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Digital Animals

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Recently, I was in northern Kenya, watching a reticulated giraffe as it chewed carefully at the soft leaves between thorns at the top of an acacia tree. Giraffes are wonderful and strange animals. Their movements are lumbering and awkward, yet curiously graceful; their vertiginous neck and bold orange crazy-paving coat seem better suited for a child's pyjamas than as adaptions to the diverse perils of the African savannah.

The giraffes in this part of Kenya have been declining, and scientists are trying to find out why. The particular giraffe I was watching had a small box the size of a cigarette packet attached to its horns (actually made of cartilage covered in skin, and called "ossicones"). This was a solar-powered satellite tag, attached by researchers from the San Diego Zoo. The tag contains a GPS, and every hour it sends a signal via a satellite to record the giraffe's location. The researchers can overlay giraffe's track through day and night onto a Google Maps satellite image. The scientist can analyse where it goes and where it lingers, and infer the factors that shape its daily life, or eventual death. The tagged giraffe is subject to surveillance just like a shopper in a mall.

This capacity to track wild animals is recent, a new human super-power conferred by digital electronics, miniaturization, satellite communication and visualization. This tagging programme only began in 2017. Many species are now routinely tagged in this way, for example terrestrial and marine mammals, birds, fish or turtles. In theory, any animal with a large enough body size to allow for the weight of tag, batteries and attachment devices can be tagged, although the cost of the process (and the feasibility of immobilising the animal and attaching the tag safely and humanely) mean that the procedure is mostly confined to rare species.

To a scientist, the stream of digital data from the tag is simply a new, faster, cheaper and better way to obtain information. In theory, a giraffe could be followed by an observer with a map, so perhaps the digital tagging programme just represents the kinds of novel opportunities afforded by digital technology: more data more cheaply from a tireless automatic field worker. What seemed strange to me (and presumably to the giraffe) is the new normal for conservation and animal behaviour researchers.

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Yet there is more to it than that. As I watch the giraffe move through the Kenyan bush and interact with other giraffes, or avoid hunting lions, scientists in the USA are also tracking it, via a satellite. It occurs to me that if I get too close, perhaps they will even detect its reactions to me. The tag gives the giraffe a digital presence, a second life lived through the continuous unspooling of location data. The giraffe is in the savannah, a material location, but also in the scientist's geographic information system, and indeed in server farms and temporary storage in its transmission from animal to satellite and down again. This digital life is thin, a trace in space and time. But some digital tags, for example those attached to whales or seals, contain other data (pressure to show water depth, or even a camera). In principle there is no limit to the range of sensors that can be attached to a tag, beyond weight, cost and battery life. The

digital life of animals is open to diversification, with enriched streams of data for scientists to ponder over.

Moreover, this digital life is – also in theory – eternal. While in Kenya, I also looked at movement data from an elephant that had been collared about five years ago because it was an inveterate breaker of fences and raider of farmers' fields. It lived in a landscape where smallholder farms abutted land where elephants could roam, and the attractions of fields of maize compared to thorn bush led the animal to raid constantly, with disastrous impacts on local people. In the end, its depredations became so serious that it was tranquilized and moved by low-loader to a different area, without farms. It has since died. But its farm raids are preserved in digital form, night after night, breaking the regional electric fence at dusk and wandering, with followers, from field to field until just before dawn, like a party of excited students on a pub-crawl.

The digital enrolment of individual giraffes and elephants through scientific tags is just one feature of a much wider process of progressive digitalization. The distinction between animal and machine is breaking down. This is true of the idea of the animal as organism, i.e. as a living object, bounded by skin or cuticle, and all its physical interactions throughout its life with other organisms and the physical world. So the satellite tag thus attaches the physical giraffe to its digital avatar.

But digitalization also changes the *idea* of the animal, meaning a form of organic organisation and performance associated with the living body. Digitalization may go beyond simply recording a crude and simplified version of the animal's physical life. It may involve the creation of new digital lives, which have no analogue in nature. Let me explain what I mean, by using a series of examples.

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The first kind of digitalization is perhaps the most extreme. Digital technologies allow the creation of wholly artificial robotic animals. The Sony Corporation released *AIBO* in 1999 as a robotic pet, and *Tekno the Robotic Puppy* was launched in 2000, achieving millions of sales worldwide. A glance at any online toy retail site shows a wide range of robotic animal pets, for example dogs, cats, or monkeys. In Japan especially, there is a lot of interest in the potential of such devices, programmed to realistic responses to human affection, in providing companionship for older people. In robotics, bio-inspired design is a key field, going beyond biomimicry (copying biological systems) to devise mechanisms that are simpler and more effective than those in nature.

Bio-inspired robotic locomotion has become a central element in robotics, driven in particular by investment from the US government's Defense Advanced Research Projects Agency (DARPA). Famously, DARPA funded Boston Dynamics to create *BigDog*, a quadruped robot capable of carrying 150 kilograms of military kit at four miles per hour. Another project was to create the *Energetically Autonomous Tactical Robot*, a robotic vehicle that could fuel itself using plant biomass (although this one had wheels and not legs, so its "animal" credentials are perhaps less secure). A glance at YouTube shows an unnerving collision of science and fantasy in the rapid advances of military bio-robotics.

Perhaps the strangest digital robotic animals are those imitating insects. Again, DARPA is driving innovation. There is military interest in swarm robots; cheap intelligent robots

moving together like swarms of insects. Such digital animals could undertake surveillance or even carry weapons. DARPA has funded work on larger robotic insects, for example a robotic cockroach that shares the real animal's ability to squeeze into tight spaces.

Not all robots are digital, but digital technology is central to the creation of these devices that move and behave like animals, but are not alive. The success of their simulation of natural movement makes them uncanny. It is as if they are alive, even though their energy comes from batteries and their integrated movements from lines of computer code. Whatever design principles are drawn from nature, these simulated animals are devised entirely by human ingenuity. Their design evolves, but only as the requirements of DARPA contracts or other funding – and the ingenuity of human creators – specifies. Their purpose is defined by the web of contracts and patents that structure the activities of the research teams who build them.

Although military researchers have long sought to train intelligent or social animals to do military tasks (for example horses, sniffer dogs, carrier pigeons or, more recently, clandestine work with cetaceans), they do not by and large share human goals. It is therefore not entirely surprising (even if it is shocking) that robotics researchers have tried to integrate computer control systems into living animals by creating cyborgs.

In 2006, DARPA issued a call for proposals to develop insect cyborgs. Researchers at the University of California, Berkeley, worked out a way to insert wires through the exoskeleton of a beetle (the chunky flower beetle, five centimetres long): into its brain, optic lobes, and wing muscles. A "backpack" of electronics (radio receiver, circuit board and battery) allowed signals to be sent that could make the insect fly, and could steer it in flight. The bio-hacking of insects in this way has now become common. In 2013, the company Backyard Brains raised kick starter funding for RoboRoach, described on the company's website as "the world's first commercially available cyborg" (backyardbrains.com/products/roboroach). This was marketed as ideal for "a teacher or parent that wants to teach a student about advanced neurotechnologies". The electronics and the cockroach had to be ordered separately.

These cyborgs are both organic and digital. Unlike a human kept alive by a pacemaker, or whose life is enhanced by glasses or hearing aids, they are under human direction through embedded digital devices. They are alive, but their freedom of movement or action is subject to specific control. The purpose they are given by their human handler goes quite outside their evolved responses to the environment or to other organisms (as a trained dog, perhaps, responds to its handler along channels ingrained by evolution as a pack animal). Their behaviour, and the course of their lives, is directed from code within the computer. Unlike the tagged giraffe, their digital presence does not simply track and mirror their real existence, it determines it. Their digital accessories make them a new animal, part organic, part machine.

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A second dimension of digitalization is the way technologies allow for the creation of virtual animals, and indeed virtual worlds to contain them. Digital representations of living animals may or may not reflect known forms in the real world.

Many digital animals are imaginary. Fantasy animals have become a standard plot device for filmmakers. Dragons, for example, have moved from oral folklore to novels to the screen with varying degrees of verisimilitude, from *How to Train your Dragon* (2010) to *The*

Hobbit: The *Desolation of Smaug* (2013) or *Game of Thrones* (2011). Some films have realized imagined worlds consisting of whole novel ecologies, notably perhaps *Avatar* (2009), where the planet Pandora was home to a diverse bestiary, including the flying great leonopteryx and the hammerhead titanothere, as well as the humanoid na'vi themselves. The power of digital art to evoke an apparently connected and functioning ecosystem (of marine-life inspired plants as well as animals) was the key to the film's remarkable success. This was a nature film, but a nature populated by imaginary animals. Like the Harry Potter spinoff *Fantastic Beasts and Where To Find Them* (2016), digital animals offered a pimped up version of the mundane real world.

Digital technologies have also supplied imaginary beasts as virtual pets. Back in 1996, the Japanese toy maker Bandai released the *Tamagotchi*, a pocket-sized electronic device with an LCD screen portraying an imaginary creature. This electronic pet required constant care and feeding using tiny buttons on the device, or it would die. A year later, Bandai created *Digimon*, a monster whose power could be built up and used to fight others. In 1998, Nintendo launched an electronic version of the Pokémon, *Pikachu*. Not only did the owner have to feed and clean it, but also take it for walks (tracked by the device's pedometer).

Digital technologies are increasingly important in the virtual representation of real animals. The classic examples of this are also in film, with the recreation of extinct species. The velociraptors and Tyrannosaurus of *Jurassic Park* (1993) were shockingly believable, as was the more educative evocation of prehistoric worlds in the TV mini-series *Walking with Dinosaurs* (1999). Computer games use the same technologies, simulating ecosystems and animals, often with incredible fidelity.

Digital film technologies have been extended with virtual and augmented reality. These digital devices simulate a physical environment (which could be real or artificial), allowing the user to turn, move and interact with virtual objects. This technology has been used by museums and conservation organisations to create immersive environments (coral reefs or forests for example), complete with their characteristic animals. You can, for example, take a virtual tour of key US National Parks, experiencing their "natural wonders" via virtual reality, captured for all time and accessible to anyone with enough bandwidth and the right headset.

Augmented reality offers an even more intriguing prospect. Here, computer-generated animals can be overlain onto a real-world environment. The power of such technologies was shown in the success of Pokémon Go, an augmented reality mobile phone game launched in 2016. Players used their phone's GPS to locate Pokémon "species" in real-world locations, seeing them displayed on their phone camera. By 2019 the game had been downloaded more than a billion times. In 2017, the startup Internet of Elephants launched an app called *Safari Central* that used augmented reality to overlay images of six animals onto the user's phone camera images of their everyday environments. By August 2019, the app had been downloaded by 180,000 unique users, and over 100,000 photographs of people and their favourite animals had been uploaded to their website.

Virtual animals can be real or unreal, but digital technologies make them *seem* real. Moreover, they have escaped film, with its long-standing ability to blur the boundaries between fantasy and reality, to inhabit real places. Fantastic animals, like Pokémon, can escape the computer to appear in the real world. A few years ago, research showed that primary school children in the UK recognised more Pokémon characters than wild animals.

Now these novel animals can be brought onto streets – or nature reserves. And real animals can be made to exist – to move and to perform behaviours – in places where real animals do not (elephants in Trafalgar Square, for example, or rhinos in the living room).

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The creation of virtual animals, like the invention of life-like robots and the use of surveillance devices to plug animals into digital worlds, seems an inevitable part of the industrial revolution of the late twentieth century, and the rise of digital technologies in all their forms. In his 2011 book *Technological Nature*, Peter Kahn talks about the growing power of technologies that mediate, augment, or simulate the natural world. Non-human nature is increasingly not sensed directly but mediated by technologies, of visualisation or surveillance. And digital animals, whether created in simulated worlds or with physical body parts, are increasingly important parts of the imagined ecology of the world humans perceive around them.

Does this matter? On the one hand, perhaps not. Many applications of digital technologies to animals are somewhat fanciful, and expressing concern about them might seem to be worrying about what might happen in the future. On the other hand, there must be a concern that the virtual and the digital will come to supplant the organic and real in the minds and affections of the public.

There are two obvious problems with this. The first is the erosion of authenticity, the breakdown of the physical sense that nature is real, and therefore that the way humans treat it has real implications. Commentators widely deplore the apparent dependence of young people (and adults) on the screens of mobile devices, and the consequential difficulty they have in distinguishing between reality and the imagined. Others highlight the importance of giving children direct physical experience of non-human nature (for example Richard Louv in his ideas about "nature deficit disorder" in his 2005 book *Last Child in the Woods*).

The second problem is that is if nature can be created and preserved digitally, it might undermine the value of living animals. As Colin Ellard points out in *Places of the Heart*, there will, perhaps, seem to be little that is special about an actual animal if it is possible to access digitally "an authentic 3D immersive experience that will have exactly the same effects on the senses".

The rendering of animals using digital technology is a novel power. There are many exciting and positive possibilities, from better science to understand conservation problems, to wider accessibility to (and potentially understanding of) wild animals and the habitats they live in. Yet, like other examples of novel powers, there are also responsibilities. Will the use of digital tracking have positive outcomes for the animals that are tagged, or simply feed a data-hungry science machine? How will robotic devices created by bio-imitation be used and for what purposes? How are virtual worlds – and virtual species – to be deployed in ways that maintain wild spaces and life-chances of wild animals?

Scientists, and those of us who marvel at their works, need to look beyond the hype, and address the implications of digital animals, not least for ourselves.

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