James Lovelock in his lab — inventions, notebooks and other materials from which will go on show at the Science Museum in London from 9 April.

EARTH SYSTEMS

No place like home

The newest chapter in James Lovelock's Gaia saga holds out hope, finds **Tim Lenton**.

In *A Rough Ride to the Future*, James Lovelock argues that humans must survive difficult days ahead if their descendants are to become the future saviours of Gaia — the self-regulating Earth system that he conceived nearly 50 years ago. No longer just another species, as he argued in *The Ages of Gaia* (Oxford University Press, 1988), *Homo sapiens* is now “one of the truly important species of the Earth's history”, destined to help Gaia to survive in the face of an ineluctably brightening Sun. The inventor's audacious book is thus part science fact and part science fiction, homily and history lesson.

Lovelock argues that our information-based cultural evolution is now a million times faster than good old natural selection. He traces this remarkable transition back to Thomas Newcomen's invention of the steam engine in 1712. That coal-powered engine's capacity to perform sustained useful work exceeding 1 kilowatt is Lovelock's thermodynamic definition of the start of the Anthropocene — the planetary epoch defined by human transformation. Powered by fossil fuels, the ensuing positive feedbacks have propelled an exponential growth in material flows, human population and information processing.

But human innovation is just the latest in a long line of biological ‘innovations’ that have transformed Earth. For example, roughly 3 billion years ago, photosynthetic bacteria evolved the ability to split water, leading to the build-up of oxygen in Earth's atmosphere. Lovelock argues that this innovative capacity of life was crucial to the making of a world that supported human evolution, is crucial to our reshaping of the planet today, and will be essential for both our survival and Gaia's.

So, how does Lovelock rate our chances of making it through this century? Having heralded the apocalypse in *The Revenge of Gaia* (Allen Lane, 2006) and backed off a bit in *The Vanishing Face of Gaia* (Allen Lane, 2009), here he tries to shut the stable door after the horse (climate change) has bolted. He sees no prospect of us collectively reducing carbon dioxide emissions, and has nothing good to say here about geoengineering.

A Rough Ride to the Future: The Next Evolution of Gaia
JAMES LOVELOCK
Allen Lane: 2014.

That leaves adaptation as the only option.

Lovelock pictures most of us retreating to high-tech cities protected from the ravages of climate change by air conditioning — if we can afford it. He sees a glimmer of hope that a dwindling supply of cheap fossil-fuel energy may be slowing our exponential growth in material consumption. Meanwhile, to power those high-tech cities, he remains a consistent fan of nuclear power and even shows a soft spot for natural gas, while continuing to critique the weak and intermittent supply of wind energy. He fails to discuss solar power, perhaps because he sees an unlimited supply of renewable energy as a great danger to us and to the planet — we are, collectively, still too immature to handle it wisely.

Lovelock sees us as tribal carnivores, doomed to bumble around in the technological world we have created. But at long last he seems to be conceding that we might grow culturally to the point of becoming a constructive part of Gaia. This is the heart of the book — the vision of a teleological future Gaia, filled with foresight and purpose to survive, thanks to the consciousness bestowed on her by humanity. For example, we can consciously intervene to protect Gaia from future asteroid impacts. The irony here

is that teleology is exactly what Lovelock had to purge from his original Gaia hypothesis to satisfy his scientific critics. They may well squirm at the sight of “Gaia’s goal” returning.

The reason Gaia needs our help, Lovelock argues, is that the unconscious negative-feedback mechanism that has so far kept the planet cool is destined to fail. Up to now, the Sun’s brightening, which tends to warm Earth, has been counteracted by accelerated weathering of the continents, which has decreased CO₂ levels in the atmosphere. But before we started boosting it, the CO₂ concentration was getting close to the lower limit for photosynthesis. Hence there is a need for either some other cooling mechanism, or a more heat-tolerant intelligent life form.

Lovelock tentatively speculates on what such creations might look like. First he imagines us symbiotically merging with electronic components to form a world of cyborgs, using biological and artificial intelligence to sense and regulate the planet’s state. Eventually he sees wet organic life having to be replaced by dry electronic life that is better able to cope with an over-hot Sun. He even imagines such artificial life forms ‘evolving’ much faster than us, because information is transferred much faster by electronics than by neurons.

This is a popular science book. Yet it does reveal something about how the author’s remarkable mind works — making intuitive leaps between topics that most of us would not think to connect. One moment he is dwelling autobiographically on the cultural environment that fostered his own inventiveness, the next he is considering how invention accelerated the evolution of life. The leaps are so great that at times even Lovelock seems unsure where his argument is going. But this is strangely appropriate when the subject is the long-term future.

A Rough Ride to the Future is a more optimistic book than its two predecessors, although Lovelock still thinks that there will be a massive drop in human population — by means that remain unclear. What he seems to be doing, perhaps unwittingly, is creating a belief system to help us through the difficulties ahead. There is a sense here that Lovelock has been to the mountain top, looked over, and seen a promised land. Now almost 95, he may not get there with us, but he wishes humanity and Gaia an exciting future together. ■

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PSYCHOLOGY

The clamorous mind

Susanne Ahmari reviews a personal and scientific journey through obsessive-compulsive disorder.

The adage that you can’t judge a book by its cover fails with David Adam’s *The Man Who Couldn’t Stop*. The title is scrawled repeatedly in urgent letters, thrusting us into the mindset of someone suffering a near-constant barrage of intrusive thoughts — the manifestation of obsessive-compulsive disorder (OCD) that is the book’s topic. In the pages that follow, Adam, editor of *Nature*’s Editorials section, leads us on an insider’s tour of the OCD brain, providing insight into the cultural and scientific evolution of how we view and treat a disorder that affects up to 3% of people worldwide.

Adam’s book is equal parts historical journey, scientific discussion and stark personal memoir of his battle with often shocking thoughts that come out of nowhere, the symptom of OCD that he describes as “a snowflake that fell from the summer sky”. A common example of such thoughts is the fear of harming someone else despite having no intent or desire to do so. For Adam, they took the form of fears that he had accidentally contracted HIV. Although his book pays homage to earlier works, including Judith Rapoport’s iconic *The Boy Who Couldn’t Stop Washing* (E. P. Dutton, 1989), it has a unique voice born of first-hand observations of Adam’s own changing mental processes, and his expertise as a science writer.

Although his historical anecdotes are informative and entertaining, Adam is at his best when linking the evolution of his illness with possible scientific explanations. Current theories suggest that OCD stems from abnormal communication in the brain between cortical areas involved in higher-order cognition — such as reward-based decision-making — and basal ganglia structures important for selecting actions. Human studies suggest that genetic and environmental factors contribute to this disruption. However, despite intensive efforts, it has been difficult to nail down specific genetic culprits, and the role of environmental factors, such as childhood infection with streptococcus, is unclear

The Man Who Couldn't Stop: OCD, and the True Story of a Life Lost in Thought
DAVID ADAM
Picador: 2014.

and controversial.

Accounts from sufferers may provide hints about how OCD evolves. In a particularly evocative story, Adam describes his attempts to combat the barrage of unwelcome thoughts about HIV by repeatedly calling the UK National AIDS hotline to check whether he was at risk. No matter how many times he called, disguising

his voice to avoid recognition, he was only briefly reassured. He notes, “They would tell me that they had already given me an answer and that I needed to accept it. I didn’t want that. I wanted the hit.” This comparison between taking an addictive drug and seeking reassurance highlights important potential research avenues for neuroscientists trying to understand how inexorable cycles of obsessions and compulsions are initiated and maintained.

As Adam himself points out, the ending of the book is a little unsatisfying. There is no dramatic revelation of the root of his illness, no ‘eureka’ moment when scientists discover the cause of obsessions. His OCD gets significantly better with a lot of hard work, serotonin-reuptake inhibitors, exposure therapy with response prevention, and continuous vigilance, but intrusive thoughts linger in the background even

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