distinguished record in engaging with indigenous people in a sustained way. We have had many extended engagements and collaborations around research that have been very rewarding for all the parties involved. It's also been an extremely positive experience to share our collections through lending to major exhibitions in the countries of origin.

"Another more meaningful way of working with indigenous communities has been projects such as 'Pacific Presences', funded currently for five years through a European Research Council advanced grant. Work on material culture almost inevitably involves international collaboration, and we have done so with many small, experimental exhibitions, sharing photographs with communities in the Pacific, as well as through work with partner museums across Europe.

"Benin bronzes notoriously exemplify colonial confrontation and conflict in Africa in the 1890s. We try at once to be upfront about difficult histories, and to communicate the complications of the histories. Like most museums, we receive very few outright repatriation requests. Many indigenous peoples prioritise working together. They see these objects as ambassadors for their cultures."

of its objects can be on display at any given time, but the stores are actively researched by a bewildering range of global scholars.

The Museum contains significant material from all over the world, with some of its best-documented collections

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**P** Words  
Stuart Roberts

# The zoologist who looks after more than a million dead insects

“By the time I was ten my bedroom was brimming with wildlife”



Credit: Nick Saffell

**T**here can't be many people with a 20-year-old exotic newt living in their kitchen.

Ed Turner's passion for wildlife started at an early age, and by the time he was ten his bedroom was brimming with wildlife. Today, he's Curator of Insects at the Museum of Zoology, where he combines research with teaching.

#### **I must have been an awful child.**

I was fascinated by animals and, aged five or so, I began collecting insects and other creepy-crawlies from my parents' garden. To begin with, I kept them outside in an array of buckets but then I began filling my bedroom with all kinds of creatures. My parents were wonderfully tolerant – but they did draw the line at snakes.

#### **As Curator of Insects, I'm responsible for 1.2 million specimens.**

They come from all over the world and include collections made by Charles Darwin and Alfred Russel Wallace. Each year we add to the collection, either specimens donated by other entomologists or insects collected as part of our own research.

#### **I'm never bored – it suits me to be busy.**

As well as my role as curator, I teach both undergraduate and graduate students, and carry out my own research. My focus is on Sumatra where, with colleagues, I'm working with the palm oil industry to mitigate some of the effects of rainforest clearance.

#### **By the time I was ten my bedroom was brimming with wildlife.**

I had stick insects, tarantulas, lizards, frogs and even quails. We went on holidays to Dorset and I brought back lots of rock pool animals, including some tiny grey mullet, which I kept in a seawater tank for almost a decade. Looking after all these creatures was almost a full time job – but I did go to school too. I still have an exotic newt that I bought around that time. It lives in a big tank on the floor of our kitchen and it's over 20 years old.

#### **Gerald Durrell's books were a big influence.**

As a child, I could identify with his passion for wildlife and for first hand observation. Like him, I looked after injured animals: I once took an injured squirrel into school. The most useful of Durrell's books for me was *The Amateur Naturalist*, co-authored with his wife Lee. It taught me

to think about the animals and plants found in different habitats, and gave excellent practical advice, including how to prepare your own museum skins.

#### **Many people played a part in developing my interest in biology.**

My parents and family come top of the list, plus my biology teacher at school and the close friends I grew up with. As a teenager, I joined the Amateur Entomological Society and went on their summer camps. They were organised by some really inspiring entomologists, who gave tirelessly of their time and really developed my understanding of insects.

#### **I made a last-minute application to Cambridge.**

There were lots of brighter children in my year, so I wasn't sure whether I would apply. I think I got in just as much on the strength of what I'd done outside school as my GCSE results. Once I got the offer of a place, I started to work much harder.

#### **At Cambridge, I met lots of gifted and inspiring researchers.**

I owe them an enormous debt of gratitude, particularly

my PhD supervisor, William Foster. Over the years, I've come to realise that successful research is largely about the people you work with. We are very lucky to have an excellent group that makes doing research not only interesting but also fun.

**I did my PhD on the Bird's Nest Fern and the insects that live in it.** These ferns are epiphytic – they grow on other plants but not as parasites – and are native to the tropics of Africa and Asia. They're also popular house plants – you can even buy them in supermarkets. To live in the rainforest canopy, they have large drainpipe-like leaves that funnel water and fallen leaves into their base. The mixture decomposes, providing the plants with their own compost. Bird's Nest Ferns are full of insects, and my PhD investigated this diversity as well as how it changed when forest was logged and cut down for agriculture.

**I'm excited about our latest projects in Sumatra.** We're collaborating with oil palm producers to find ways of improving palm oil yield and, at the same time, making the natural environment more biodiverse. You can never bring back a rainforest once it's gone – but there are things you can do to reduce the impact of agricultural expansion and make tropical agriculture more sustainable. It takes time and patience but there's a lot of potential.

**Teaching is a vital part of my job.**

Perhaps the most valuable thing you can do as a biologist is teach people about the natural world. I've been lucky enough to teach most age groups – from children to mature students. I've found that nearly everyone is interested in biology as long as it is presented in the right way. In my room at the Zoology Department, I have lots of live insects which I keep for talks and outreach events. They're great for getting school children interested in biology, and equally good for engaging more mature audiences.

*People make Cambridge University unique. Cooks, gardeners, students, archivists, professors: all have a story to share. Read over 30 stories now published in our series 'This Cambridge Life' <https://medium.com/this-cambridge-life>*

*The Museum of Zoology is currently undergoing an extensive refurbishment programme and is due to open within the next year.*



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Interview  
Alex Buxton

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**“The painting was peculiar – incoherent yet careful, a jumble of oddities. The more I looked, the more I felt that none of it made sense” p. 26**