



# responsible science

Issue No. 1  
Winter 2019

The journal of Scientists for Global Responsibility (SGR)

A membership organisation promoting responsible science and technology  
Part of the campaign awarded the 2017 Nobel Peace Prize.

## **An alarmist's guide to climate change**

Bill McGuire

## **Lethal and autonomous – coming to a sky near you**

Peter Burt

## **The psychology of cutting plastic pollution**

Jan Maskell

## **News from SGR**

Nuclear weapons campaigning

Science4Society Week 2019

One Planet – One Life

Obituary: Stephen Hawking

**FOCUS  
ON AI**



## Contents

Editorial ..... 1

### News from SGR

Nuclear weapons campaigning ..... 2  
 Climate roundup ..... 2  
 Science4Society Week 2019 ..... 2  
 Ethical careers activities ..... 3  
 New report shows artificial intelligence in dim light ..... 3  
 Military science activities ..... 3  
 One Planet – One Life: new SGR project ..... 3  
 Obituary: Stephen Hawking ..... 4  
 The new National Co-ordinating Committee ..... 4

### Letters

Air pollution ..... 4

### Features

CLIMATE CHANGE

An alarmist’s guide to climate change ..... 5  
 Cars and climate change: the need for more ambition ..... 7

FOCUS ON AI

Lethal and autonomous: coming soon to a sky near you ..... 8  
 Prospects of robotic warfare are chilling but recognised ..... 10  
 We need to talk about driverless cars ..... 12  
 Is artificial intelligence putting the world on steroids? ..... 13

SECURITY

Defence diversification: international learning for Trident jobs ..... 14  
 Unaffordable and unachievable: the continuing problems of Trident renewal ..... 16

ENVIRONMENT

The fall of fracking? ..... 18  
 The psychology of cutting plastic pollution ..... 19

MARTIN RYLE

A man ahead of his time – How Martin Ryle saw the future of energy ..... 20  
 Martin Ryle, war and peace ..... 20

### Book review

Drawdown: the most comprehensive plan ever proposed to reverse global warming ..... 22

### Events

SGR Conference: Artificial intelligence: how little has to go wrong? ..... 23  
 The 2018 Martin Ryle Lecture: Research and the public good ..... 24  
 Join SGR ..... 25





## Editorial

Welcome to *Responsible Science*, SGR's new journal in which we will explore some of the biggest ethical challenges facing science and technology today. We'll also keep you up to date with what we're doing, as an independent, membership organisation made up of hundreds of natural scientists, social scientists, engineers, IT professionals, architects and more. You'll read about our work to promote responsible science, design and technology, as well as debates happening more broadly.

In this issue, for example, you can find out why it is rational to be an 'alarmist' where climatic upheaval in a piece specially commissioned for this journal from the world leading expert on climate and geo hazards, Prof Bill McGuire. His article comes in the wake of the most recent report from the Intergovernmental Panel on Climate Change (IPCC) which focused on the new consensus that global warming must be limited to 1.5°C.

To do that, argued the IPCC, will require 'rapid, far-reaching and unprecedented changes in all aspects of society'. Especially in the relatively wealthy, high consuming parts of the world, what we eat, the energy we use and the scale of what we consume will all need to change, and quickly. It was striking too, that at the last international climate talks held in Katowice, Poland, the four states guilty of obstructing progress and general levels of ambition were the United States, Saudi Arabia, Kuwait and Russia – all either major military manufactures or buyers of arms. You can read Barnaby Pace in this issue, writing on behalf of the Nuclear Education Trust, on the need for diversification away from economic dependence on the nuclear arms industry.

Turning concern into action, in response to pressing climate issues, SGR has become a founder member of the Rapid Transition Alliance, a new international initiative created to accelerate action to halt climate breakdown. In keeping with that sentiment, Prof John Whitelegg, argues for more ambition in changing our transport system, and that major reductions in vehicle pollution are only achievable if we set our sights beyond the techno-fix of electric cars.

Elsewhere, you can find Dr Jan Maskell's thoughts on another issue which has been dominating headlines, the psychology of cutting plastic pollution. What made an issue that has been pressing for decades suddenly become a cause celebre?

But a major focus of this issue of *Responsible Science* is the role and many challenges raised by artificial intelligence (AI). Once again the role of the military in technological development comes up. Both Dr Peter Burt and Prof John Finney go into detail on the threats posed by the military appropriation of artificial intelligence, and look at what must be done to prevent the 'morally repugnant' prospect of machines with the power and discretion to take human life. The UK's role in developing the technology for autonomous weaponry is also exposed.

With the threat from nuclear weapons again increasing – not least due to the planned US withdrawal from the Intermediate-range Nuclear Forces (INF) treaty – Dr Philip Webber and Dr Stuart Parkinson critically examine the UK Trident programme. In particular, they highlight how government spending watchdogs have labelled the scheme 'unachievable'.

Much is happening and there is much to read about it and still more to be done. SGR is only one very small player amid these era-defining issues. Nevertheless we are determined to do all we can to make the maximum, positive contribution to the changes that need to happen, and to promote responsible science being at the heart of all these issues. You may notice from the new look of our journal that we have changed ourselves too. We know it is important to communicate on what we care about as clearly as possible. For that reason we are updating several of the things we do, including even our look so that we can do it as well as possible. We hope you like it, and that you enjoy this first edition of our new journal. We are our members, so we also hope you will become a member if you are not already (see join form on p. 25), and if you are a member that you will recommend that others join too. Together we will be stronger and a greater force for promoting responsible science.

**Andrew Simms**  
Assistant Director, SGR



# News from SGR

## Nuclear weapons campaigning

International tensions over nuclear weapons have again grown in recent months – and SGR has continued to work with other organisations to get the disarmament message out more widely.

Among the most disturbing developments is the USA's announcement that it will withdraw from the Intermediate-range Nuclear Forces (INF) Treaty. This treaty has been a cornerstone of arms control since 1987 – banning a whole class of nuclear weapons – thus helping to end the Cold War. SGR has been a signatory of open letters and statements calling for the US government not to withdraw and for the UK government to do more to shore up the treaty. One of the letters appeared in *The Guardian*. We also submitted a response to a House of Lords inquiry into the issue. There continues to be an urgent need to shore up nuclear arms control, as the USA and Russia especially are showing little interest in preserving existing agreements.



SGR staff and members have also taken part in protests at key UK nuclear facilities. On Hiroshima Day in August, we joined local CND campaigners at BAE Systems in Barrow, where the new Dreadnought submarines are being built. In September, we joined international campaigners at the 'Nae Nukes' demonstration outside the Faslane naval base near Glasgow, where British nuclear-armed submarines are based. A key message promoted by these activities was the need to support the 2017 UN nuclear ban treaty. Although the UK government continues to resist this treaty, 70 nations have now signed it, with ratifications growing too.

SGR has also been very active in raising awareness of the nuclear weapons threat by using the internet, especially our website and social media. As an indication of the level of interest in our work, our reports on nuclear weapons have been viewed over 5,500 times in the last six months.

## Climate round-up

Fossil fuel companies continue to promote their public image through sponsoring major cultural institutions ranging from the arts to, even more controversially, science museums. When Manchester Museum of Science and Industry accepted sponsorship from the oil company Shell for its exhibition,

"Electricity: the spark of life", SGR joined tens of thousands of others in signing a petition for the museum to drop Shell as a sponsor. In response to concerns raised several organisations, including the Manchester-based group Carbon Coop, pulled out of events due to be held at the museum. As part of the campaign against fossil fuel sponsorship coordinated by the group Culture Unstained, a formal complaint, also supported by SGR, was lodged previously with the London-based Science Museum over its partnering with BP, Shell and Statoil, which, said the complaint was, 'undermining its integrity as a scientific institution'.

Fracking is still in the headlines as the faltering progress of fossil fuel companies like Cuadrilla, at their flagship drilling site at Preston New Road in Lancashire, creeps forward. Measures imposed by the Environment Agency means that works has been repeatedly stopped due to seismic activity linked to the fracking activities. Apart from local impacts, fracking is heavily criticised for being incompatible the UK's climate obligations. For a fuller update see the feature article on p.18.

Publication of the IPCC's landmark report on keeping global warming below 1.5°C led to calls for much greater ambition on climate action. In response SGR has become a founder member of a new, international campaign to accelerate action. Read about the Rapid Transition Alliance in our feature on 'An Alarmist's Guide to Climate Change'.

## Science4Society Week 2019



As usual, SGR's Science4Society (S4S) Week will be running in late March, this year from 9<sup>th</sup> to 17<sup>th</sup>. Dozens of teaching resources can be downloaded free from our dedicated website – [www.s4s.org.uk](http://www.s4s.org.uk) – so please do help us to publicise these to any science teachers you know.

In advance of the week, co-ordinator Jan Maskell presented some of our material at the annual conference of the Association for Science Education in January. She promoted our competition – this year run jointly with the ASE – in a workshop called 'What do you want to do when you grow up?' The competition encourages students to consider their motivation for doing work that makes a difference, what is a globally responsible career, and what are the issues people want to address in their work? The competition deadline is 1<sup>st</sup> March 2019 and the details are available at [www.s4s.org.uk/competition](http://www.s4s.org.uk/competition)

She also presented a new S4S resource 'Rewriting the Headlines' in a session titled 'Chocolate is Good for you! Official'. The resource helps students critically assess the accuracy of the media reporting of science. Using recent headlines and articles, students explore how research is translated from specialist areas to the media coverage we read every day. Then they rewrite the headlines.

In the session 'Play the Food Game' the carbon and water footprints and nutritional values of the food we eat were explored. Science4Society's food cards – one of our free, downloadable resources – were used to play versions of the

food game. These activities helped participants understand what foods would form a low carbon and nutritious meal.

## Ethical careers activities

In summer 2018, SGR was awarded a grant from the Martin Ryle Trust for a feasibility study which aims to determine:

- key environmental and other ethical career options for science, design and technology professionals, together with their current level of availability in the UK;
- the extent of existing, readily available information about ethical career options, together with the format in which it is presented;
- the most appropriate methods of communicating ethical careers information to young people and students of all ages;
- the extent of staff, finance and other resources that would be needed to produce suitable new materials and effectively disseminate them, as the basis of a new SGR project in this area.

The study so far has included extensive desk research as well as interviews, meetings, a survey and focus groups. A draft report was due to be completed as we went to press. The project researcher was Jan Maskell.

## New report shows artificial intelligence in a dim light



In a new briefing on the challenges of artificial intelligence, which included a poll of SGR's membership, over 80% believed that there is a medium to high chance of things going badly wrong. The briefing, *'Artificial intelligence: how little has to go wrong? Autonomous weapons, driverless cars and friendly spies in the home'*, published to coincide with SGR's annual conference, explores a range of both obvious and more subtle threats and raises stark warnings from

across scientific disciplines. Questions posed include whether artificial intelligence is evolving quicker than the regulation to manage it, and whether it can even be effectively regulated. It also asked whether we are sufficiently able to imagine what major problems may yet emerge.

In response to the poll, 96 percent said that they believed AI needs more regulation, and 82% lacked confidence that under current circumstances AI could be harnessed for in a way to produce net benefits for society, saying that AI was most likely to create a dystopian rather than a utopian future. The feature article on p.13 gives a more detailed summary, including details of how to get a copy of the full report.

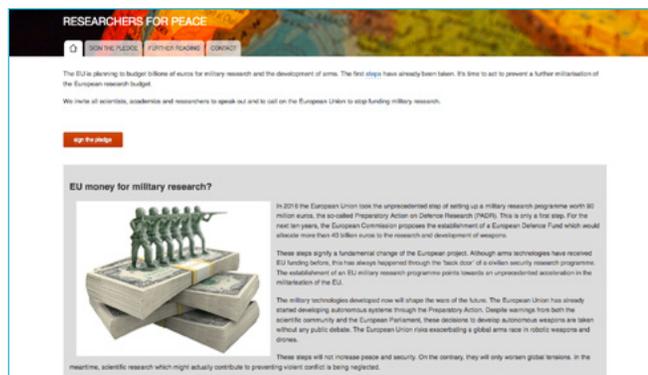
## Military science activities

SGR continued to be very active on the issue of military influence on science.

Our joint campaign with other European peace organisations against a new €13 billion EU fund for military R&D gathered

pace. Over 1,000 researchers have now signed the *Researchers for Peace* statement opposing the new fund.

In addition, over 170 academics signed an open letter calling for R&D which contributes to autonomous weapons to be excluded from EU research funding. 42 civil society organisations from across Europe also signed a public statement opposing the fund. Our activities received a good deal of media coverage, including in *Science* magazine, *Times Higher Education*, *EU Observer*, *Huffington Post UK* and *Science Business*. If you haven't yet signed the RfP statement, you can do so at: <https://www.researchersforpeace.eu/>



SGR has continued to work with campaigners on armed drones and autonomous weapons, inputting to a new report by Drone Wars UK (see p.8) and signing an NGO statement delivered at the UN. Numerous SGR members also signed an international pledge not to work on research on autonomous weapons, organised by the US-based Future of Life Institute. These activities complemented SGR's conference and report on the risks of artificial intelligence – see p. 22.

Stuart Parkinson has given two presentations on military science issues in recent months – at CND's Future Wars conference in London and an event for local peace campaigners at Leeds Beckett University. He also had an article published in *Laboratory News*, contrasting international military spending with funding to tackle climate change.

To mark the centenary of the end of World War I in November, SGR had a stall at a national peace fair. In addition, an article from the *SGR Newsletter* (No. 44) summarising how WWI accelerated the industrialisation of war became the most popular page on our website in the last six months of 2018, with about 4,300 visits.

SGR also input to a new report on arms conversion published by the Nuclear Education Trust – see article on p. 14.

## One Planet – One Life: new SGR project

SGR has recently been successful in its application for funding from Ørsted's Walney Extension Community Fund for an education project called 'One Planet – One Life'. This will be run for two years in secondary schools in a designated beneficiary area across Lancashire and Cumbria.

'One Planet – One Life' is a workshop event designed for students in Years 7-9 (aged 12-14). It will engage young people in thinking about alternative and sustainable ways of living and raise awareness of the role of individuals in contributing to and preventing climate change.

From the workshop, participants will be able to understand:

- the impact of individuals on the planet

- the idea of carbon footprints
- the components of their own carbon footprints
- the importance of behavioural choices

Ideas about reducing carbon emissions and different ways of living are woven together with discussion of personal values and what change means for individuals. Through a relaxed and relatively structured workshop approach, participants will experience a variety of exercises, games and discussions.

The students will be expected to run a small project of their own design prompted by the content of the workshop. This could be within their school, for their peers, in their families or for the wider community. These will demonstrate the impact of 'One Planet – One Life' workshops.

The project is co-ordinated by Jan Maskell. For more information, see: <http://www.sgr.org.uk/projects/one-planet-one-life-about>

## OBITUARY

### Stephen Hawking, 1942–2018



Photo: Rogelio A. Galaviz C. via Flickr

Most people now will be aware that Stephen Hawking, world famous physicist, died in March last year, at the age of 76. Stephen had been a patron of SGR since its formation in 1992, and of its predecessor Scientists Against Nuclear Arms.

Although he will be most remembered for his contribution to research in astrophysics and cosmology, and for popularising the subjects, Stephen also regularly warned about how the misuse of science and technology could endanger human civilisation and our environment. For example, in 2006, he said, "Life on Earth is at the ever-increasing risk of being wiped out by a disaster, such as sudden global warming, nuclear war, a genetically engineered virus or other dangers we have not yet thought of."<sup>1</sup>

He was especially supportive of SGR's work on nuclear disarmament and our opposition to the renewal of the UK's Trident nuclear weapons system. In 2007, he said, "Nuclear war remains the greatest danger to the survival of the human race. To replace Trident would make it more difficult to get arms reduction and increase the risk."<sup>2</sup> In 2016, he co-signed an SGR open letter from leading scientists and engineers calling on MPs to vote against Trident renewal.<sup>3</sup>

Stephen studied physics at Oxford University. At the age of 21, he was diagnosed with motor neurone disease, and expected to live for only two more years. However, the disease was of a form which progressed more slowly, hence his unusual longevity. Despite his health issues, he pursued academic work vigorously. His innovative research in mathematics and physics led to important breakthroughs in the understanding of black holes and the Big Bang. He became Lucasian professor of mathematics at the University of Cambridge – a post previously held by Isaac Newton and Charles Babbage – at the young age of 37.

However, it was the publication of his popular science book, *A Brief History of Time*, in 1988 that propelled him to fame. It went on to sell 10 million copies, entering the Guinness Book of Records for the length of time it spent on the best-sellers list.

He won a string of scientific accolades, including the Albert Einstein award, the Wolf prize, the Copley medal, and the Fundamental Physics prize. He also received the UK Companion of Honour, and the US Presidential Medal of Freedom.

In a media release issued at the time of his death, Stuart Parkinson, Executive Director of SGR, said "Prof Hawking cared deeply about the future of humanity and the responsible use of science and technology. One of his key concerns was the threat from nuclear weapons. We will miss his support and send our deepest condolences to his family."

<sup>1</sup> Washington Post (2006). [http://www.washingtonpost.com/wp-dyn/content/article/2006/06/13/AR2006061301185\\_pf.html](http://www.washingtonpost.com/wp-dyn/content/article/2006/06/13/AR2006061301185_pf.html)

<sup>2</sup> The Independent (2007). <http://www.independent.co.uk/news/uk/politics/not-in-our-name-campaign-launched-against-trident-436428.html>

<sup>3</sup> SGR (2016). <http://www.sgr.org.uk/resources/stephen-hawking-and-other-leading-scientists-urge-mps-vote-against-trident-renewal>

## The new National Co-ordinating Committee

The election for SGR's National Co-ordinating Committee for the coming year was held during the Annual General Meeting on 3 November 2018 (see report on p. 23). The following were elected:

**Chair:** Dr Philip Webber

**Vice-chair:** Dr Jan Maskell CPsychol

**Treasurer:** Alasdair Beal CEng

**Secretary:** Martin Bassant MPhil

**Committee members:** Steve Ballard; Dr David Hookes; Dr Paul Marchant CStat; Simon Reed

## READER'S LETTER

In the feature article entitled 'Air pollution: one of the greatest hazards of our times' (*SGR Newsletter*, no.46, pp.15/16), I was surprised to note that the only mention of air pollution from cigarette smoke was in Reference 5. I'd like to point out that the ban on smoking in public places – inaugurated in Wales – and discouragement of 'lighting up' in homes, has had a favourable influence upon inhalation of fumes by those in close proximity to smokers. I can remember the time when buildings such as public houses and community venues were smoke-filled to the extent of creating a very hazy atmosphere. I also recall visitors to my home taking for granted that no permission for this needed to be sought from the householder. Another unfavourable experience was being subjected to wafts of smoke as a regular occurrence in the working place (this was an Inland Revenue office), not just at breaktimes.

Having quite recently moved to a small town from the countryside, I am shocked to observe a large number of smokers in the area where I live, from young people waiting to catch the school bus, to mothers with infants, to older men and women. But I guess that it's better this way than chain-smoking in their houses – if they don't do it there as well.

Margaret Hunt, Swindon



# An alarmist's guide to climate change

Feedbacks and tipping points are being dangerously downplayed in the climate debate, argues Prof Bill McGuire. It's time for some healthy and realistic alarmism

**H**ave you noticed how the term 'alarmist' has been hijacked? In the context of climate breakdown, habitat and wildlife loss and other environmental issues, it has become synonymous with scaremongering; with the voice of doom. In certain circles it is frowned upon and judged to be a hindrance to getting the global warming message across. Iconic broadcaster David Attenborough is the latest to express the view that 'alarmism' in the context of the environment can be a 'turn-off' rather than a call to action. But are such viewpoints justified, especially when our world and our society teeter on the edge of catastrophe? After all, the simplest, most straightforward, meaning of an 'alarmist' is someone who raises the alarm. Is this not what we need now more than ever; to be told the whole story – warts and all? The alternative, it seems to me, is to play down the seriousness of our predicament; to send a message that is incomplete, and to conveniently avoid or marginalise predictions and forecasts that paint a picture regarded as too bleak for general consumption. Surely, this is the last thing we need at this critical time?

No-one could ever accuse the Intergovernmental Panel on Climate Change (IPCC) of being alarmist. Because every sentence of IPCC report drafts is pored over by representatives of national governments – some of whom are lukewarm or even antagonistic to the whole idea of climate change – the final versions are inevitably conservative. The closest the IPCC has come to sounding an alarm bell can be found in its latest report *Global Warming of 1.5°C*, published in October. Here it warns that emissions must be slashed within 12 years (by 2030) if there is to be any chance whatsoever of keeping the global average temperature rise (since pre-industrial times) below 1.5°C, and fall to zero by 2050.

Notwithstanding the unlikelihood of achieving net zero global emissions in a little more than three decades, the pace and degree of climate change are about more than just anthropogenic emissions. They are also influenced by tipping points and positive feedback loops; sudden changes in the behaviour of ice sheets, carbon sources and sinks, and ocean currents, which can accelerate warming and its consequences way beyond the expected. Depressingly, but perhaps not surprisingly, the latest IPCC report's *Summary for Policymakers*<sup>1</sup> – let's face it, the only bit likely to be read by the movers and shakers – includes just

one brief mention of feedbacks and has nothing at all to say about tipping points. The justification for this appears to be that because it is not possible to assign levels of confidence to such known unknowns, they cannot be included. But it is difficult not to conclude that the real reason is to tone down the threat in order to appease those governments that view climate change as a nuisance that they would like to go away.

The decision to bury concerns over tipping points and feedbacks in the depths of the full report rather than flagging them in the Summary is nonsensical. Touting the critical importance of drastic action while at the same time soft peddling the threat has the potential to backfire, providing the obvious get out: well, if the situation is not so bad, maybe the response doesn't need to be that urgent. If drastic, life-changing, action is being mooted, people need to know – have a right to know – why. They need to be presented with a complete picture showing how bad things might get – however scary or poorly constrained.

Bringing the potential consequences of tipping points and feedbacks into the equation inevitably transforms perceptions of the dangers we face. Suddenly, climate change ceases to be something vaguely inconvenient that we can leave future generations to deal with. Instead, it becomes far more of an immediate threat capable of tearing our world apart. Take sea level, for example. The IPCC's 5<sup>th</sup> Assessment Report,<sup>2</sup> published in 2013 and 2014, predicts – for a worst case scenario – that global mean sea level could be about a metre higher by the end of the century. Bad enough for millions of coastal dwellers, but nothing compared to what our descendants might experience if a tipping point is crossed that sees the Greenland and/or West Antarctic ice sheets start to disintegrate in earnest. Models that do incorporate this, point to sea level rising far more rapidly. One suggests that the ice loss in Antarctica could occur at a much faster rate than expected, leading to global average sea level being more than 3m higher at the end of the century.<sup>3</sup> Another, based upon correlations between temperature and sea levels during the last interglacial, which ended around 115,000 years ago, proposes that sea level – in theory at least – could climb by as much as 5m by 2100.<sup>4</sup>

Worrying evidence that we might be at a tipping point in Antarctica comes from a very recent study on the rate of ice

## CLIMATE CHANGE

loss from 2012 to 2017. During this five-year period, Antarctic ice loss shot up threefold, from 76 billion tonnes annually, to a colossal 219 billion tonnes.<sup>5</sup> In total, more than 2.7 trillion tonnes of Antarctic ice has melted in the last quarter century, adding three quarters of a centimetre to global sea level. At the new rate, the contribution over the next 25 years would be 1.5cm. Not enough to worry about in its own right. If, however, the rate of increase is maintained over this period, then the annual rise by 2043 would be close to a catastrophic five centimetres a year. And this is without the growing contribution from Greenland and from the increasing expansion of sea water as the oceans warm.

And there are other causes for serious concern too. None more so than the behaviour of the Gulf Stream and associated currents (together making up the AMOC – Atlantic Meridional Overturning Circulation) that warm north-west Europe and also have a big influence on global weather patterns. In the distant past, surges of meltwater from shrinking ice sheets have caused the Gulf Stream to shut down. Now, it looks as if it might be in danger of doing so again as huge volumes of freshwater from the crumbling Greenland Ice Sheet pour into the North Atlantic, forming a so-called ‘cold blob’.

The IPCC’s official line is that another complete shutdown is ‘very unlikely’, but this is not the same as ruling it out. And there are certainly some worrying signs. The Gulf Stream has slowed by 15 – 20 percent since the middle of the 20th century and is now at its weakest for at least 1600 years.<sup>6</sup> The Gulf Stream has a tipping point, and – evidence from the past shows – can shut down in just a few years when this is crossed. The problem is that no-one knows when – or even if – this will happen. If it does, the ramifications will be sudden and widespread. The North Atlantic region will cool dramatically, particularly across the UK, Iceland and North West Europe, while sea ice will expand southwards (without, it should be emphasised, counteracting the trajectory of climate change). Sea-levels along the eastern seaboard of North America could rise at three to four times the global average rate. Further afield, changes to weather patterns

are forecast to include a weakening of Indian and East Asian monsoons, which could have devastating consequences for crop yields. No-one is saying that the Gulf Stream is in imminent danger of collapse. Nonetheless, the threat is not insignificant, and as such should be soberly touted, not wilfully ignored.

Of the many and varied feedback loops and tipping points linked with rapid anthropogenic warming, perhaps the most disquieting involves the vast tracts of permafrost at high latitudes – both on land and beneath the sea. Trapped beneath this frozen crust are colossal quantities of methane, a greenhouse gas that has a warming effect 86 times greater than carbon dioxide. Fortunately, methane has a relatively short residence time in the atmosphere and breaks down to carbon dioxide within a few decades. Nonetheless, major outbursts of methane from the rapidly thawing permafrost are capable of causing climate mayhem with little or no warning. The geographic region of most concern is probably the submarine permafrost that floors the East Siberian Continental Shelf, where an estimated 1400 billion tonnes of carbon, in the form of methane, is lurking beneath a frozen carapace that is thawing rapidly.

According to Natalia Shakhova and colleagues,<sup>7</sup> as much as 50 billion tonnes of this is available for sudden release at any time, which would – at a stroke – hike the methane content of the atmosphere 12 times. According to a study published in 2013,<sup>8</sup> a discrete methane ‘burp’ on this scale, could advance global warming by 30 years and cost the global economy USD60 trillion – a figure close to four times the US national debt. Once again, the occurrence of such an outburst is far from a certainty and there are other issues to consider, including how much methane is absorbed by the ocean as it bubbles upwards. Notwithstanding this, there is a potential danger here that needs to be promulgated rather than hidden away, so that the scale of the climate change threat is clear to everyone.

So – to conclude – be alarmed; be very alarmed. But don’t let alarm feed inertia. Use it instead to galvanise action. For your children’s and their children’s sake, stand up and do something about it. Drastically change your lifestyle; become an activist; vote into power a government that will walk the walk on climate change, not just talk the talk. Or – preferably – all three.

*Bill McGuire is Professor Emeritus of Geophysical & Climate Hazards at UCL and a co-director of the New Weather Institute. His current book is Waking the Giant: how a changing climate triggers earthquakes, tsunamis and volcanoes.*

### References

- 1 IPCC (2018). Global Warming of 1.5°C. Summary for Policymakers. [http://report.ipcc.ch/sr15/pdf/sr15\\_spm\\_final.pdf](http://report.ipcc.ch/sr15/pdf/sr15_spm_final.pdf)
- 2 IPCC 2013-14 5th Assessment Report. <http://ipcc.ch/report/ar5/>
- 3 Le Bars, D. et al. (2017). A high-end sea-level rise probabilistic projection including rapid Antarctic Ice Sheet mass loss. *Environmental Research Letters* 12.
- 4 Hansen, J. et al. (2016). Ice melt, sea level rise and superstorms: evidence from paleoclimate data, climate modeling, and modern observations that 2 °C global warming could be dangerous. *Atmos. Chem. Phys.*, 16, 3761-3812.
- 5 The IMBIE Team (2018). Mass balance of the Antarctic Ice Sheet 1992–2017. *Nature*, 558, 219–222.
- 6 Caesar, L. et al. (2018). Observed fingerprint of a weakening Atlantic Ocean overturning circulation. *Nature* 556, 191–196.
- 7 Shakhova N. E. (2008). Anomalies of methane in the atmosphere over the East Siberian shelf. *Geophysical Research Abstracts* 10, EGU2008-A-01526. Abstract.
- 8 Whiteman, G., Hope, C. and P. Wadhams (2013). Vast costs of Arctic change. *Nature* 499, 401–403.



**Rapid  
Transition  
Alliance**

**The new Rapid Transition  
Alliance wants your stories of  
how change happens quickly**

The climate crisis, and the new consensus that warming must be kept below a 1.5°C temperature rise, calls for a new speed and scale of change. The Rapid Transition Alliance, of which Scientists for Global Responsibility is a founding member, was formed to help make that happen. It was launched at the House of Commons in London in December 2018 on the opening day of international climate talks happening simultaneously in Katowice, Poland.

The Alliance is a unique, international grouping of organisations committed to rapid transitions to avert climate breakdown. Members’ organisations range from those specialising in research, policy development, practical work in communities and campaigning. Their combined expertise ranges from economics, to finance, ecology, energy, technology and much more.

One of the biggest obstacles to rapid transition is people’s belief that it is really possible. The alliance is finding evidence based hope for a warming world. These are stories of change from today and in the past that show how rapid transitions can happen. That means quantifiable changes in our values, behaviours, attitudes, and use of resources, energy, technology, finance and infrastructure that can happen and guide what we do over the next five to ten years. Do you know an example that people can learn from? If so, go to [www.rapidtransition.org](http://www.rapidtransition.org) and fill out a simple form to share your story.

# Cars and climate change: the need for more ambition

Prof John Whitelegg, Liverpool John Moores University, argues that major reductions in transport pollution are only achievable if we set our sights beyond electric vehicles and driverless cars.

In the recent Budget, the UK government announced huge spending of £29 billion for roads.<sup>1</sup> This comes on the back of a recent rise in the greenhouse gas (GHG) emissions of UK cars – in contrast to falling emissions in most other sectors of the economy.<sup>2</sup> It is clear that the government does not take the issue of pollution from cars seriously enough.

Decarbonising passenger road transport has been heavily researched especially in Sweden under the ‘Fossil Fuel Free’ policy discussion and in Germany in many publications by the Wuppertal Institute for Climate, Energy and the Environment. The conclusion from such work is that there is no significant technical or financial problem in totally decarbonising land transport. While the focus of UK government policies tends to be on improving vehicle efficiency – at which it is not doing well – there are actually larger gains to be made from ‘modal shift’ – a wholesale move away from car transport. The problem is a lack of will on the part of politicians to try to implement ‘joined-up’ policies that have a proven impact on reducing GHGs from the transport sector. The measures and interventions that will reduce GHG emissions from cars by 100% were set out in a report which I co-wrote for the Stockholm Environment Institute back in 2010.<sup>3</sup>

Despite this evidence, the UK’s central and local government continue to push forward with extensive road-building projects. Most local authorities are implementing or have recently implemented road schemes, including the Hereford Western Bypass, the Heysham M6 Link Road, the Shrewsbury North West Relief Road and the Port of Liverpool Access Road. These will increase traffic volumes and GHG emissions – as demonstrated by the robust scientific evidence presented in the 1994 SACTRA report which concluded that new roads generate new traffic.<sup>4</sup>

The UK is remarkable in its dismissal of best practice in decarbonising land transport, including cars. The performance of the city of Freiburg in southern Germany is a compelling example of what can be achieved. Through a consistent, funded, co-ordinated transport strategy over at least three decades, Freiburg has reduced car use to 21% of all trips every day and increased bike use to 34% (see figure 1).<sup>5</sup> In a typical UK city – e.g. Liverpool – approximately 2% of all trips every day are by bike and approximately 55% by car. Fundamental GHG reduction in the transport sector can only be achieved by modal shift away from the car on the scale already achieved in Freiburg and many other German, Dutch, Swedish and Danish cities.

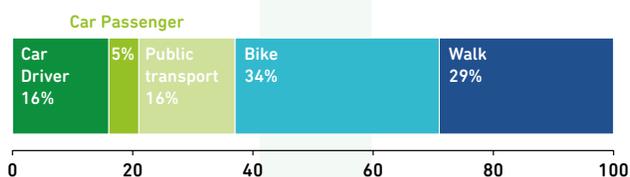


Figure 1 – % breakdown of journeys in Freiburg by transport mode, 2016

It is also important to question some of the perspectives commonly presented in this area<sup>6</sup> – especially related to the costs of driving, driverless cars and electric vehicles:

- Cars “are often cheaper than public transport”. This is not the case although it is a generally held perception. The total cost of travel by car includes obvious things like fuel but also includes less obvious things that need to be replaced at intervals depending on use, e.g. tyres, brakes, exhaust systems. When all costs that vary by distance travelled are included, a car trip is more expensive than a bus trip.<sup>7</sup> In addition, there is a large literature on externalities. Who is paying for the costs generated by the driver but not paid for by the driver, e.g. damage from GHG emissions, deaths and injuries in road crashes, health impacts from local air pollution?
- “Car travel is just too attractive”. This may be the case in the UK where we have created a poor quality public transport system and do not fund safe cycling infrastructure at the same level as is normal in Denmark or the Netherlands. The alternatives to car travel are far more attractive than the car in places such as Copenhagen, Berlin, Lund, Oslo, Zurich or rural Switzerland.
- Driverless cars (autonomous vehicles) strengthen and deepen the car-centric ideology that currently dominates all UK discussions. The driverless car still needs road space and converts our streets into vehicle-dominated unpleasant spaces when they should be people-friendly and child-friendly spaces. They also are intended to replace public transport and will need physical changes to streets to stop pedestrians and cyclists “getting in the way”.<sup>8</sup>
- Electric vehicles (EVs) may well reduce GHGs but only if a secure electricity supply is based on very high levels of renewable energy. EVs still produce particulate (PM) emissions from non-exhaust sources (brake wear, tyre wear and road surface abrasion). The European Environment Agency has stated that “90% of total PM emissions from road traffic by end of decade will come from non-exhaust sources”.<sup>9</sup>

John Whitelegg is a Visiting Professor, School of the Built Environment, Liverpool John Moores University.

## References

- 1 HM Government (2018). Budget 2018: documents. <https://www.gov.uk/government/publications/budget-2018-documents>
- 2 Committee on Climate Change (2018). Reducing UK emissions: 2018 Progress Report to Parliament. pp.153-154. <https://www.theccc.org.uk/publication/reducing-uk-emissions-2018-progress-report-to-parliament/>
- 3 Whitelegg, J. et al. (2010). *Towards a Zero Carbon Vision for UK Transport*. Stockholm Environment Institute. <https://www.sei.org/publications/towards-zero-carbon-vision-uk-transport/>
- 4 SACTRA (1994). *Trunk Roads and the Generation of Traffic*. Standing Advisory Committee on Trunk Road Assessment, Department of Transport. <http://www.bettertransport.org.uk/sites/default/files/trunk-roads-traffic-report.pdf>
- 5 Whitelegg, J. (2018a). *Mobility: A New Urban Design and Transport Planning Philosophy for a Sustainable Future*. Amazon Direct Print.
- 6 Freeman, R. (2018). Cars and climate change. SGR Newsletter, No. 46. <http://www.sgr.org.uk/resources/cars-and-climate-change-decarbonising-passenger-road-transport>
- 7 Whitelegg, J. (2018a). *Op cit*.
- 8 Whitelegg, J. (2018b). Driverless Cars: On a road to nowhere (Book review). *World Transport Policy and Practice*, vol.24.1. <http://worldtransportjournal.com/wp-content/uploads/2015/02/24.1opt.pdf>
- 9 European Environment Agency (2016). *Air Quality in Europe 2016*. p.18 <https://www.eea.europa.eu/publications/air-quality-in-europe-2016>



## Lethal and autonomous: coming soon to a sky near you

Dr Peter Burt of Drone Wars UK says that, in spite of contrary assurances, the UK is developing the components of autonomous weaponry.

In the debate about the use of armed drones we frequently find governments arguing that drones are weapons which conduct precision strikes, reducing civilian casualties. Some commentators go further, suggesting that drones are increasingly allowing ‘risk free warfare’ to be waged, with drone crews operating their aircraft from bases far from the battlefield and facing minimal risks of death or injury.

Such narratives play a part in the growing push towards the automation of military technology, and are used to justify the trend for drones to become increasingly autonomous, that is, able to operate with reduced, or even no, human input. Drone technology provides a platform for the development of lethal autonomous weapons – sometimes labelled ‘killer robots’ – able to select and engage targets without human intervention. Drones that kill are an authoritarian technology which will allow the development of new roles in warfare, drawing on their surveillance and loitering capacities and their ability to work together in swarms. Nations which uphold humane values and support democracy and human rights should be opposing the development of such technology.

The UK government says that it has “no intention to develop” autonomous weapon systems. But despite this, the Ministry of Defence (MoD) is actively supporting research into new technology which would allow weaponised drones to undertake autonomous missions.

Developments in drone technology are being enabled by advances in the fields of computing (notably machine learning and artificial intelligence – AI), robotics, and sensors able to detect objects and changes in the surrounding environment. Currently this technology is focused on simple tasks – often described as ‘dull, dirty, or dangerous’ – such as logistics and supply, or conducting search patterns. However, as the technology evolves it is gradually becoming capable of undertaking more complex operations.

Drones are currently evolving in a ‘modular way’, and lethal autonomous weapons are likely to emerge as new combinations of existing technology rather than entirely new systems.



Figure 1: Functions of an autonomous drone

Drone technology provides a platform for the development of lethal autonomous weapons as advances in different areas of technology gradually allow drones to evolve to become more autonomous.

Figure 1 shows some of the functions of an autonomous drone. Advances are being made in each of these fields of development. In many of these areas, this is not an issue (green blocks). In other areas, known as ‘critical functions’ (red) which are associated with the use of force, this is a concern. Some functions, such as the gathering and on-board processing of intelligence, are a ‘halfway house’ between the two, depending on the use to which the information is put.

How much of a risk is this? Although we usually think of autonomous weapons as belonging to the realm of science fiction, the prospect of their deployment is now on the horizon. An improvised small armed autonomous drone is “something that a competent group could produce” according to Stuart Russell, Professor of Electrical Engineering and Computing at the University of California and a leading voice against the development of autonomous weapons. A working system “could then be fielded in large numbers in eighteen months to two years. It’s really not a basic research problem”.

However, such a weapon would pose a grave challenge to the laws of war (see John Finney’s article on p.10). As well as legal

problems, there are also significant technical risks posed by the unpredictable behaviour of such systems, potential loss of control through hacking or spoofing, the danger of ‘normal accidents’ arising in complex systems which are not fully understood, and the potential of misuse for purposes that weapons have not been designed or authorised for.

### The UK’s position

Government policy on autonomous weapons was set out in 2017 in a Joint Doctrine Publication from the Ministry of Defence on Unmanned Aircraft Systems. The document gave the following definition for autonomous systems:

“An autonomous system is capable of understanding higher-level intent and direction. From this understanding and its perception of its environment, such a system is able to take an appropriate action to bring about a desired state. It is capable of deciding a course of action, from a number of alternatives, without depending on human oversight and control, although these may still be present. Although the overall activity of an autonomous unmanned aircraft will be predictable, individual actions may not be.”

The document went on to say: “The UK does not possess fully autonomous weapons and has no intention of developing them. Such systems are not yet in existence and are not likely to be for many years, if at all.”

This sounds reassuring, and has presumably been designed to be so. However, the MOD definition is based very much on the long-term potential of autonomous weapons, rather than the state of technology as it is today. The Ministry of Defence has been accused of ‘defining away’ the problems associated with autonomous weapons by setting such a high threshold of technical capability to determine them. The House of Lords Select Committee on AI points out that definitions adopted by other NATO states focus on the level of human involvement in supervision and target setting, and do not require “understanding higher level intent and direction”, which could be taken to mean at least some level of sentience. The Select Committee described the UK’s definition of autonomous weapons as “clearly out of step with the definitions used by most other governments”, which limits the government’s “ability to take an active role as a moral and ethical leader on the global stage in this area”.

This definition also allows the MOD to pretend that it is not undertaking research into autonomous weapon systems. Despite the reassurance in the Joint Doctrine Publication, research conducted by Drone Wars UK shows that the MOD is actively supporting the development of autonomous drones.

### UK research into military autonomous systems and drones

The government’s Industrial Strategy, published in November 2017, describes artificial intelligence, data, and robotics as priority areas for future investment. Consequently, artificial intelligence and robotics are also funding priorities for the Engineering and Physical Sciences Research Council (EPSRC). The position is similar inside the Ministry of Defence. The October 2017 Defence Science and Technology Strategy described autonomous technology and data science as “key enablers” presenting “potential game-changing opportunities”. Research into autonomous systems, sensors, and artificial intelligence is underway through the Defence Science and Technology Laboratory (DSTL) and the Defence and Security Accelerator (DASA) programme.

One example of such a research programme was the ‘Autonomous Systems Underpinning Research’ (ASUR) programme, a joint industry / academia programme funded by DSTL and managed by BAE Systems. The aim of the programme was to develop a science and technology base to allow the production of intelligent unmanned systems for the UK’s armed forces. Among the programme’s outputs were a system to ‘hand over’ targets from high level to lower level drone systems; a computer system to plan and manage drone swarm missions, and a drone capable of landing in confined spaces by a perched landing, similar to the way birds land.

Paradoxically, civil sector research into artificial intelligence and robotics has a greater influence on the development of military technology than research funded directly by the military itself. This is because the main innovators in autonomous technology and artificial intelligence – the consumer electronics sector, internet companies, and car manufacturers – are in the civil sector. Research budgets and staff salaries in these companies dwarf those available in the military.

However, the military is keen to get a slice of the cake. According to General Sir Chris Deverell, Commander of Joint Forces Command and responsible for the UK’s military intelligence and information, “The days of the military leading scientific and technological research and development have gone. The private sector is innovating at a blistering pace and it is important that we can look at developing trends and determine how they can be applied to defence and security.”

An example of the military use of civil sector information technology is Project Maven – a Pentagon project to use artificial intelligence to process drone video feed which uses image recognition software developed by Google among its algorithms. Encouragingly, employee pressure forced Google to withdraw from Project Maven, showing that scientists and engineers can successfully influence the development of authoritarian technologies. Google’s withdrawal from Project Maven was far from a token victory as the pressure from employees acted as a ‘line in the sand’ for the company. Partly as a result of ethical concerns, Google subsequently withdrew as a bidder for the US Department of Defense Joint Enterprise Defense Infrastructure (JEDI) programme – a billion-dollar contract to develop a cloud provider computer system for the US military. Google is a powerful innovator with considerable talent among its employees, and the Department of Defense is not happy about losing access to this expertise. Robert Work, former Deputy Secretary of Defense responsible for Project Maven, stated on the record that he was ‘alarmed’ at the prospects of Google employees making moral demands of this nature.

Not surprisingly, military contractors have been heavily involved in the development of autonomous drones. BAE Systems has developed a whole string of autonomous demonstrator aircraft, including the Taranis experimental stealth drone which is reportedly able to identify and attack targets autonomously. Qinetiq and Thales Group are other key players working on autonomous systems for the MOD, and to a lesser extent Lockheed Martin, Boeing, Airbus Defence and Science, MBDA are also involved.

Within academia, partnership work takes place in collaboration with military contractors who draw on specialist research facilities and expertise available in universities. BAE Systems and Thales, among others, have formal strategic partnership arrangements with certain universities. The EPSRC promotes co-operation between universities and the MOD in relation to

## FOCUS ON AI

AI – for example through the Alan Turing Institute, the national institute for data science. With funding from EPSRC, five universities – Cambridge, Edinburgh, Oxford, University College London, and Warwick – have collaborated to form the Institute. One of the Institute’s core areas of research is defence and security, and it has entered into a strategic partnership with GCHQ and with the Ministry of Defence, through DSTL and Joint Forces Command.

Using the Freedom of Information Act, Drone Wars UK undertook a brief survey of collaboration between the Ministry of Defence and military contractors with a sample of university departments. Some examples of collaboration are shown in Table 1.

**Table 1: University research on autonomy and drones funded by the MOD and / or military contractors**

University	Area of collaboration
Cranfield University	Autonomous systems
Imperial College	Sensors and data analytics
Loughborough University	Autonomous systems
University College London	Imaging and sensors
University of Cambridge	Control and performance
University of Liverpool	Ship-launched drones

### The UK and autonomous weapons: the current state of play

The evidence indicates that far from having “no intention of developing” autonomous weapons, the Ministry of Defence is actively funding and engaged in research and development of

technology which would allow weaponised drones to undertake autonomous missions.

The UK government, together with the governments of France, Israel, Russia, and the USA, has also explicitly opposed a proposed international ban on the development and use of autonomous weapons. The Foreign and Commonwealth Office has stated that, “At present, we do not see the need for a prohibition on the use of lethal autonomous weapon systems, as international humanitarian law already provides sufficient regulation for this area”.

Drone Wars UK believes that the government should not be blocking steps to outlaw authoritarian technology of this nature. The UK should support the introduction of a legal instrument to prevent the development, acquisition, deployment, and use of fully autonomous weapons. In order to allow transparency over its own research in this field, the government should publish an annual report identifying research it has funded in the area of military autonomous technology and artificial intelligence. We would like to see MPs and Peers doing more to investigate the impact of emerging military technologies, including autonomy and artificial intelligence, and pressing the government to adopt an ethical framework to control their development and use.

As well as having potential military applications, artificial intelligence also has massive potential to transform the world for the better. The government should therefore fund a wide-ranging study, perhaps under the auspices of the Alan Turing Institute, into the use of artificial intelligence to support conflict resolution and promote sustainable security. Alongside this, the government should initiate a broad and much-needed public debate on the ethics and future use of artificial intelligence and autonomous technologies, particularly their military applications.

*This article is based on a research study by Drone Wars UK, ‘Off The Leash’, which was funded by the Open Societies Foundation. The report including full references is available online at [www.dronewars.net](http://www.dronewars.net)*

## Prospects of robotic warfare are chilling but recognised

John Finney argues that we must act to prevent the ‘morally repugnant’ prospect of machines with the power and discretion to take human life

Robots have been with us for a long time. The first traffic light system was set up in Parliament Square 150 years ago in 1868 by railway signals engineer J. P. Knight, who used moving semaphore arms, with red and green lights for night-time operation. Its life was, however, limited: following a gas leak, there was an explosion and a policeman was injured. The first automatic traffic lights, operating with fixed time intervals, were installed in Wolverhampton in 1926, while the first vehicle actuated signals were installed at the corner of Cornhill and Gracechurch Street in the City of London.

As technology has advanced, robotic systems are being used in an increasingly wide range of applications throughout society. This wider application raises significant ethical issues. Industrial robots have been used for many years, and service robots in the home – for example robotic lawn mowers and vacuum cleaners – are being increasingly used to free us from activities that are often seen as domestic chores. Robotic systems are



also increasing in healthcare, child and care of the elderly. As computing power continues to increase, and so-called artificial intelligence (AI) techniques are implemented, self-driving vehicles become a possibility, both for civilian use and military

application in unmanned aerial, surface and submarine vehicles ('drones'). The prospect of fully autonomous weapon systems looms in the not-too-distant future.

In general, using a robotic system puts an intermediary device between the 'user' and the outcome of the robot's action. This raises questions such as:

- How does the intermediary affect our legal and ethical responsibilities?
- How might this change with the complexity of the intermediary technology (which may ultimately lead to full autonomy of the intermediary)?
- If our responsibilities are reduced in some way by the presence of the intermediary, who or what takes them on?
- How might these changes influence other externalities?

Focussing on military robotic systems, we have a number of legal instruments that should be considered. International Humanitarian Law (IHL) applies to actions during armed conflict, while Human Rights Law applies otherwise. The UN Declaration of Human Rights and the EU Charter of Fundamental Rights are also potentially relevant. All these instruments were devised many decades ago when technology was much less developed. For example, the 1949 Geneva Conventions were not written with computers in mind – the big invention of the year was the 45 r.p.m. gramophone record! In 1977, when the Additional Protocols were agreed, the PC was in the early stages of development (some of us will remember the Apple II and the Commodore PET), and the world's information and communication technology capabilities were many orders of magnitude less than today.

Central to IHL are the principles of distinction (for example, between a combatant and a civilian), proportionality (the action should be proportional to the perceived threat) and accountability (responsibility for the action taken). So we need to consider how these principles fare when the actions are controlled remotely, and when the actions are undertaken autonomously by the weapon itself. In principle, we need to:

- Scrutinise the mapping between the applications of new technologies and current laws and customs of war
- Try to understand how these can or cannot be followed in the light of these – and likely future – developments
- Suggest a way forward for developing a set of ethical principles relating to the development and use of modern robotics in warfare.

A recent report by the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST)<sup>1</sup> considered these questions, as well as the ethical implications of robotics in the non-military situations mentioned above. COMEST itself is an advisory body and forum of reflection set up by UNESCO, mandated to "formulate ethical principles that could provide decision makers with criteria that extend beyond purely economic considerations".

In its deliberations, COMEST made the distinction between deterministic and cognitive robots. The actions of the former are controlled by a set of algorithms whose actions can be predicted. In contrast, cognitive robots, which can learn from experience, from human teachers and potentially on their own, can develop an ability to deal with their environment on the basis of what has been learned. Compared to 'traditional'

deterministic robots, cognitive robots can make decisions that cannot be predicted by a programmer.

This distinction is important. The behaviour of the deterministic robot is determined by the program that controls its actions. Responsibility for its actions is therefore clear, and regulation can largely be dealt with by legal means. In contrast, a cognitive robot's decisions and actions can be only statistically estimated, and are therefore unpredictable. Its behaviour in environments outside those it experienced during learning are in essence 'random' and can be potentially catastrophic. So assigning responsibility for the actions of what is partly a stochastic machine (subject to random actions) is problematical.

COMEST's recommendations used a framework of ethical values and principles based on the common thread of Human Responsibility. It included the concepts of human dignity, interdependency (human, animal, environment), privacy, do no harm, responsibility (liability, transparency, accountability), beneficence (proportionality, cultural diversity) and justice (equality, non-discrimination).

With respect to remotely piloted armed robotic systems, the report notes that these have given society the ability to wage war remotely, and so threatens to change fundamentally the nature of armed conflict. They raise legal and ethical issues that States have so far failed to address. For example an attacker can kill an adversary without threat to him or herself, targeted killing removes the right to justice, and remote killing contravenes the principle of human dignity. In summary, the report concludes:

- In addition to legal issues, there is a strong moral principle against an armed robot killing a human being;
- States should reconsider using armed drones in conflict situations, as they have done for e.g. anti-personnel mines and blinding laser weapons;
- Unless action is taken soon, the future prospect is of continuous remote conflict and justice-denying targeted killing.

On autonomous weapons, COMEST concluded that legally, their deployment would violate International Humanitarian Law, and ethically that they break the guiding principle that machines should not make life or death decisions about humans. They lack the technical capability to ensure compliance with the principles of distinction and proportionality. Moreover, the authority to use lethal force cannot be legitimately delegated to a machine – killing must remain the responsibility of an accountable human. The overall recommendation was that for legal, ethical and military-operational reasons, human control over weapon systems and the use of force must be retained.

In conclusion, although the future prospect of robotic warfare is chilling, this is recognised in some of the highest quarters. In his September 2018 speech, the UN Secretary General commented that "The impacts of new technologies on warfare are a direct threat to our common responsibility to guarantee peace and security".

As he also said: "Let's call it as it is. The prospect of machines with the discretion and power to take human life is morally repugnant." Scientists are not alone in having a responsibility to try to prevent these possibilities becoming reality.

*John Finney, Department of Physics & Astronomy, London Centre for Nanotechnology University College London, and British Pugwash.*

<sup>1</sup> COMEST (2017). <https://unesdoc.unesco.org/ark:/48223/pf0000253952>



# We need to talk about driverless cars

Perry Walker of Talk Shop led a discussion on autonomous vehicles at the 2018 Responsible Science conference and discovered participants thinking that – whether for or against them – driverless cars don't mix well with people.

**A**fter lunch, the conference divided into small groups to try out a discussion kit on driverless cars. This was developed by Talk Shop with support from Nesta under their 'Everyone Makes Innovation Policy' programme.

As you might expect, nearly 60% of those present reckoned that they knew at least a fair amount about driverless vehicles before the discussion began. By the end, that was up to 85%. At the start, in round numbers, 40% were against AVs (autonomous vehicles) with 15% for them – the rest being unsure. By the end, both these numbers had risen, as more people came off the fence, with half being against and 40% in favour.

Each group discussed two out of six possible topics. 'What are the biggest risks?' was the subject discussed by the highest number of groups. The comment that struck me as most profound was 'Unintended consequences', linked to 'More complicated interlocking agents involved in every journey – e.g. technology and corporations another factor in accidents.' A couple of groups worried both about the risks of crashes – and about how responsibility would then be allocated. Another commented that 'Vehicle design is likely to favour vehicle users over others.'

The next most popular topic was 'What will be the most significant effects on human behaviour – and what should we do about them?' The most positive effect was 'road rage goes down'. Groups were concerned about the interaction between humans and AVs. Examples included:

- Takes time to change human behaviour – longer than technology change
- Problem with reaction time delay with partial automation
- Losing ability to interact/act as people in future have fewer driving skills.

The most striking conclusion was that 'People will take more risks around autonomous vehicles – e.g. stepping out to test autonomous vehicles' and therefore there should be 'total segregation of AVs from drivers' cars and pedestrians'.

The third most frequent topic 'What would you like the effect of driverless vehicles to be on vehicle ownership and public transport?' What people wanted was a reduction in vehicle ownership and an integrated public transport system. What they feared was summed up in these two questions: 'Can AVs work in parallel with existing systems?' and 'Will AVs companies buy up trains and buses and run them down?'

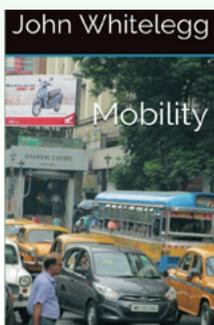
Finally, there was 'What will be the biggest effects of AVs on the environment and health?' Funnily enough, one group supported segregation for much more positive reasons than above – it would encourage cyclists and pedestrians. And, to end with, one group left me with an image of how the future might look different – they foresaw convoys of vehicles perhaps becoming the norm on our roads.

85% of the people who took part found it enjoyable. The comments generally backed that up: 'Learned more than I expected, more worried, clearer than before' and 'socially wonderful!' One group though thought that there were 'Leading questions' and that the 'framing was unduly positive towards AVs'. A constructive suggestion was 'We are all either no-car or slight-car users, 3 use bikes – suggest this should be a question'. And the comment that pleased most of all was that it was a 'decent attempt at democracy'.

For more information about TalkShop, see:

<http://www.talkshopuk.org/>

For a summary of the rest of the conference, see p.23.



## Mobility: A New Urban Design and Transport Planning Philosophy for a Sustainable Future

Prof John Whitelegg, Liverpool John Moores University

Price: £7.70

To purchase: <https://tinyurl.com/yaubbkvg>

This book sets out a rationale for a transformation of the mobility landscape and argues that the sustainable transport options simply cannot thrive in a world that remains wedded to more mobility

and the manifestations of that cultural and political bias (subsidy, infrastructure and an astonishing lack of attention to death, injury, air pollution, climate change and social justice).

The book argues for the explicit adoption by all levels of government of three zeros:

- Zero death and injury in the road traffic environment
- Zero air pollution from traffic sources
- Zero carbon transport

# Is artificial intelligence putting the world on steroids?

Andrew Simms, author of SGR's briefing on AI, argues that it is likely to pile up as many problems as solve them

The debate on the impact of artificial intelligence (AI) and machines capable of learning and acting autonomously tends to lurch between technological optimism and catastrophic warnings of humans losing control.

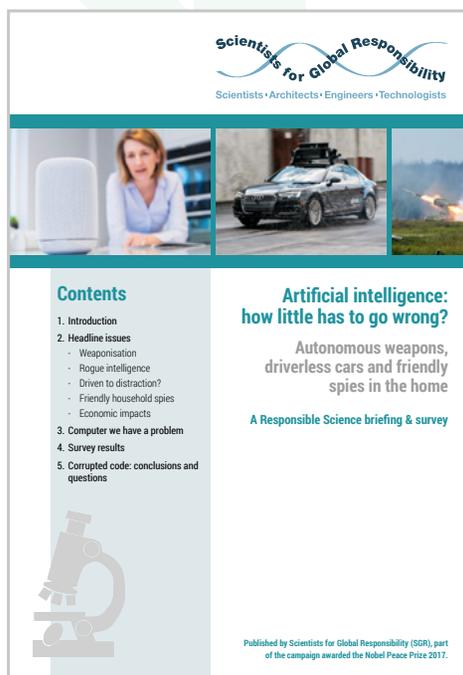
Often overlooked, however, is the way that AI will simply have the effect of putting the world on steroids – a general intensification of business as usual – including the environmental impact of overconsumption and the human cost of inequality.

Alarm bells are already ringing. There are fears about the development and deployment of autonomous weapons, that decide for themselves who to kill – so called 'killer robots' (see articles on p.8 and p.10) – and about how AI will lead to a kind of 'supercharged surveillance society' by combining big data with, 'smart' domestic devices, facial recognition technology and CCTV.

One emergent consequence of AI being used in a seemingly prosaic office situation was bias being accelerated in an Amazon recruitment programme which taught itself to prefer male job candidates by learning from past trends, and scoring applications lower that contained keywords like 'woman' or 'women's'. "The biggest danger is that we use these tools to entrench our existing biases and compound the injustice that we already see in the world around us," Mustafa Suleyman, Co-founder and Head of Applied AI at DeepMind, told the BBC recently.

Similarly, an AI generated persona called TAY developed by Microsoft, and used on the social media site Twitter, evolved from having an innocent, millennial character to being a crude racist in less than a day. AI-driven digital assistants are interacting with our online identities, big data and sophisticated marketing techniques, and compiling huge amounts of information about us, with the objective of maximising what we buy and consume.

In that context, a new survey of concerned scientists drawn from the membership of Scientists for Global Responsibility – around half of whom are from the natural sciences such as physics, chemistry and biology, with the next largest group being from engineering and information technology – asked if AI would tend more toward a future that was utopian, dystopian or unchanged. Over eight out of ten chose dystopian, and over nine out of ten also thought that AI would deliver more power and economic benefit to corporations rather than citizens. The great majority also thought that the chances of things going badly wrong, in everything from autonomous weapons to driverless cars and digital assistants, was high or very high. Crucially over 90



percent thought there was an urgent need for more regulation.

Mark Carney, Governor of the Bank of England, says it's all part of a fourth industrial revolution which will not only tilt the balance of power further away from low paid workers to the owners of finance, but 'substantially boost productivity and supply', or, in other words, make a lot more stuff using fewer people. Predictions of job losses due to the interaction between artificial intelligence and automation range from the Bank of England's own warning, that around half of current jobs in the UK total are at risk, to an Oxford University study estimating that 35 percent of current types of jobs in the UK will become obsolete.

From the environmental perspective, the recent special UN report on meeting the 1.5 degree climate target, concluded that 'rapid, far-reaching

and unprecedented transitions' were needed across the whole of society, with priorities for immediate action being, 'low energy demand, [and] low material consumption'. But, global demand for coal, oil and gas are all growing, as is the total amount of resources we take from the biosphere, and fossil fuel consumption is set to rise for decades, according to the International Energy Agency.

Into this crisis comes AI which is already being seen as an opportunity to intensify environmentally damaging resource extraction. An embattled oil and gas industry sees AI as a 'potent' tool and a 'godsend'. As one leading industry journal says, 'As resources become increasingly scarce and the oil price squeeze has forced exploration and production levels to 70-year lows, AI can come to the rescue in finding new sources.' Of course these things will only happen if we let them. To ensure a better future, a new briefing by Scientists for Global Responsibility, *AI: how little has to go wrong?* recommends that 20 percent of all AI research and development funding should go on assessing potential benefits and harm, which seems better than merely crossing our fingers and hoping things will be okay.

Technology is not destiny, and we do not have to do something just because we can. It is about choices that will make the world better, but to make those choices we need information and a sense of what constitutes responsible science.

More detail and references can be found in SGR's new report on AI, which can be downloaded from: <http://www.sgr.org.uk/publications/artificial-intelligence-how-little-has-go-wrong>

Printed copies can be ordered from the SGR office. For contact details, see back page.

## SECURITY

## Defence diversification: international learning for Trident jobs

Barnaby Pace, Nuclear Education Trust, explores how international examples of defence diversification programmes show what a successful programme could look like in the UK – answering concerns about employment should the British nuclear weapons programme be cancelled or curtailed.

**N**orman Augustine, retired chairman of military contracting giant Lockheed Martin, famously said in 1995 that the experience of defence contractors moving into civilian production “has a record unblemished by success”.<sup>1</sup>

Augustine was wrong. A study recently published by the Nuclear Education Trust (NET)<sup>2</sup> identified valuable examples from around the world of defence diversification programmes which show important lessons in what can make such programmes successful.

### Back on the UK political agenda

The issue of defence diversification – also known as arms conversion – has been back on the agenda in the UK with supportive statements from Labour leader Jeremy Corbyn and major trade unions, as well as engaged civil society activists.

Diversification is particularly relevant in the debate over the Trident renewal programme. One of the more frequent claims given in favour of replacing Trident, the UK’s nuclear-armed submarine programme, is that the programme is essential to maintain employment in certain areas. This argument is attractive to many in the trade union movement and Labour Party who might otherwise oppose Trident replacement on ethical or policy grounds. The issue, for them, is about the potential loss of highly skilled employment clusters in these areas.

Questions also remain about the project’s affordability and technical feasibility and, in addition, the political commitment to nuclear arms is not guaranteed given the numerous flaws in the policy of nuclear deterrence. There have also been serious questions raised over whether Trident’s submarine-based system is even workable in the future with rapid developments in submarine detection technology. For example, a scenario where swarms of unmanned underwater drones work together to track submarines is a distinct possibility in the next few decades.<sup>3</sup>

### Shrinking employment in the arms sector

The hardship individuals and their families could face as a result of arms industry job losses is real and shouldn’t be underestimated. In the event of a change of government, Trident



replacement could still be scaled back or cancelled entirely and the key questions then would be how severe is the impact on workers and what can be done to mitigate the harmful effects and capitalise on the opportunities?

Employment in the UK arms industry has been in decline for several decades. The arms industry lobby group ADS, estimates that in 2016 the industry directly employed 142,000 people in the UK.<sup>4</sup> This is down from previous UK government estimates of 155,000 jobs in 2000/01 and 405,000 jobs in 1980/81.<sup>5</sup> This decline is part of a long-term downward trend in employment in the UK arms industry due to the increasingly capital intensive nature of the work carried out, growing automation, globalised supply chains, limited increases in military spending and a highly competitive arms export market.

This decline clearly shows the failure of the long running UK government strategy to support arms industry workers by supporting arms exports. This strategy should face even closer scrutiny now, given the alleged murder of *Washington Post* columnist Jamal Khashoggi by the largest recipient of UK arms, the government of Saudi Arabia.<sup>6</sup>

Out of the estimated 142,000 people employed in the UK arms industry, only approximately 11,500 jobs are currently supported by Trident according to CND research.<sup>7</sup> The employment supported by replacing Trident meanwhile is estimated at between 26,000 and 30,000 with many of those jobs not appearing until after new submarines come into service in 2031.

### Making a success of economic transition

Cancelling Trident’s replacement does not inherently mean putting this number of people out of work but there will be an impact on regions most heavily dependent on the programme. However, the money that could be saved by cancelling Trident replacement is vast, estimated at between £140bn and £205bn over its lifetime. Even if some pay-back on cancelled contracts is required, just a tiny fraction of what is left could easily cover the very modest costs of diversification programmes.

Nevertheless, even where diversification has been deemed to be a success, the costs of the reallocation of resources from military industry to civil production should not be understated.

## Box 1 – Key lessons from international diversification experiences

Workers and communities must take the lead on making decisions for diversification, but a broad partnership involving all stakeholders is necessary for success.

Political support for diversification must come from national, regional and local levels.

Action must be taken at early stages to proactively assist communities in diversification, rather than reacting to a crisis. Suggested timelines to organise and plan for diversification range from three to five years as a minimum.

Funding must be made available not just for putting a plan into action but for organising, analysis of the situation,

planning and then implementation.

Existing organisations, relationships and expertise must be identified and taken advantage of and efforts should be made to ease the transition into more competitive civilian markets. Joint ventures and network learning should be encouraged.

There is a real cost for workers and communities, especially where new economic activity cannot be created in the same location through an idealised plant-based conversion programme. Every international case study identified involved substantial job losses in the short term.

On the other hand, economic transition always results in upheaval, and ‘do nothing’ is not an option: trends in defence spending and markets show that employment in the arms manufacturing sector is already shrinking. Diversification should not be portrayed as a manifesto to save every job but a tool to mitigate the impacts of change and provide opportunities.

There is an entirely justifiable debate to be had over whether job losses in the arms industry deserve special attention, or state support, above and beyond that offered to other sectors. However, there are clear reasons to consider government funding for diversification.

First, disarmament should not lead to unemployment as this creates a perverse disincentive for peace-orientated activities and reductions in military expenditure. Second, incentives for the transfer of resources from the defence sector to civilian production are vital in order to develop a country’s industrial and technological base as well as to provide employment. This is especially relevant where arms industry workers have particularly valuable skills and knowledge that have been built up working on government contracts. These workers’ abilities can be thought of as a national asset that should not be squandered. Thirdly, the arms industry’s principal customer is the government, on whose behalf resources were committed to weapons manufacture. As such, there is arguably a societal obligation to help return them to commonality with their civilian counterparts.<sup>8</sup>

Furthermore, as military spending has become increasingly capital intensive it produces relatively few jobs. A University of Massachusetts study concluded that, if the US government invested \$1 billion in alternative civilian sectors rather than on military production, it would generate up to 140% more jobs.<sup>9</sup> For example, investments in clean energy, health care and education create a much larger number of jobs across all pay ranges, including mid-range-paying jobs and high-paying jobs.

The possible transfer of skilled engineering talent from the arms industry into efforts to fight climate change is also tantalising, both because of some clear crossover in the skills needed and because of the obvious security benefits in fighting climate change. 208,000 people are already directly employed in the UK low carbon and renewables sector, nearly 50% more than in the arms industry.<sup>10</sup>

Proposals for conversion have already been made for each major location that would be affected by the cancellation of Trident – and many of these include a switch to green jobs.

### Learning from workers and communities

The NET study assessed accounts of post-Cold War diversification programmes in Estonia, Germany and Italy, post-Apartheid South Africa’s efforts to convert its nuclear weapons factories, and an on-going programme in the USA for diversifying regions dependent on military contracts. Each of these programmes followed a different approach and had various levels of success but there were common factors which give lessons for future efforts.

The research showed that the best ideas and innovations nearly always come from the workers and affected communities – but on their own, these are not enough. A broad partnership is needed to tackle the issues and, for the best chance of success, the arms companies themselves, national and local government, trade unions, civil society, academia and other stakeholders must all fulfil their role in supporting workers and affected communities in making decisions for their future. This coalition must be given appropriate support in organising, analysis and planning as well as implementation. It was found that years of preparation are needed for a plan to be successful, so diversification planning should begin long before job cuts are expected. More detail on the lessons learned are given in Box 1.

Speaking at the parliamentary launch of the NET report, Fabian Hamilton MP, Shadow Minister for Peace and Disarmament, said:

*“While it is not yet Labour Party policy to scrap Trident, I am committed, not only to transitioning away from nuclear weapons, but to protecting jobs at the same time. High-skilled jobs are good for our economy and, if we decide to transition away from Trident, defence diversification is the only way to ensure that the vital skills used in the development of Britain’s nuclear weapons are not lost... A defence diversification strategy would go hand in hand with Labour’s plan to invest in our economy. We do not lack the talent, we simply lack the funding. There is no denying that Trident is a major employer in some parts of the country, so proper funding must be made available so those in high-skilled work, stay in high-skilled work.”*

Several trade unions, as well as Jeremy Corbyn, have already called for a publicly-funded Defence Diversification Agency to be set up that could provide coordination, assistance and finance to diversification efforts.

## SECURITY

NET hopes that this research will inform political parties, trade unions and civil society on what action can be taken now to build coalitions and analyse local economies so that the UK can protect workers while taking the right decisions for our security.

*Barnaby Pace is the author of Defence Diversification: International learning for Trident jobs,<sup>2</sup> a new report from Nuclear Education Trust, an independent charity.*

## References

- <sup>1</sup> *Washington Post* (1995). A Conversation with Norman R. Augustine, chairman and chief executive of Lockheed Martin Corp. <http://www.washingtonpost.com/wp-srv/business/longterm/lockheed/augustine.htm>
- <sup>2</sup> NET (2018). Defence Diversification: International learning for Trident jobs. <http://www.nucleareducationtrust.org/defence-diversification-international-learning-trident-jobs>
- <sup>3</sup> O'Malley, J. (2016). The submarine drones that could depower Trident. <http://www.alphr.com/the-future/1003587/the-submarine-drones-that-could-depower-trident>
- <sup>4</sup> ADS Group (2017). UK Defence Outlook 2017. <https://www.adsgroup.org.uk/reports/uk-defence-outlook-report-2017/>
- <sup>5</sup> DASA (2003). Estimated UK Employment Dependent on Ministry of Defence Expenditure and Defence Exports. <http://webarchive.nationalarchives.gov.uk/20140116143358/http://www.dasa.mod.uk/publications/finance-and-economics/archive/defence-statistics-bulletins/defence-statistics-bulletin-number-05-expenditure-and-defence-export-1-march-2003.pdf>
- <sup>6</sup> SIPRI (2017). The state of major arms transfers in 8 graphics. <https://www.sipri.org/commentary/blog/2017/state-major-arms-transfers-8-graphics>
- <sup>7</sup> CND (2016). Trident and jobs. <https://cnduk.org/resources/trident-and-jobs/>
- <sup>8</sup> Thorsson I (1984). *In Pursuit of Disarmament*. Liber, Stockholm.
- <sup>9</sup> Pollin R. and H. Garrett-Peltier (2011). The U.S. Employment Effects of Military and Domestic Spending Priorities: 2011 update. University of Massachusetts-Amherst. [https://www.peri.umass.edu/fileadmin/pdf/published\\_study/PERI\\_military\\_spending\\_2011.pdf](https://www.peri.umass.edu/fileadmin/pdf/published_study/PERI_military_spending_2011.pdf)
- <sup>10</sup> Office of National Statistics (2018). UK Environmental Accounts: Low Carbon and Renewable Energy Economy Survey: 2016 final estimates. <https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/finalesimates/2016>



## Unaffordable and unachievable: the continuing problems of Trident renewal

Dr Philip Webber and Dr Stuart Parkinson, SGR, examine the growing financial and technical problems of renewing the UK's nuclear weapons system.

**S**GR has published a range of reports and articles about the huge risks caused by continued deployment of the UK's nuclear weapons.<sup>1</sup> But in this article we want to focus on the rapidly rising costs and technical difficulties involved in the renewal of the Trident system.

The main element of this programme is the construction of four new nuclear-armed 'Dreadnought class' submarines. The budget allocated to this project by the government in 2015 was £31bn, together with an unprecedented £10bn Treasury-guaranteed contingency fund.<sup>2</sup> Other elements of the renewal programme include:

- a new design of nuclear reactor to power the submarines;
- maintenance of 180 nuclear warheads, which may themselves be replaced by a new design in the 2020s;

- missile-related work, although the missiles themselves will still be manufactured and maintained by the USA, and leased to the UK under long-standing 'nuclear-sharing' agreements.

It is also important to note that Trident renewal is only part of what the government calls the Defence Nuclear Enterprise (DNE), which also includes other nuclear-powered, but conventionally-armed, submarines (Astute class and Trafalgar class) and the various supporting organisations. Overall, the ten-year budget for this enterprise is a whopping £51bn, over a quarter of Britain's planned spend on military equipment.<sup>3</sup>

### "Unaffordable", says NAO

In May 2018, the National Audit Office (NAO) – the parliamentary watchdog which assesses the delivery of

government programmes – published a review of the DNE.<sup>4</sup> It highlighted an “affordability gap” of £2.9bn over the period 2018–28, as well as the decision by the government to use £0.6bn of the contingency fund to help manage budgetary problems this financial year. In November, the NAO published a review of the whole military equipment plan.<sup>5</sup> It described the plan as “unaffordable” pointing to an expected shortfall of £7bn over the next ten years and the distinct possibility that this could rise to £15bn under unfavourable circumstances. The projected overspend on the nuclear programmes was high among the NAO’s concerns.

A recent report from the British American Security Information Council (BASIC)<sup>6</sup> has drawn together the latest information about the cost increases, and estimated that capital cost of Trident renewal has now grown to £47.3bn. The largest cost increases over and above the budget for the nuclear programme arise from a two-year delay – leading to an extra £2bn required for life extension work for the existing Vanguard class submarines – and the post-Brexit referendum depreciation of the pound against the dollar which is estimated to add a further £2bn to components being made in the USA, such as missile tubes.<sup>7</sup>

Once running costs – of approximately £2.2bn a year from 2030 to 2060 – are added, the lifetime costs of the programme grows to over £110bn. Decommissioning costs are an additional burden.

So, even if you support the Defence Nuclear Enterprise, the costs are staggering – but there is even worse news...

### “Unachievable”, says IPA

In July, the Infrastructure and Projects Authority (IPA) – a high-level watchdog which reports to HM Treasury and the Cabinet Office – published its annual report<sup>8</sup> which included a damning assessment, especially of the Dreadnought submarine project. The project was “in doubt, with major risks or issues apparent in a number of key areas. Urgent action is needed to address these problems and/or assess whether resolution is feasible.” On the project to build the new nuclear reactors for the submarines, the IPA was even more critical. “Successful delivery of the project appears to be unachievable. There are major issues with project definition, schedule, budget, quality and/or benefits delivery, which at this stage do not appear to be manageable or resolvable.”

You’d think it couldn’t be any worse for a programme than being well over-budget, delayed, and labelled “unachievable”. But there is worse. There are also the often-forgotten costs of the Defence Nuclear Enterprise: liability for the decommissioning and disposal of 30 submarines. These costs are currently estimated at £10.3bn – a figure which has nearly trebled since 2015.<sup>9</sup>

### The skills gap

The NAO has highlighted a factor central to all these ongoing problems. “Having insufficient skilled staff,” it says, “remains a risk across the Department... sustaining sufficient civilian and military nuclear staff remains one of the Enterprise’s top strategic issues”.<sup>10</sup>

This raises another issue, which has been highlighted by researchers at Sussex University.<sup>11</sup> They argue that a key reason

why the government decided to go ahead with astonishingly expensive subsidies for the new Hinkley C nuclear power plant was related to maintaining UK nuclear skills which could also help underpin the Trident renewal programme.

### Time to quit

SGR has long argued that the UK should stop using science and technology to support aggressive military postures and that there are clear benefits both in terms of security and cost of moving to genuinely defensive approaches based on the concept of ‘sustainable security’.<sup>12</sup> Nuclear weapons are the epitome of an unsustainable security strategy and create enormous risks for humanity and the global environment.

It is now also abundantly clear that technical and cost management problems are a major issue for Trident renewal. The case for abandoning this grandiose project – and committing the UK to a future without weapons of mass destruction – is becoming stronger by the day, especially as the UN Treaty for the Prohibition of Nuclear Weapons approaches ‘entry into force’. Now is the time to take this bold but crucial step.

*Dr Philip Webber is Chair of SGR.*

*Dr Stuart Parkinson is Executive Director of SGR.*

### References

- 1 SGR (2018). The nuclear weapons threat: main outputs. <http://www.sgr.org.uk/projects/nuclear-weapons-threat-main-outputs>
- 2 HM Government (2015). National Security Strategy and Strategic Defence and Security Review 2015. [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/478933/52309\\_Cm\\_9161\\_NSS\\_SD\\_Review\\_web\\_only.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/478933/52309_Cm_9161_NSS_SD_Review_web_only.pdf)
- 3 NAO (2018a). The Defence Nuclear Enterprise: A landscape review. <https://www.nao.org.uk/wp-content/uploads/2018/05/The-Defence-Nuclear-Enterprise-a-landscape-review.pdf>
- 4 NAO (2018a) – as note 3.
- 5 NAO (2018b). Ministry of Defence: The Equipment Plan 2018 to 2028. <https://www.nao.org.uk/wp-content/uploads/2018/11/The-Equipment-Plan-2018-2028.pdf>
- 6 BASIC (2018). Blowing up the Budget. <http://www.basicint.org/report-blowing-up-the-budget/>
- 7 BASIC (2018) – as note 6
- 8 IPA (2018). Annual Report on Major Projects, 2017-18. Annex D [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/721978/IPA\\_Annual\\_Report\\_2018\\_2.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/721978/IPA_Annual_Report_2018_2.pdf)
- 9 NAO (2018a) – as note 3. pp.38-39. The total of 30 includes 20 which have left service and 10 currently in service.
- 10 NAO (2018a) – as note 3. p.42.
- 11 Stirling A, Johnstone P (2017). <http://data.parliament.uk/writtenevidence/committeeevidence.svc/evidencedocument/public-accounts-committee/hinkley-point-c/written/70983.pdf>
- 12 SGR (2013). Offensive Insecurity. <http://www.sgr.org.uk/publications/offensive-insecurity>

## ENVIRONMENT

# The fall of fracking?

The future of UK fracking is delicately balanced and will send a signal about serious climate policy says SGR's Andrew Simms

Natural gas was claimed to be a bridge to a clean energy future, and part of the answer to climate change. That was a reason given, or at least a defence for, going ahead with fracking – the process of releasing gas from underground rock by injecting liquids at high pressure. Now it seems that the bridge has collapsed leaving a precipitous drop into both climatic and, too frequently, geological instability.

In the UK, official commitment to the development of fracking has sat uncomfortably alongside waning support for renewables, which has tipped-over into outright obstruction where the development of onshore wind is concerned.

Research published in the US journal *Science* in the summer of 2018, that took account of leaks of methane – a potent greenhouse gas – from the oil and gas industry, concluded that total emissions related to the development of natural gas could, in the short term, equal the warming effect of coal use. The IPCC made clear in its recent report on limiting warming to 1.5°C that the critical period for action was over the next twelve years. But the research on gas revealed that there was no net climate benefit from gas replacing coal for at two decades, much too long a waiting time to be part of an effective strategy against climate breakdown. Worse, however, is that gas is seen to displace not just coal, but low carbon energy sources like renewables.

In recent years the problem of methane leakage in oil and gas production has been revealed to be both larger in scale and more damaging in climate terms than previously thought.

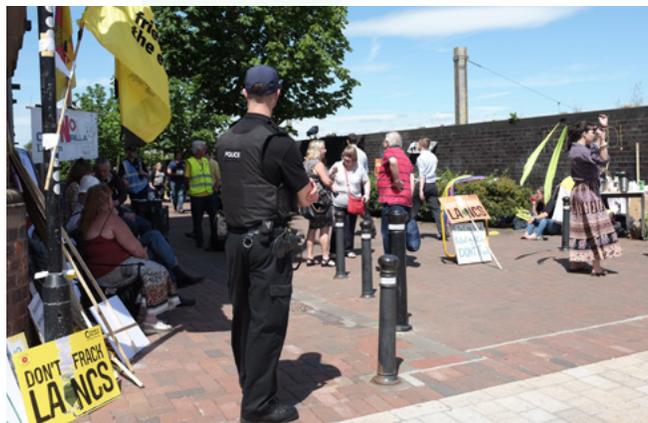
All these issues come in addition to more local, immediate concerns surrounding the activity of fracking.

In the UK attention has focused on developments at the Preston New Road fracking site near Blackpool, in Lancashire. Operations began but have been repeatedly halted due to seismic activity – ground tremors – happening as a result, above the safety level set by the Environment Agency.

The industry is pushing for current regulations to be relaxed – arguing that they are unnecessarily strict and stand to make fracking uneconomic if they are kept. So far, however, the rules are being maintained.

Separately, however, at least two independent experts have said that the current regulations are inadequate and that the research on which they are based is flawed. One is geologist, Prof David Smythe, who spoke at SGR's 2016 conference about the undue influence of the fracking industry on academia, including their hostility toward critical voices, including his own. The other is chartered engineer, Mike Hill, who was involved in fracking operations at a site called Preese Hall, which were shut down in 2011 because of seismic activity. He too has faced hostility for being critical of the industry.

In a further twist, seismic activity recently shut down a large section of conventional onshore gas extraction in the Netherlands. The geology is more sensitive there, but the



Demonstration against fracking in Lancashire

common factor appears to be that the industry underestimated the seismic risks.

In early 2019 the campaign group Friends of the Earth lost a High Court challenge against fracking at Preston New Road, having argued that the Environment Agency failed to consider methods for lower environmental impact when granting a licence to fossil fuel firm, Cuadrilla, to develop the site. But, while current regulations are being maintained, ten local authorities under the umbrella of the Greater Manchester area announced plans to write a 'presumption against drilling' into the planning policies. This would effectively place a ban of fracking in the region, stopping the sector in its tracks.

## References

- Alvarez, R. A. et al. (2018). Assessment of methane emissions from the U.S. oil and gas supply chain. *Science*. <http://science.sciencemag.org/content/361/6398/186.full>
- Think Progress (2013). IPCC Warns Methane Traps Much More Heat Than We Thought. October 2, 2013. <https://thinkprogress.org/more-bad-news-for-fracking-ipcc-warns-methane-traps-much-more-heat-than-we-thought-9c2badf392df/>
- The Guardian* (2018) Minor earthquakes emerge as major threat to UK fracking. 1 November 2018. <https://www.theguardian.com/environment/2018/nov/01/minor-earthquakes-emerge-uk-major-fracking-threat-lancashire>
- Prof David Smythe's blog (2018). There may be trouble ahead. 22 October 2018. <http://www.davidsmythe.org/frackland/?p=551>
- Blog by Mike Hill, Chartered Engineer (2018). Save the Fylde – keep the earthquake safety limit at 0.5. 12 November 2018. <https://drillordrop.com/2018/11/12/guest-post-save-the-fylde-keep-the-earthquake-safety-limit-at-0-5/>
- Channel 4 News (2018). Why the Dutch are ditching gas extraction. 12 November 2018. <https://www.channel4.com/news/why-the-dutch-are-ditching-gas-extraction>
- The Guardian* (2018) Gas field earthquakes put Netherlands' biggest firms on extraction notice. 23 January 2018. <https://www.theguardian.com/environment/2018/jan/23/gas-field-earthquakes-put-netherlands-biggest-firms-on-extraction-notice>
- For the latest updates, see the Drill or Drop website: <https://drillordrop.com/>

# The psychology of cutting plastic pollution

Dr Jan Maskell, SGR, examines the potential of behaviour change to help to reduce plastic waste.

The BBC's *Blue Planet II* series has given a welcome boost to public awareness of plastic pollution in our oceans. The images of fish and divers swimming through a soup of plastic waste have both enraged and inspired people, some of whom have been modifying their personal behaviour by refusing, reducing, re-using and recycling single-use plastic. It also is one of the issues that the UK government tackles in its 25-year environment plan, while the BBC itself is now aiming to phase out single-use plastics at all its sites by 2020.

These moves by government, businesses and individuals are laudable, but there is still much to be done. There are many places where psychology can play a part in enabling behaviour change to enhance the technology and policy that is still to be implemented.

## Learning from the plastic bag tax

Plastic has become ubiquitous in our modern lives. But the properties that make it so useful – like durability – are also the ones that create environmental problems. We have developed a 'disposable' lifestyle where around 50% of plastic is used just once and thrown away. According to Greenpeace, up to 12 million tonnes of plastic ends up in our oceans every year – that's the equivalent of one rubbish truck every minute. Once in the ocean, it can kill wildlife through, for example, suffocation or clogging animals' stomachs.

There are many contributors to this plague of plastic waste – an obvious example being the plastic bag. One piece of legislation has already been successful in cutting down the number of plastic bags being used – the mandatory 5p charge per bag. There are now proposals to introduce a charge on other single-use plastics, such as disposable coffee cups.

Around 2.5 billion disposable cups are thrown away each year in the UK – the equivalent of 5,000 every minute. These cups are difficult to recycle or compost as they are usually a blend of cardboard and plastic to make them waterproof. The so-called 'latte levy' is a suggested charge of 25p on each cup. Would this help to tackle the waste created by the 'take-drink-dispose' culture? The difference between the plastic bag tax and a latte levy is that the consumer then 'owns' the plastic bag and can use it again – and it can be recycled. With a coffee cup, once you have paid your 25p, you have nothing else to show for it – and you still need to dispose of the cup – to landfill! So a charge on coffee cups may give a nudge to consumers to move away from the throwaway culture, but it is unlikely to bring about lasting change in isolation.

It is therefore important to use a combination of measures. If the cups were also recyclable or compostable, this would help reduce the waste. But if we went one step further – and made them reusable – this would make the biggest difference of all. But this would require a greater level of behaviour change by the coffee drinker.

## How can psychology be used to help?

To bring about successful behaviour change requires actions to improve motivation, opportunity and capability.

The writer George Marshall points out some of the reasons why we are not motivated to act.<sup>1</sup> The first is the lack of a *personal* connection to the issue, for example, 'I do not throw plastic waste directly into the ocean'. The second is absence of an *abrupt* change, in that it takes years for plastic waste to build up in the environment. The third reason relates to *immorality*. If we do not see, or are unmoved by, pictures of seabirds with stomachs full of plastic waste, we will not act. Finally, there is the question of immediacy. Does the plastic waste affect us *now*? The acronym, 'pain', has been suggested to summarise these four obstacles to our motivation to act – personal, abrupt, immorality and now. Effective action needs to take these four into account.

Having the motivation to change is important, but it must be supported by the opportunity and the capability to change. I might want to refuse plastic – but if all the items in the shop are packaged in plastic, my options are limited. What could be done to help individuals make better choices?

Knowledge is the first step. This is where *Blue Planet II* has played a huge role in raising awareness. But education on its own is not enough to ensure behaviour change happens.

Next the physical environment can be designed such that it is easier to choose the environmental option. Some of this will rely on suppliers and retailers rethinking how they offer their products. Minimising packaging, making it from easy-to-recycle or compostable materials, and clear labelling on how/where to recycle all help. Technological innovation and legislation can have a particular effect here.

There are also actions that can be taken at the point of purchase of our drink that change the default option to an environmental one. If the aim is to make the default bringing your own cup, then retailers could take a number of actions. Firstly, the advertised price would be for the reuse option, and an extra charge would be made to include a throwaway container. The server could be trained to ask, 'Do you have your own cup?' as an initial question. To make bringing your own container more desirable, they can be made to look more attractive. Indeed, this is already being done by some outlets.

These actions take advantage of some important psychological concepts: 'social norming'; and 'loss aversion'. A social norm is 'what people like you' do. As Griskevicius and fellow researchers found,<sup>2</sup> social acceptability and what 'normal' people do was effective in encouraging behaviour change. Meanwhile, psychological research has also demonstrated that people are especially keen to avoid experiencing a loss. Hence an extra charge for choosing the less environmental option is more likely to drive social change. This experience is borne out by the plastic bag tax.

Introducing changes are more effective if they are done in a timely manner. The current public concern about plastic pollution makes this an ideal time to make re-usable cups and bottles the 'normal' option. Policies encouraging behaviour change can be powerful in helping to deal with the problem of plastic waste. However, they need to be used wisely, with a combination of carrots and sticks, and top down and bottom up strategies, to be effective.

*Dr Jan Maskell is a chartered occupational psychologist, and vice-chair of SGR.*

## References

- 1 Marshall, G. (2014). *Don't even think about it: why our brains are wired to ignore climate change*. Bloomsbury.
- 2 Griskevicius, V. et al., (2008). Social norms: an underestimated and underemployed lever for managing climate change. *International Journal of Sustainability Communication*, vol.3, pp.5–13.

## Martin Ryle

In two articles marking the centenary of former Astronomer Royal, Martin Ryle (1918 – 1984), Dr Alan Cottey, secretary of the Martin Ryle Trust, describes how, early on, he saw the flaws in nuclear and fossil fuel energy and how renewables were the answer; and in *Martin Ryle – War and peace*, gives a brief account of Martin Ryle's intense and complex relations with war and peace.

### A man ahead of his time – How Martin Ryle saw the future of energy

Sir Martin Ryle is known primarily as a pioneering radio astronomer. Another distinguished astronomer, Michael Rowan-Robinson,<sup>1</sup> described him as someone “on whom the establishment had lavished all the prizes and recognition in its gift.” One notices the ‘had’ and asks what happened next.

The answer may be found in the introduction of the Royal Society's biographical memoir<sup>2</sup> “... turning eventually to a deep concern about the future of mankind in the age of nuclear power and warfare.” One may divide Ryle's adult life into three phases – radar in World War II, radio-astronomy, and a curtailed third phase (Ryle died relatively early, at age 66) as an anti-establishment researcher, advocate and campaigner on peace and the proper use of science and technology.

#### Energy

The earliest publication (excluding letters) of Ryle's third phase was on nuclear power.<sup>3</sup> Although the grotesque nuclear arsenals and the associated policies attracted Ryle's most passionate denunciations, nuclear energy formed a framework for his political thinking. He insisted that the connections between nuclear power and nuclear militarism were fundamental and they corrupted civil society.<sup>4</sup> Nuclei were not an acceptable source of energy, but neither were fossil fuels. This was not for today's consensual reason, namely climate change.<sup>5</sup> The generally incisive Ryle was not one of the few scientists who took seriously that possibility. Like most at the time, following the 1973 global oil crisis, he was influenced by the prospect of exhaustion of fossil fuel reserves – even coal in the longer term.

He was thus led to advocate more research into renewable energy sources and efficient energy use. Despite his ill-health, he and a small team produced a couple of important works on renewable energy.<sup>6,7</sup> These emphasise the role of short term heat storage in making alternative energy sources, especially wind, more viable. These proposals may, in some respects, still be ahead of their time. They were far ahead in the 1970s. Musgrove<sup>8</sup> reports how the UK government's Department of Energy ranked five principal sources of alternative energy in the order wave (most promising), solar heat, geothermal, tidal, wind (least promising). Ryle is given credit for promoting the case for wind power, which has become a leading renewable energy source today.

#### The relevance today of Ryle on energy

I identify three main ways in which Ryle's work on energy is important today – historic, holistic and moral. The energy work is of historic importance because it was done in a short period (around 1976 to 1984) and the thinking of that time differed remarkably from today's thinking. Then, wind was considered

to have poor prospects and photovoltaics (PV) were widely expected to continue in their niche role. Today, according to the global renewable energy report REN21,<sup>9</sup> of the 161 GW of global newly installed renewable power capacity in 2016, 47% was solar PV and 34% wind power. And, as already noted, the need to move away from fossil fuels was for a reason, exhaustion, that is not now seen as paramount.<sup>5</sup> These examples warn us that some of our current ideas will soon appear misguided. If only we knew which ones!

Ryle's energy work was holistic in that he saw the importance of addressing the renewable sourcing, efficient use and storage of energy as an interconnected system.

Finally, and characteristically, he turned to the study of all aspects of energy as a moral issue, a personal imperative to contribute to resolving the great practical problems created or exposed by scientific knowledge and technique. He was intense and sometimes intemperate.<sup>2</sup> Perhaps this was the price of being more than simply a brilliant scientist and engineer.

#### References

- 1 Rowan-Robinson, M. and A. Rudolf (1985). *Martin Ryle's Letter*. Menard Press, London.
- 2 Graham-Smith, F. (1986). Martin Ryle. Biographical memoir. *Biographical Memoirs of Fellows of the Royal Society*, Vol 32, pp 497–524. <http://rsbm.royalsocietypublishing.org/content/roybiogmem/32/495.full.pdf>
- 3 Ryle, M. (1976). Nuclear Energy: The Serious Doubts that Put our Future at Risk. *The Times*, 14 December, p 14.
- 4 Ryle, M. (1981). *Towards the Nuclear Holocaust*. Menard Press, London.
- 5 Weart, S.R. (2008). *The discovery of global warming*. Harvard University Press, Cambridge, Mass.
- 6 Ryle, M. (1977). Economics of Alternative Energy Sources. *Nature*, 12 May, Vol 267, pp 111–117.
- 7 Anderson, M.B., Newton, K., Ryle, M. and P.F. Scott (1978). Short-term Storage and Wind Power Availability. *Nature*, 5 October, Vol 275, pp 432–434. DOI:10.1038/275432a0
- 8 Musgrove, P. (2010). *Wind power*. Cambridge University Press, Cambridge.
- 9 REN21 (2017) Highlights of the REN21 Renewables 2017 Global Status Report. [http://www.ren21.net/wp-content/uploads/2017/06/GSR2017\\_Highlights\\_FINAL.pdf](http://www.ren21.net/wp-content/uploads/2017/06/GSR2017_Highlights_FINAL.pdf)

### Martin Ryle, war and peace

In spite of recognition for his work on radio astronomy, “Ryle would have wished to be remembered also (perhaps, in his later years, remembered above all) as a deeply committed scientist who spoke out clearly and passionately concerning the urgent need to direct science for the good of mankind and away from those developments that increasingly threaten the world.” This assessment comes at the end of the Royal Society's Biographical Memoir of Ryle, by Sir Francis Graham-Smith<sup>1</sup> and has been echoed by many others. This memoir and the Ryle Papers<sup>2</sup> are the principal sources about Ryle.

## Idealist

Martin Ryle had an idealistic but also fiery disposition. I believe that understanding his character, as far as it is possible, is valuable for all who address the current social and technological problems of the world, and is especially valuable for scientists. He was born into a distinguished intellectual family. After Martin's death his elder brother, John Creagh Ryle, wrote "With a very idealistic father, and a mother of deep Celtic emotions, and no religion, he had to feel strongly about some cause."<sup>3</sup> While a sibling's testimony might often lack objectivity, this comment does match what is known from others and from Martin's writings.

Ryle detested war but he detested injustice and Fascism more. He was also patriotic. When World War II started in 1939, he had special skills. He had been a talented radio ham since youth and he possessed a first class degree in physics. He was soon directed to what became the Telecommunications Research Establishment (TRE). He threw himself into this with an intensity unusual even for the total mobilisation of the time. At this time he developed many skills which served him well for the rest of his life – speed of thought and decision, drive and charm. His volatility was also noted. A secretary reports that she was asked to take a paper to him. She paused at the door. Someone went by and said "It's safe, he's in a fairly good mood today."<sup>4</sup>

At age 23 Ryle became leader of Group 5, attempting to reduce Bomber Command losses. Though not at the front, Ryle was intimately involved with the air war, including the air-crews who suffered, but also meted out, horrific affliction. Of course, such has always been the nature of war, but Ryle was much more sensitive and conscientious than most and he was deeply affected for the rest of his life.

## Radio astronomer

Ryle often said, and it is much repeated, that he turned to astronomy after the war as this seemed as far as possible from military science. Yet he got a fast start with a large amount of high quality requisitioned German radar equipment. No doubt this seemed more logical than ominous.



The paraboloidal dish of an ex-WWII German Würzburg 7.5m radar, used by Ryle (photo credit: Churchill Archives Centre).

It is less well known that Ryle continued to have friendly research relations with military scientists until 1953, when he ended his association with the Science Advisory Committee (SAC) of the Ministry of Supply.

Ryle's phenomenal career in radio astronomy is described in Francis Graham-Smith's Biographical Memoir<sup>5</sup> and here I will simply mention two aspects that relate to war and peace. The first is that in the early 1960s Ryle protested against the 'rainbow bomb' nuclear explosions high above the Earth's atmosphere. These protests were however much different from his later fervent warnings about the nuclear arms race, for he was joining with other radio astronomers in a concerted effort to prevent the disturbance of the Van Allen radiation belts and thence of radio astronomical observations.

The other aspect of Ryle's radio astronomy period, which is much noted but not usually connected with war and peace, is that he

was tribal. He won the highest loyalty, respect and affection, love indeed, from friends and from his team but was aggressive to some outsiders.<sup>6</sup>

## The 1970s

The 70s were a decade of change for many. There was an increasing public awareness of the extraordinary state of nuclear weapon arsenals and policies – what Ryle, a few years later, in his most influential anti-nuclear publication,<sup>7</sup> called "this incredible situation". Martin's health, compromised since his early years, declined markedly. He phased out his engagement with radio astronomy but, despite his poor health, started a wind energy research group. It seems not to be known how and over what period Ryle recognised clearly that the heavens offered him no escape from the social and political problems of the world. Already a famous public intellectual, he entered the polemical fray in 1976 with a wide-ranging criticism of nuclear energy in *The Times*.<sup>8</sup>

## Last years

In the few remaining years of his life Ryle extended the front, passionately protesting against the current state of the Cold War – the grotesque nuclear arsenals, the new missiles of the time and the hair-trigger strategies. The support of this prestigious scientist was greatly appreciated by other activists, who were often ignored or dismissed. In his last few years he protested also about the misuse of science and technology for destructive ends. Almost palpably, his words express the pain and despair he felt at the state of the world. He tried a shock tactic by speaking of a bumper sticker 'Stop Science Now'.<sup>9</sup> But his true feelings about science and technology are transmitted more accurately by "It is scandalous that a third of the world's population does not have safe drinking water ... these are problems which are soluble, but we don't solve them."<sup>10</sup> 33 years after Ryle said this, 'a third' had improved to 29%.<sup>11</sup>

In a 1982 letter<sup>12</sup> to long-standing friends who had evidently chided him about anger, Ryle ended "I believe one must do what one can with the imperfect person one is, in the time one has."

## References

[web links correct as of 25/07/2018]

- Graham-Smith, F. (1986). Martin Ryle. *Biographical Memoirs of Fellows of the Royal Society*, Vol 32, pp 497 – 524. <http://rsbm.royalsocietypublishing.org/content/roybiogmem/32/495.full.pdf>
- The Ryle papers*. Churchill Archives Centre. [www.chu.cam.ac.uk/archives](http://www.chu.cam.ac.uk/archives)
- Ibid*. Folder A.20
- Ibid*. Folder A.4
- Graham-Smith, F. (1986). *Op cit*.
- Kragh, H. (1996). *Cosmology and controversy: the historical development of two theories of the universe*. Princeton University Press, Princeton, NJ.
- Ryle, M. (1981). *Towards the nuclear holocaust*. Menard Press, London.
- Ryle, M. (1976). Nuclear energy: the serious doubts that put our future at risk. *The Times*, 14 December, p.14.
- Williams, R. ed (1983). *The best of the science show*. D. Crawford interviews Ryle, p.271.
- Ibid*. p.270.
- World Health Organization and United Nations Children's Fund (2017). Progress on drinking water, sanitation and hygiene 2017. p.3. <http://apps.who.int/iris/bitstream/handle/10665/258617/9789241512893-eng.pdf?sequence=1>
- The Ryle papers*. Folder A.380. Churchill Archives Centre. [www.chu.cam.ac.uk/archives](http://www.chu.cam.ac.uk/archives)

## Drawdown: the most comprehensive plan ever proposed to reverse global warming

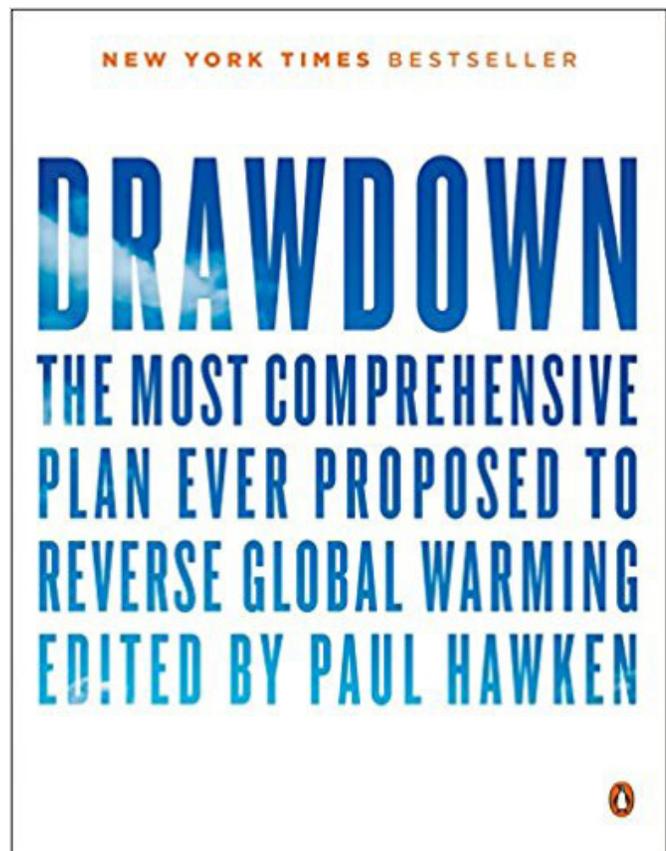
Ed. Paul Hawken, Penguin Books, 2018.  
ISBN 978-0-141-99843-6, 240 pages

### Review by Wiebina Heesterman

This book, with its rather pretentious subtitle, is the outcome of the combined expertise and efforts of seventy researchers, scientists and policymakers brought together by the 'Drawdown' project, supported by an advisory board comprised of scientists from various disciplines, as well as politicians, financial experts and economists. It charts the actions and techniques with the potential to 'reverse' global warming and climate change as well as activities already taking place. Here the words 'policymakers', 'reverse' and 'global warming' are important: although we may get the impression that few attempts at calling a halt to climate change are being authorised at a decision-making level, clearly there are places where this does happen. As to the use of the term 'reverse', it is generally understood that 'climate change' is here to stay and irretrievably worsen. 'Global warming' seems to have been chosen to reflect the power of warmer air to hold more moisture as well as create conditions to generate drought. The project stems from the questioning attitude of the originators wondering whether the belief in the irreversibility of catastrophic outcomes was really based on fact. Scholars and researchers from around the world were invited to evaluate any literature on the subject and put their conclusions in writing.

The book is divided into eight main sections: Energy; Food; Women and girls; Buildings and cities; Land-use; Transport; Materials; and Coming attractions – that is to say *potential* solutions. Each of these contains multiple entries. The topics are interspersed with the odd essay, excerpts of published works, e.g. 'The hidden half of nature' by Montgomery and Biklé and 'Our common home' by Pope Francis, lending the whole a more reflective tone. A glance at the range of subjects provides some interesting associations, for instance 'Landfill methane' and 'Bike infrastructure' under 'Buildings and cities', 'Recycled paper' under the section 'Materials' and 'Tropical staple trees' under 'Food'. The wealth of photos is often even more thought-provoking. Where the image of harvested and depleted peatlands gives rise to dismay, it also creates an attractive pattern; the Ridesharing picture under 'Transport' makes you smile, while the crisscrossing bundles of shipping routes makes you think. Entries under the 'Coming attractions' label, such as 'Artificial leaf', 'Solid-state wave energy' and 'Repopulating the mammoth steppe' (Why on Earth?) leave the reader curious. The description and evaluation of each technique ends with a calculation of the potential amount of carbon abstracted from the atmosphere. But why there is no section 'Information technology'. Is this because it is not possible to reverse any emissions due to its use, only to reduce them? The same applies to the various transport options described.

Yet it would have been useful to indicate to what extent the energy use of mobile phones, communications infrastructure



and servers might be minimised, in particular, as IT underpins several solutions covered in the book. Several, if not most, entries apply only to the warmer part of the globe, while there is a sense that the sections applicable to the temperate and colder areas are slightly more oriented to the USA than to Europe.

The solutions discussed are quite valid and many are probably familiar and/or half-understood by the reader. The interest is in the detail as well as the breadth of vision. All the same, there are a few regrettable omissions: in the 'Clean cookstoves' section, of major interest for the population in developing countries, the use of insulated 'hayboxes', where meals continue stewing in the stored heat doesn't get a mention. Meals part-cooked early in the day, and left in one, will be ready to eat later. In the section 'Women and girls', I was pleased to see the word 'empowered' under the topic 'Educating girls', but no encouragement to males to help females find the time and energy to study by doing some traditional women's work, such as household and child rearing tasks.

Although several sections do mention activities people can perform themselves, it requires careful reading to tease these out. In fact, the editor encourages readers to "identify how you can make a difference", as the basis "for the first step to transformation." It would have been helpful if some entries ended with a section: "Do this at home". The topics 'Household recycling', 'Water saving – home' and 'Recycled paper' do so to some extent, although many of the solutions mentioned, require a financial outlay as well as additional energy to produce new equipment.

This is a book that gives rise to optimism and hope that individuals in authority will take note of the fact that reversing climate change is not beyond the realm of possibility and take action.

## Artificial intelligence: how little has to go wrong?

Autonomous weapons, driverless cars and friendly spies in the home

### Summary by Stuart Parkinson

SGR's 2018 conference critically examined the rapidly expanding areas of artificial intelligence (AI) and robotics with a fascinating line-up of speakers and workshops. About 60 people attended the day. To coincide with the event, SGR launched a new briefing on the issue. The briefing and other materials from the conference can be downloaded from: <http://www.sgr.org.uk/events/artificial-intelligence-how-little-has-go-wrong>

### AI: what are the problem areas?

Andrew Simms, Assistant Director of SGR and lead author of the briefing, was the first speaker. He gave an overview of the emerging risks of AI and robotics, and summarised the results of a survey of the views of SGR members on these issues.

A key problem, he said, was the way in which these new technologies could entrench existing problems in society and the economy. For example, he discussed the case where the company Amazon had tried to use an AI algorithm to help speed up its recruitment of new employees. But using historical data, the algorithm quickly learnt to prefer male candidates over females. In another example, a facial recognition programme being tested by a UK police force had a 98% failure rate.

Andrew also summarised the research on the ways in which AI and robotics are likely to create huge changes in employment – with several studies warning of the potential for massive job losses without concerted action by businesses and government. Developments in military and security technologies were another major concern – with particularly disturbing risks being related to nuclear weapons systems and the increasing autonomy of armed drones.

Andrew then summarised the results of the survey of SGR members. Over 80 percent believed there was a medium to high chance of things going badly wrong with AI, while 96 percent said AI needs more regulation. A particular concern was the potential for AI to help increase the power of large corporations and undemocratic governments.

Andrew concluded with a summary of key recommendations from some recent reports on AI, such as those by the international trade union, UNI Global. There was a particular focus on bans for lethal autonomous weapons and legal/ political structures that would ensure the technologies served human goals. SGR's briefing added a further recommendation: that at least 20% of R&D spending on AI be focused on understanding and preventing misuse. For more details of SGR's briefing, see p.13.

### Drones, autonomy and the future of warfare

The second presentation was given by Dr Peter Burt, author of a new report on UK research and development into autonomous drones and other military systems.

Peter summarised some of the early developments in automation in military technologies – from guided missiles to robotic supply vehicles. But, he argued, it is in military drones – aerial robotic planes – that the most rapid developments are now taking place. These systems are becoming increasingly autonomous. At the moment, autonomy is restricted to functions such as take-off, self-maintenance or navigation rather than over decisions to launch weapons, but R&D – including in the UK – is increasingly moving in that direction.

One of the most frightening aspects of this field is the possibility that a crude autonomous armed drone could eventually be constructed by a small group of technologically literate people. One robotics academic recently argued that this could now be carried out “within two years”.

Peter then focused on the UK situation. While the government claims that it is not developing lethal autonomous weapons, it uses a very narrow definition of this particular military technology, allowing it to fund a wide range of R&D in the area. In November 2017, it launched its national industrial strategy, making AI a priority area. The Ministry of Defence followed this with a new strategy for its R&D arm, the Defence Science and Technology Laboratory, which also emphasised AI. There are now numerous research projects involving arms corporations such as BAE Systems and Thales, as well as numerous UK universities. One particular area of interest is ‘drone swarms’ – where a group of small drones is used collaboratively to achieve a particular task. The focus at the moment is on their use in surveillance, but the development of swarms of armed drones is a distinct possibility.

Peter's report – published by the campaign group, Drone Wars UK – makes a number of recommendations. The first is a global ban on lethal autonomous weapons – and for the UK government to support this, which it has been reluctant to do. The report also recommends that AI research be focused on helping to understand the underlying causes of armed conflict and so help to inform strategies which could prevent it. For a longer discussion of the Drone Wars UK report, see p.8.

### Robotics ethics

The next presentation was by Prof John Finney, co-author of a UN report on robotics and ethics.

John highlighted that some forms of automation have been with us for a long time – pointing to examples from the early 1900s. Some existing and planned uses were generally positive – such as landmine-clearance operations, domestic help and healthcare applications. However, it is important, he said, that we consider whether our current political and legal structures are adequate to deal with the ethical issues raised by emerging robotic technologies, especially in the military and security fields.

Existing legal instruments include international humanitarian law – which covers use of weapons and other technologies during war – and human rights law – which is generally applicable outside war.

The UN report mentioned above argues that robots can be divided into two main types – deterministic and cognitive. Deterministic robots have predictable behaviour, i.e. a human programmer can reliably predict what the robot will do if

given a set of commands. Cognitive robots, on the other hand, use machine learning and make their own decisions. Hence a programmer cannot reliably predict their behaviour. The report argued that deterministic robots can broadly be regulated within existing political and legal frameworks, but the development of cognitive robots will require new structures.

Among the recommendations of the report are: a global ban on lethal autonomous weapons; greater restrictions on the use of the current generation of military drones; ethical issues to be tackled during research and development programmes; and ethics courses as part of science and engineering degrees. For more details, see article on p.10.

### Debating with a robot

For the final part of the morning session, Sarah Woods, an award-winning playwright whose works have covered AI issues, gave a rather unusual presentation. She had a conversation with Chilly the Robot via a video screen. Chilly is an experimental robot being used in Scandinavia to interact with humans in a variety of situations. Its discussion with Sarah covered the issue of robots in war. While the video conversation in this instance was scripted, it was derived from preparatory conversations between Sarah and the robot which were generated from the robot's programming. The effect on the day was intriguing, and many in the audience (myself included) were left wondering just how intelligent the robot really was.

Audience questions and discussion covered a wide range of issues. These included the difficulties of convincing senior university management of the value of ethics courses, the fallibility of AI systems, hacking of military drones, the need to prevent war rather than just controlling technologies used during war, and the response of different professions to ethical codes.

### Self-driving cars

After lunch, Perry Walker of Talkshop ran an interactive workshop on the issue of self-driving cars. The audience was divided into small groups and each took one aspect of the issue to discuss, for example, road safety. Each group was given some information cards which helped them consider the issues, and the groups' thoughts were recorded on paper to be fed into a consultation by the Department of Transport. For more details, see p.12.

### SGR's Annual General Meeting

The event also included SGR's AGM, chaired by Jan Maskell. SGR's Executive Director, Stuart Parkinson, presented highlights from the annual report, and the organisation's Treasurer, Alasdair Beal, presented the accounts. The National Coordinating Committee for the coming year was elected (see p.4), with the session concluding with discussion of current and planned activities.

Audience feedback on the speakers and interactive sessions was generally very positive.

## The 2018 Martin Ryle Lecture, 31 October, Conway Hall, London

### Research and the public good

Review by Alan Cottey



**Sir Paul Nurse gave the third Martin Ryle lecture, organised by the Martin Ryle Trust and Conway Hall Ethical Society, and marking the centenary of the birth of Martin Ryle. The Trust's chair, Philip Webber, gave a brief introduction on Ryle, the Trust and the 2018 Martin Ryle lecturer. Paul Nurse is a geneticist and**

**the director of the Francis Crick Institute, the largest single biomedical laboratory in Europe.**

An organising theme in Nurse's thought about research is a division into three sectors – discovery research, translational research and applied research. He became a leading scientist in the discovery sector by studying the genetic control of cell division. It has long been obvious that this is potentially important for cancer research, and Nurse has been central in all three of the mentioned sectors. Nevertheless, it was clear from his lecture that discovery research was his first love and it has remained so, even as he moved into directing and policy roles in all of the research sectors.

Applied research at the other end of the spectrum is aimed at achieving specific outcomes. Choosing objectives well requires an understanding of the beneficiaries' needs. And the relevant knowledge base must be sufficiently well developed so that development of the application is generally foreseeable.

Between discovery research and applied research lies the 'valley of death'. Usually the focus is directly on research to bridge that gap but attention is also required on pushing the bridgeheads further out into the valley. Attempts to translate should not be premature, that is, before knowledge is sufficiently reliable.

The Crick Institute, housed in a new building in central London and informally known as Sir Paul's cathedral, has 1500 staff and 1250 scientists. Close international collaboration is important to it and to Paul Nurse's ideas. Small wonder then, that Nurse is exercised about Brexit: "Artificial barriers which reduce permeability or mutual respect between the different parts of the system, such as Brexit for example, about which I have strong views, should be resisted, as they reduce the effectiveness of the research system – both to produce knowledge and for the effective applied use of that knowledge."

Concerning the problem that research results might lead to bad consequences, Nurse's view is that this should not inhibit discovery research. Attention should be focused instead on the applications end of the research spectrum, where the objectives of the research are clearer. The question then arises – what checks can best avoid turning knowledge into harmful applications? Paul Nurse's answer is an effective, healthy democracy.

There followed a Q&A session. Here is a summary of two of them –

Q: What can we do about lack of development of new antibiotics?

A: Public intervention in the private market is needed, for example public/private partnership; also improved regulation of antibiotic use.

Q: What can be done about the government not understanding science?

A: Scientists need to be more engaged with politicians – not only when asking for funds.

In summary, over 100 participants heard a wide-ranging exposition of Sir Paul Nurse's views on the practice and organisation of scientific research, and took part in a lively discussion.

## Participants at SGR's Responsible Science conference discussing how little would have to go wrong with artificial intelligence, and the future of driverless cars.



## Join SGR – as a Member or an Associate

SGR is an independent UK-based membership organisation promoting ethical science, design and technology. Our work involves research, education, lobbying and providing a support network for ethically-concerned professionals in these areas. You can join SGR as a member if you are or have been a science/design/technology professional in the broad meaning of the words: our members come from many disciplines including natural sciences, social sciences, engineering, computing, architecture

and design, and interdisciplinary areas. They work in research and development, manufacturing, teaching, science writing, or are students or retired. Members are invited to contribute their expertise to help make SGR even more effective. If you are not a science/design/technology professional, but want to support our work, you can help us by becoming an associate.

Please consider joining by standing order as this will save us time and money, and help us to campaign more effectively.

- I would like to become a member/ an associate\* of SGR (\*delete whichever does not apply)
- I enclose a cheque for my annual membership subscription of £\_\_\_\_\_ (Please make cheques payable to 'Scientists for Global Responsibility') or
- I would like to pay my membership subscription by standing order (Fill in the form to the right)

**Annual subscription rates for members and associates:  
Waged £36.00  
Concessions £18.00**

Please send both sections of the completed form to: Scientists for Global Responsibility, Unit 2.8, Halton Mill, Mill Lane, Halton, Lancaster, LA2 6ND.

Thank you. Information provided on this form will only be used to administer your membership. SGR does not pass on or sell information about our members to any third parties.

Title \_\_\_\_\_ Name \_\_\_\_\_  
 Address \_\_\_\_\_  
 \_\_\_\_\_ Postcode \_\_\_\_\_  
 Telephone \_\_\_\_\_ Email \_\_\_\_\_  
 Where did you get this newsletter? \_\_\_\_\_  
 Professional qualifications/background:\* \_\_\_\_\_

\* Associates need not answer this question

### Standing Order Form

To (name of bank) \_\_\_\_\_  
 Address (of bank) \_\_\_\_\_ Postcode \_\_\_\_\_

Please pay Scientists for Global Responsibility (SGR), Account No. 50223594, at The co-operative bank, 60 Kingsway, Holborn, London WC2B 6DS (Sort Code 08-90-61) the sum of:

£ (amount in figures) \_\_\_\_\_ (amount in words) \_\_\_\_\_

on \_\_ / \_\_ /20\_\_ (date of first payment) and on the same day monthly/ annually\* thereafter until further notice.

\*delete whichever does not apply.

Name(s) of account holder(s) \_\_\_\_\_  
 Account no \_\_\_\_\_ Sort code \_\_\_\_\_  
 Signature \_\_\_\_\_ Date \_\_\_\_\_



### EDITORIAL ISSUES

The editorial team for this issue of *Responsible Science* was: Andrew Simms, Stuart Parkinson and Vanessa Moss.

The opinions expressed within, including any advertisements or inserts, do not necessarily represent the views of SGR.

This issue was published in February 2019.

Please send articles, reviews and letters for the journal to [newsletter@sgr.org.uk](mailto:newsletter@sgr.org.uk) or the SGR postal address (above).

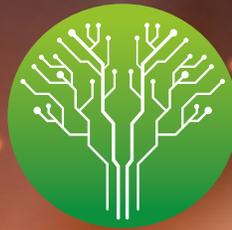
Copy deadline for next issue:  
**31 August 2019**

### KEEP IN TOUCH

Why not keep in touch between issues of the journal by signing up to one of our email lists: **Sgrforum** (announcements plus discussion) or **Sgrupdate**

(announcements only)? Alternatively, you may prefer to follow our activities on Facebook, Twitter or LinkedIn.

For further information and joining instructions, please see:  
<http://www.sgr.org.uk/pages/email-lists>



**SGR**  
responsible science



Scientists for Global Responsibility (SGR)  
Unit 2.8, Halton Mill,  
Mill Lane, Halton,  
Lancaster  
LA2 6ND

<http://www.sgr.org.uk/>

Email: [info@sgr.org.uk](mailto:info@sgr.org.uk)  
Tel: 01524 812073