

the IUPN. Nineteenth-century polymath Alexander von Humboldt, for instance, saw nature as a “living whole” and predicted climate change. Soviet scientist Vladimir Vernadsky introduced the idea of Earth’s life-supporting zone in his 1926 book *Biosfera*. But by the 1950s, an infrastructure of expertise and mainstream will had arisen to sustain the global approach.

A new cadre of experts was called upon to help inform public understanding. They included biologist Rachel Carson — who had been publishing popular books on marine biology since 1941 — and ecologist William Vogt, author of the 1948 *Road to Survival* (A. Rome *Nature* 553, 152–153; 2018). In 1954 came geochemist Harrison Brown’s rumination on planetary resources and human population, *The Challenge of Man’s Future*. In 1970, the first Earth Day took place — and systems scientist Jay Forrester developed a model of global dynamics based on 120 lines of computer code. That laid the basis for the Club of Rome’s hugely influential report *The Limits to Growth* in 1972.

The environment as an idea “burst into life in a futurological soup”, as the authors write, but it was also driven by pioneering scientists compelled to provide solutions to the degradation they witnessed. The ambitious 1955 international symposium *Man’s Role in Changing the Face of the Earth*, called by the New York-based Wenner-Gren Foundation for Anthropological Research, began to shift the emphasis to humanity as culprit. It brought together the likes of geographer Carl Sauer, zoologist Marston Bates and urban-planning theorist Lewis Mumford, but regrettably only one woman: plant geneticist Janaki Ammal, then leading the Botanical Survey of India.

A decade on, Future Environments of North America, convened by the US Conservation Foundation in Warrenton,

Virginia, and including many of the same people, looked to extend those ideas across disciplines, from conservation to geology, economics and sociology. ‘Public policy’ and ‘management’ became part of established discourse, and the vision of Canadian ecologist Pierre Dansereau was widely embraced: “A valid imaginary reconstruction of our world is now our greatest task. It may even be the condition of our survival.”

Five decades on, that warning is more important than ever. Overwhelming evidence reveals how Earth-system processes, from hydrology to biology, are altered by human activity. With the concept of the Anthropocene, an epoch defined by human impact on Earth, reaching the mainstream — as much metaphor as formal term — it is useful

to look back and consider how conversations sustaining this theme first found voice, and to examine the challenges this radical way of thinking faced. Many now well-known threads in modern conservation and ecology — resources, biodiversity, pollution and climate change — have a cultural history. *The Environment* maps that territory well.

As I was reading it, the 2018 special report of the Intergovernmental Panel on Climate Change launched in South Korea. It finds that limiting global warming to 1.5°C above pre-industrial levels, rather than 2°C, (as pledged in Paris in 2015) will require “rapid and far-reaching” transitions in land use, energy, industry, buildings, transport and cities. Refusal will trigger a staggering sequence of knock-on effects

“As environmental movements past have shown, we need imagination, accuracy, long-term political will — and hope.”

at every scale. At least twice as many key insect pollinators and plants would be likely to lose half their habitat. Corals would be 99% lost. There are thousands of other desperate scenarios, across species and landscapes. Beyond “integrated expertise” — a concept unfortunately challenged by leaders of some of the world’s most powerful economies — concerted, immediate action by governments is imperative. Individual action is still crucial, but might not be enough without policies that look beyond the political short term.

In 1987, Earth scientist Wallace Broecker noted in *Nature*: “We play Russian roulette with climate, hoping that the future will hold no unpleasant surprises” (W. S. Broecker *Nature* 328, 123–126; 1987). That narrative of ecological collapse has finally found its audience: as Warde, Robin and Sörlin show, we have progressed since the word environment bubbled into public consciousness. But some still refuse to listen. How can so central a concept retain urgency and impact in the decontextualized online war of words, truth, lies, expertise and its rejection by the march of populism?

As environmental movements past have shown, we need imagination, accuracy, long-term political will — and hope. “The environment is about people, too,” the authors note, “and how they respond to its changes and challenges.” Our relationship to nature goes far beyond resources, amenity or the scientific idea of an archive we learn to read. There are, as *The Environment* shows, ethical complexities in how we use and abuse the planet — and in how we frame its improbable riches. ■

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SPACE SCIENCE

A rock legend retells the race to the Moon — in 3D

Queen guitarist and astrophysicist Brian May’s latest collaboration is a stereoscopic delight, finds **May Chiao**

In 2019, it will be 50 years since the first Moon landing. Almost more remarkable is that no human has touched that surface since Gene Cernan’s lunar stroll during the last of NASA’s Apollo missions in 1972. To celebrate the scale of that programme, writer and editor David Eicher, together with

Brian May — astrophysicist, Queen guitarist and stereoscopic photographer — take us back to the beginning in the spectacular *Mission Moon 3-D*.

On 25 May 1961, President John F. Kennedy declared that the United States would land a man on the Moon and bring him

Mission Moon 3-D: Reliving the Great Space Race

DAVID J. EICHER AND BRIAN MAY
London Stereoscopic Company (2018)

safely back before the decade was out. That ambitious timetable surprised the president’s own science advisers, as well as the US Congress and the rest of the world. Kennedy was spurred by the phenomenal successes of Soviet space exploration. Sputnik 1, launched in 1957, was the first artificial satellite to orbit Earth; and a month before Kennedy issued his challenge, Yuri Gagarin had become the first human in space.

The story of how NASA overtook the Soyuz programme during the cold war has been told many times — in interviews and books and on film. So what do Eicher and May bring to the table?

Primarily, Eicher compares the Soviet ▶

▶ and US space programmes — their successes and failures. This political, cultural and technical context is enriched with information that has come from the cosmonauts themselves in recent years. For example, details of the accidents and deaths that hindered the Soviet lunar programme, from the cosmonauts' point of view, enable Eicher to tell a more complete story. He strikes a fine balance between detail and readability.

But the book is so much more. Its 150 stereo photographs, which can be seen in 3D through a stereo viewer, make it an immersive experience. Since childhood, May has collected stereoscopic devices — a Victorian technology in which two photographs of the same subject (taken a small horizontal distance apart) are displayed side by side. Looking at these through a viewing device, at a certain distance and with eyes 'relaxed', the brain creates the perception of depth, and previously unresolved details jump into focus. The pairs of images that Eicher and May include show everything from cosmonaut Alexei Leonov, the first spacewalker, in 1965, to the *Apollo 12* lunar module *Intrepid* flying insect-like above the Moon's surface in 1969. A hand-held LITE OWL viewer developed by May is included with the book with instructions (see go.nature.com/2ezgyg6). For those struggling to see in 3D, try starting with high-contrast images such as the one of Comet 67P/Churyumov-Gerasimenko.

Stereo photography was not an aim of the Apollo missions. But many sequential photographs were taken — for instance by Stuart Roosa in *Apollo 14* while circling the Moon — which enabled May to assemble several pairs. May and his team also trawled the NASA archives to find serendipitous pairs of photographs or film stills with just the right baseline separation. To illustrate the



A stereoscopic image of US astronaut Gene Cernan next to a lunar rover during an Apollo 17 moonwalk.

Soviet effort, for which no sequential images existed, they had to convert 'mono' photographs into stereo pairs.

As these vivid images remind us, the pace of progress would have been much slower without the fierce competitiveness of the space race. However, the cold-war wall between the two countries made avoidable, sometimes tragic, mistakes inevitable. One chilling example is the *Apollo 1* accident in 1967. During a routine countdown rehearsal, a fire erupted in the craft's main capsule, which contained pure oxygen; astronauts Roger Chaffee, Gus Grissom and Ed White died almost instantly. (Only later was a quick-release hatch added to the design.) Six years before, unbeknown to NASA, trainee cosmonaut Valentin Bondarenko had suffered a similar fate during a test in Moscow. The two superpowers' first cooperative spaceflight would have to wait until 1975.

Mission Moon 3-D devotes significant



space to the ultimate sacrifice made by humans (and animals) in the name of space exploration, underlining the risks of propelling earthlings into an alien environment. Now, NASA, the Russian, Japanese and Chinese space agencies, and the private companies SpaceX and Blue Origin, plan to send humans back to the Moon. Before that happens, any benefits must be weighed carefully against the risks, and the expense. Reaching Mars will demand that several nations work together, with involvement from the public and private sectors. Robotic and telescopic missions cost much less and can reach more-distant planets and moons. But there is no substitute for human experience; and while we wait for another foot to fall on an extraterrestrial landscape, books such as this one give us an inkling of that ultimate thrill. ■

May Chiao is chief editor of *Nature Astronomy*.

TECHNOLOGY

The *Doctor Who* theme and beyond: female pioneers of electronic music

Joanne Baker lauds a paean to the experimentalists of the BBC Radiophonic Workshop.

The history of electronic music usually centres on the men (including Pierre Schaeffer, Olivier Messiaen, Pierre Boulez, Karlheinz Stockhausen and Edgard Varèse) who developed *musique concrète* from recorded everyday sounds in Paris in the mid-twentieth century. Also in those decades, a group of sound engineers — many of them women — were making waves in an old London skating rink.

The BBC Radiophonic Workshop

Synth Remix

93 Feet East, London.

8 November 2018; Touring 8–11 November.

produced effects and theme tunes for the British broadcaster, including iconic sounds for the sci-fi television and radio programmes *Doctor Who* and *The Hitchhiker's Guide to the Galaxy*, using electronic oscillators and tape loops decades before synthesizers were common. That many of

its engineers were women was, and still is, a rarity. Last week, two of them, Daphne Oram and Delia Derbyshire, were celebrated anew in Synth Remix, a concert series of live performances and DJ sets touring Britain.

Oram (1925–2003) co-founded the Radiophonic Workshop. She gained experience in mixing electronics and music during the Second World War while working for the BBC on sound balance for radio broadcasts. During Germany's bombings of London in