

► we can do better than we have done. The impacts of many technologies in fields such as energy production, robotics or knowledge management extend far beyond their operators or beneficiaries, so it is necessary to find a way to solicit and consider the views of affected populations. Scientists increasingly recognize this (J. Kuzma *Nature* 531, 165–167; 2016). A reliance on technologists alone, the author opines, would be an error because “experts’ imaginations are often circumscribed by the very nature of their expertise”. The US congressional Office of Technology Assessment, closed in 1995, used to independently evaluate a wide range of technology problems. Now viewed with nostalgia by critics who lament the scientific illiteracy of much of contemporary politics, it receives only qualified admiration from Jananoff. She concludes that, in several cases, the organization “failed to carve out the space of neutral expertise that its designers had hoped for” and instead “became one more loud, discordant note in the ongoing cacophonous debate”.

Some of the most intriguing portions of the book deal with the personally transformative effects of technology. “Our inventions change the world, and the reinvented world changes us,” as Jananoff puts it. Technology determines our sense of the possible and can enhance or diminish our natural abilities, even altering brain size and function (R. McKinlay *Nature* 531, 573–575; 2016). Our technological choices are both reflections of who we are and stepping stones towards who we will become: emerging technologies may yet redefine what it means to be human.

Depending on what we value most — power, knowledge, sustainability, conviviality or convenience — some technologies will serve us well and others must be excluded. Ethics is central to the process of choosing between them.

Expanding the scope of ethical deliberation over new technology may seem like a daunting prospect bound to impede innovation. It will undoubtedly raise questions more quickly than they can be answered. But experience suggests that many such questions will be worth asking. ■

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## Q&A Brenda Keneghan

# The polymer conservator

*For many, plastic is a dirty word — a pollutant that can't degrade soon enough. But for polymer scientist Brenda Keneghan, it's a precious material that looms large in design history. A conservator at the Victoria and Albert Museum (V&A) in London, Keneghan spends her days saving plastic items from furniture to toys from the ravages of time. Here she talks about the war against the warping, yellowing, crumbling and stickiness that plague polymers.*



### When did people first recognize that plastic degradation was a problem?

For a long time, no one noticed that plastics were degrading, because they were used for throwaway objects. But by the 1960s, a cellulose

acetate sculpture by Russian constructivist artist Naum Gabo, at the Philadelphia Museum of Art in Pennsylvania, was disintegrating. Its value made people take notice. When I joined the V&A in 1994, some people still saw plastic as an imitative material rather than a material in its own right. Now, they respect it as a medium that can take any shape, that is used to create objects and artworks that you couldn't make any other way.

### What is in the V&A's plastic collection?

We have shoes, accessories and bags from the 1920s, when manufacturers used cellulose acetate or nitrate to imitate natural materials such as amber, ivory and tortoiseshell, for example in intricate hair combs. In the 1930s and 1940s, couture designers including Elsa Schiaparelli played with the new materials, which by then also included semi-synthetics such as casein (made from milk protein and formaldehyde), in decorations, buttons and fabrics. From the 1960s, pop-art furniture made of polyurethane (PU) and other plastics emerged, including a sleek single-mould chair by Danish designer Verner Panton and inflatable furniture. There were also polyvinyl chloride (PVC) raincoats and boots. The V&A has beautiful radios and cigarette cases made of Bakelite, but that is pretty stable. In our outpost at the Museum of Childhood in London, we have a huge range of plastic toys, including PVC dolls and PU foam figures.

### How do plastics degrade?

Only five types degrade catastrophically in reaction to humidity, light and air — it's a problem of thermodynamics. It can take from a few years to a few decades. Cellulose acetate and nitrate react with moisture in the air and crumble, producing acid vapours that can corrode anything that shares their display cases. For PU, the problem is oxidation: once additives such as phenolic antioxidants are used up, the plastic crumbles. (The Museum of Childhood's PU foam puppets of television character Larry the Lamb have succumbed completely.) PVC degrades because of the plasticizer molecules that make it flexible. These sit in the mixture and creep up to the surface, making it sticky. Both plasticizers and the base polymer can undergo a reaction that makes the surface dark. Finally, natural rubber, which filled the cushions of pre-1950s upholstery and formed shoe soles, will oxidize and become brittle over time. For all of these, we can stave off the process through specialized storage and display conditions, but we can't prevent it entirely.

### What happens when the museum acquires a new plastic object?

We have to weigh up the care and cost demanded by the plastic's type, age and condition. Many older objects are not labelled, so you need to discover what plastics they are made of. We use an infrared microscope to find the material's fingerprint — how it absorbs different wavelengths of light. Smell and appearance are important, but not conclusive. Our intern Carien van Aubel is looking for features in dozens of test objects to spot similarities — perhaps production techniques or usage — that would help museums without our testing facilities to identify polymers in new acquisitions. This also applies when we put together touring exhibitions: we need to know whether the items we borrow can withstand the rigours of transport and display. In 2013, for example, we checked costumes for the V&A's





### Plastic butterfly sunglasses from the 1960s.

exhibition David Bowie Is, including PVC boots and a skirt-like structure stiffened with polyurethane foam.

### Are there any V&A pieces that are ticking time bombs?

I wouldn't say we have anything that dramatic. Much of our 3D-printed furniture is white nylon, which can yellow. We have a little cellulose acetate box by early-twentieth-century French glassware designer René Lalique that is definitely warping. The problem is worse for modern-art museums, because they have many contemporary artworks that incorporate plastics. From the 1980s, the number of plastics available exploded, and people largely stopped using the least stable ones. But plastics do not last forever, because — unlike wood, metal or stone — they can be damaged by adhesives used for repair. So even something made of Perspex might last only a century, although we don't really know because the material hasn't been around for that long.

### What brought you to the V&A?

I have always been interested in collecting old objects, but mainly plastic items that you would pick up in junk shops, such as Bakelite cigarette boxes. My first degree is in chemistry and my PhD in materials science, focusing on polymers; so when this job came up, it was nice to marry the science with art and design.

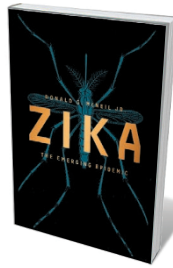
### Do artists and manufacturers factor plastics degradation into their work?

No. A lot of modern art is made of plastic, and often artists, aiming for a particular effect, ignore the manufacturer's instructions on how to mix it. So the plastic might degrade even more quickly. We also now have bioplastics, which are made to degrade. With these, you'll definitely be fighting against the tide. ■ [SEE NEWS FEATURE P.266](#)

### INTERVIEW BY ELIZABETH GIBNEY

This interview has been edited for length and clarity.

## Books in brief



### Zika: The Emerging Epidemic

Donald G. McNeil Jr W. W. NORTON (2016)

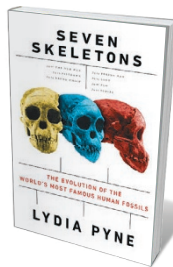
Zika is strangely anomalous. In 99% of cases, the symptoms of this mosquito-borne or sexually transmitted flavivirus are mild, but it can wreak havoc in fetuses, crossing the placenta to trigger brain defects such as microcephaly. In this agile account, science reporter Donald McNeil covers Zika's discovery in 1940s Uganda, early cases, the Brazilian outbreaks of 2015 and the implications of the virus's spread. McNeil's mapping of official responses to the epidemic, from early statements that Zika was benign to recognition of its virulence and the race towards a vaccine, underlines the burning need for viral vigilance.



### Sleep in Early Modern England

Sasha Handley YALE UNIVERSITY PRESS (2016)

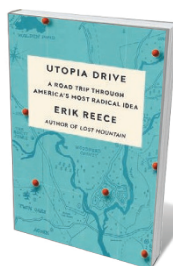
Sleep became a hotbed of speculation and science in early-modern England, reveals historian Sasha Handley in this absorbing study. A complex cultural phenomenon viewed as a fluid midpoint "on the path of transformation between life and death", it also became a proving ground for advances in physiology. So Thomas Willis — who mapped blood flow between brain and body — identified the nervous system as central to sleep regulation. Such findings fed into technologies such as nightcaps to 'protect' the brain, as well as elaborate dream theories linking blood stagnation and nightmares.



### Seven Skeletons

Lydia Pyne VIKING (2016)

Why do certain scientific discoveries gain celebrity? Lydia Pyne teases apart the histories of seven hominin fossils to find out. She reveals how a virtuosic 1911 description by palaeontologist Marcellin Boule helped to make the Old Man of La Chapelle, a nearly complete Neanderthal fossil, a species archetype and cultural icon for decades. She shows how 3.5-million-year-old australopith Lucy became a research benchmark and a world-touring superstar. And she reminds us how these nodes in our storied past grip our collective imagination even as they add immeasurably to evolutionary science.



### Utopia Drive: A Road Trip Through America's Most Radical Idea

Erik Reece FARRAR, STRAUS AND GIROUX (2016)

From 1820 to the 1850s, the US east coast heaved with social experiments, as citizens disaffected by socio-economic turmoil "plotted paradise" in nearly 200 utopian communities, only to disperse with the Civil War. Erik Reece's meander through a number of sites takes in the philosophical roots of the Shakers' sublimely ingenious designs; the lab-like confines of Walden, where Henry David Thoreau conducted his microeconomics trial; and the potential, in our globalized, hyper-consuming era, for communal economies, land trusts and other utopian solutions to re-root.



### The Long, Long Life of Trees

Fiona Stafford YALE UNIVERSITY PRESS (2016)

In this paean to the "arboreal impulse", Fiona Stafford gets under the bark of the terrestrial giants whose natural history is interlaced with our own. Interspersed with crisp black-and-white illustrations, Stafford's low-down on species from ash to yew mesh dendrology with cultural biography and pack in the facts — from 40,000-year-old evidence of olives on the Greek island of Santorini to how willows are "naturally flirtatious, cross-pollinating compulsively" and why pine forests create their own cloud cover. [Barbara Kiser](#)