Editorial: Decarbonising information work

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This editorial addressed the environmental impact of information, and the role of ethical information work in addressing this impact. The most obvious shift in the ways in which we live and work in the twenty-first century has been the inexorable rise of information and communications technologies. Technology has changed not only the ways in which we work, but the kinds of work that gets done. The coming AI revolution will undoubtedly bring more significant changes to the nature of work. While in the short term AI will likely displace current jobs, in the long term it will likely change the nature of work, driving potentially unbounded economic growth. We are on the brink of an age of limitless productivity, where intelligent machines drive growth and innovation. But at what cost?

In recent years the concept of the Anthropocene has gained traction. The Anthropocene is a proposed geological epoch intended to supersede the Holocene, the period during which human civilisation came to fruition. It signals the impact of human culture on the environment, and the long-term traces of that impact on the geological record. Key long-term markers of the impact of human activity include biodiversity loss, climate change, and chemical markers arising from industrial production and the dawn of the nuclear age. While the starting point for the Anthropocene is still under discussion, consensus is forming around the mid twentieth-century, a period that has become known as "the great acceleration" (Stefan et al, 2015). Steffan et al (2004) noted that:

> The second half of the twentieth century is unique in the entire history of human existence on Earth. Many human activities reached take-off points sometime in the twentieth century and have accelerated sharply towards the end of the century" (2004: 131).

They later reflected that "we expected to see a growing imprint of the human enterprise on the Earth System from the start of the industrial revolution onwards. We didn't, however, expect to see the dramatic change in magnitude and rate of the human imprint from about 1950 onwards" (Stefan et al 2015: 81). The great acceleration marks the starting point for a rapid rise in industrial production and the use of agrochemicals. It is less widely acknowledge that it also marks the dawn of the computing age; Creutzig et al argue that "the computer revolution coincides with the inflection point of the Great Acceleration around 1950" (2022: 482). While information and communications technology have not themselves caused changes identifiable in the geological record, the apparent synchronicity is not in fact coincidental. Creutzig et al highlight the role of computer modelling in enabling the atomic age (2022), which have become inscribed in the geological record. In addition the availability of computing power has been a major, if not the major enabler of post-war economic transformation. The Anthropocene is also the information age, and indirectly perhaps information technologies has heralded unprecedented environmental risks.

The environmental cost of information and communications technologies

The full environmental cost the digital revolution is complex and not well understood; the Parliamentary Office for Science and Technology for example note that "there have been no academic studies that estimate energy use of the ICT sector in the UK" (2022). While on the one hand information and communications technologies create energy efficiencies in a wide range of contexts, they also account for considerable energy use. This is split between the embodied energy use associated with manufacture, assembly and disposal, and the operational energy use in day-to-day operation. However rapid development of information and communications technologies and incremental improvements in efficiency make it difficult to understand their overall impact.

Across the digital lifecycle energy is consumed in (McMahon, 2018: 6):

1. Manufacturing and transporting devices that connect to form the Internet (servers, networking equipment, laptops, phones, etc.
2. Powering devices in use, including when they are on standby and when idle
3. Manufacturing, transporting and constructing the infrastructure that supports the ICT equipment
4. Powering equipment that maintains an appropriate operational environment for ICT equipment(e.g. by stopping servers from overheating)
5. Powering and operating connections between networked equipment
6. Creating and storing digital content, for example, to upload onto laptops and phones and share online
7. Recycling and disposing of devices such as computers, smartphones, chargers etc

Information and communications technologies are estimated to be responsible for 4% of global greenhouse gas emissions in their operational energy consumption (POST, 2022) and that may double by 2025; embodied energy use is estimated to account for an additional half of their energy costs for commercial uses, and up to double these operational costs for consumer devices.

These are significant costs, and several recent development have raised particular environmental concerns: crypocurrentcies, the Internet of Things (IoT) and Artificial Intelligence applications (AI). Bitcoin is a good example of these. In order to introduce an element of scarcity into the cryptocurrency, the Bitcoin mining algorithm is designed such that progressively more processing is required to "mine" each additional Bitcoin. Bitcoin mining is the process by which transactions in the blockchain are validated by applying cryptographic solutions; this proof-of-work is rewarded with new Bitcoins. As a consequence – and in part because of the unprecedented success of the currency – Bitcoin mining now use truly staggering amounts of energy. Bitcoin itself is estimated to use almost half of global energy expended in large scale data centres – as much as 127 terawatt-hours per years, more than the entire energy consumption of many countries (Kearney, 2024). Bitcoin is particularly wasteful as miners compete to validate transactions, meaning that the vast majority of the processing power expended per transaction is essentially wasted. While this is not an intrinsic cost with all cryptocurrencies – the energy uses of BitCoin has prompted other cryptocurrencies such as Ethereum to adopt more energy efficient solutions to proof-of-work.

Internet of Things devices however reveal some of the complexity associated with the environmental cost of information and communications devices. The volume of IoT devices connected to the internet is set to increase rapidly over the next few years. Intrinsically they tend to be always-on devices, consuming operational energy even when in passive mode. In addition the growth of IoT devices involves significant embodies energy costs associated with their production and eventual disposal. Therefore the environmental impact of the Internet of Things would appear superficially to be obvious. However many IoT devices are designed to produced efficiency savings elsewhere. The energy costs of smart metres for example are trivial compared to the potential energy efficiencies that accrue from the greater control over energy consumption. Smart plugs, switches, lights, thermostats, and similar devices probably generate more efficiencies than they cost to manufacture and run. The environmental impact of AI enable devices is similarly difficult to evaluate; while AI devices intrinsically consume more energy because they are doing more functional work than dumb devices, they are also able to respond to the contexts of their use. An AI enable heating panel for example is doing more work than a dumb switch, but probably saving energy overall.

But while the environmental impact of digital technology remains unclear – albeit significant – it ignores one additional area of environmental impact: the environmental cost of information itself. We often treat information as essentially synonymous with the technology on which in relies, however that is not always the case: information itself has an environmental impact, and the more bits we create, move and use, the greater that cost will be. What is more the rise in the production of data in recent years has been driven by a form of passive data creation – devices particularly smart-devices of different kinds – generating information and data that is never fed into any other process or function. While the impact of technology is only an indirect professional concern of information and knowledge managers, the impact of information is squarely within our remit. Therefore ethical information work is obliged to take into account the environmental costs of information itself, and as we shall see, these are nonnegligible.

Decarbonising information , decarbonising data.

It is easy to forget in our abstracted digital world where information is both effervescent and ephemeral that information is nonetheless always physical (Landauer, 1991). That is to say that while information itself might arise from the observation of states of matter, it nevertheless requires a physical medium of one kind or another. The physicality of information and data in library and information management was emphasised by MK Buckland, who contrasted the material nature of information with abstract concepts of information, data and knowledge (1991; 1997). Ellis (1992) later differentiated between physical and cognitive paradigms in information research, contrasting information-as-thing with those cognitive processes which are integral to meaning, understanding, and knowing. An emphasising on the physical nature of information gains support from the ways in which information has become a central concept in material science, systems theory and complexity research.

Considering information as a thing, the digital revolution can be understood as the progressive miniaturisation of information carriers, from the physical media of traditional librarianship such as books, newspapers, records and photographs to the digital media of pulses of electrons and photons. In fact this miniaturisation of information carriers is synonymous with technological miniaturisation. Microchip circuitry, for example, has shrunk from a micrometre scale in the late nineteen-sixties to around 3 nanometres today; the number of atoms used to store each bit in magnetic storage has reduced over time from hundreds of billions to just 12 in a recent experimental storage device, and around 100,000 in a standard hard drive. As information is stored and transmitted in ever smaller physical units, the environmental impact of information also reduces commensurately, such that the cost of one bit of information today is very nearly zero.

And yet very nearly zero is not quite zero. Furthermore while our capacity to store and transmit information has become progressively more efficient those gains have been outstripped by our capacity to generate ever more data. As we have covered before in Business Information Review, information is being created at a truly staggering rate, and the aggregate of those individually negligible bits, bytes, kilobytes, megabytes and gigabytes is a significant environmental impact emerging from out data dependency itself. When the writers of the 1990s report on information overload suggested workers were dying for information (Reuters Business Information, 1996), they perhaps did not imagine how literally true that could turn out to be.

The Digital Decarbolisation project based at Loughborough University has done much to raise awareness about the environmental cost of information and data. This cost arises from an inverse relationship between the density of information storage and the volume of information created and stored in contemporary culture. As our capacity to transmit and store information grows, so to does our demand for information and data. It is now estimated that 1.7mb of data is created every second for every living person (Digitaldecarg.org, 2024); that is around 54 terabytes per person per year, and the volume of data being produced is currently growing exponentially. Transmitting and storing 1 terabyte of data in the cloud may account for as much as two tons of CO2 emissions depending on the electricity generation mix of the location of the storage. In 2020 the current affairs programmeis*Dispatches* reported that an average single Instagram post by footballer Cristiano Ronaldo uses as much energy as 10 houses do in a year (cited by Digitaldecarb.org, 2024) because of its global reach to hundreds of millions of followers.

In fact as much as 65% of the data that is generated and stored is never used; this “dark data” not only generates needless environmental impact, but clogs-up business processes. Gartner describe it as “the information assets organizations collect, process and store during regular business activities, but generally fail to use for other purposes (for example, analytics, business relationships and direct monetizing)” (Gartner, 2022). It is data that did not need to be warehoused. An estimated further 15% of the data that is generated and stored is now out of date; data that should have been deleted but which hangs around indefinitely. Furthermore much of the data that organisations hoard is duplicate data; IBM estimates that “of all the data created, only 15 percent is original, and the other 85 percent is derived by copying that data for various uses in the organization” (Dailey, 2020). The only economic function of most of the information is to generate revenues for data warehousing companies.

Considered on a global scale the environmental cost of information remains relatively modest, particularly when compared to transportation, farming, and heating. Global warming will not be solved by more efficient data warehousing. Yet the growth of data may very well be unsustainable in its own terms, and just as importantly it has knock-on effects that create additional environmental harms. The more data we store the more economic activity is generated around that data, managing, filtering, searching, processing, and eventually disposing of it. In many cases environmentally ethical information practice is also *good* information practice in its own terms. Jackson and Hodgkinson cite evidence that “information workers in western Europe are losing 50% of their time every week searching for, governing and preparing data (30%) and duplicating work (20%)” (2022). Efficient use of information and data is good for business not only because it improves the efficiency with which businesses can use the data that they need, but also because it reduces exposure to legal, regulatory and reputational risks. Much of the harm of data overload could be avoided by more careful, deliberate, and *purposeful* management of organisational data resources.

Ethics in information management has tended on issues related to the uses of information and data, including privacy, surveillance and the harms that arise from information misuse. However as the scale of information and data grows the ethical consequences of that growth become more significant. Environmentally ethical information work means in part developing storage and retention policies that ensure organisaitons are not retaining redundant information and data; this not only reduces carbon emissions and costs but makes it easier and more efficient to gain competitive advantage from corporate data by reducing cognitive and administrative overheads associated with using that data. If data really is “the new oil” it is not only because of the economic benefits that it generates, but also because of the unanticipated damage that it augurs.

March 2024

Ethical information work for environmental change is one area in which information professionals can develop leadership that impacts beyond the organisation. The March 2024 issue of Business Information Review, however, also addresses information leadership in other contexts. Our first professional article is entitled "A simple plan? Reflections on how a library service secured investment for a new library management system"; written by Ray Harper it reports on securing investment for a new library management system for RNN Group , a group of UK further education (FE) colleges in South Yorkshire and North Nottinghamshire. The paper highlights the importance of contextual evidence, market sector data, the story-telling approaches to developing a business case.

Our second paper is a research article entitled "Leveraging Distributed Leadership for Effective Services Delivery in the Library System" and addressed the enhancement of flexible and fluid processes aimed at boosting creativity, drive innovations and achieve significant changes across library systems. It reflect our theme of leadership in this issue of Business Information Review, which continues in our third paper another research paper, "Determinants of Knowledge Sharing Among Civil Servants and the Moderating Effects of Leadership Styles". Leadership is also a theme of fourth paper, an opinion article "Three Leadership Roles Seen In Future Leaders" written by returning author Mostafa Sayyadi. The paper explores

Finally March 2024 is rounded off by Professor Preeti Patel's Out-of-the-Box paper addressing synthetic data. Patel is currently the Head of Computer Science and Applied Computing at London Metropolitan University. Her previous roles include Academic Leader for Applied Computing and Faculty-wide Academic Leader for Postgraduate Recruitment and Marketing. Synthetic data addresses the role of synthetic data is business applications, and explores the ethical implications associated with it. Synthetic data is artificially generated data that mimics the structure, properties, and characteristics of data generated from the real-world. The paper argues that "synthetic data holds the potential to bridge data access gaps, not only for commerce but also for research and evidence-based policymaking" and highlights it function in Privacy Enhancing Technologies.

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