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Hacking anthropology

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This essay outlines how the ‘hack’ might offer a model for anthropological research in the face of the distributed relations evidenced by digital data. The argument builds on fieldwork with citizens and activists and looks at their attempts to understand and make use of the data produced by energy sensors and monitors. Drawing on their experiences, I suggest that ‘the hack’ emerges as an important form of practice that helps people navigate the place of data in social relations. Taking the hack not just as ethnographic observation but also as a methodological proposition, I use my ethnographic material on the practice of the hack to reconsider the anthropological challenge of doing ethnography of processes that are only perceptible through numerical or digital data. To explore the value of the hack for anthropology, I introduce an example of an attempt to do ethnography in the mode of the hack. The essay ends with reflections on how the hack might provide us with new ways of getting to grips with the anthropological implications of systemic and emergent relations that are both brought to light and remade through data.

In this essay, I outline how ‘the hack’ might offer a model for ethnographic engagement in complex, emergent processes that are amenable to perception only through their traces in data. Computational infrastructures and data analytics have brought into view a host of new kinds of entities, big and small, from climate change, to DNA, to the viral patternings of online phenomena like memes and Twitterstorms or infrastructural imaginaries of smart networks of people, objects, and information. These phenomena are anthropologically fascinating, reassembling people and things in new configurations that challenge conceptual and practical boundaries between individuals and social groups, and between people and things. However, they also raise important conceptual and methodological questions about how to engage with such processes as objects of anthropological attention.

Researching data realities

I suggest that researching data realities specifically entails three key challenges. The first of these is the problem of *scale*. When we are confronted by emergent

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phenomena depicted in graphs, spreadsheets, visualizations, algorithmic effects, and digital traces, where is our ethnographer to locate themselves? Where should we be doing ethnography if we are interested in tracing the world-making capacities of environmental models or the operations of artificial intelligence? Any location can only provide a partial view on what are frequently referred to as global processes or networked systems.

This is not in itself a new problem for ethnographers. Nonetheless, as anthropologists of contemporary infrastructures (Abram, Winthereik & Yarrow 2019; Anand, Gupta & Appel 2018; Harvey, Jensen & Morita 2017) have pointed out, scale is central to issues which data makes newly available. Here the totalizing global (if not interplanetary) pretensions of discourses deployed to describe the value of digital systems depend on big numbers, total data, and extensive networks in conjuring these large-scale worlds (Tsing 2005). More prosaically, the very material infrastructures upon which the digital systems that make this large-scale world rely also, themselves, transgress national boundaries and connect places around the globe (Starosielski 2015). The discursive imaginaries and material infrastructures of digital data, then, serve to amplify and reframe longer-running concerns in anthropology regarding how to do local and situated ethnographies in the face of global networks and large-scale effects (Marcus 1995; Ong & Collier 2005).

The second problem concerns what we do with the idea of *representation*. As long as we see our job as ethnographers being the representation of other people's representational practices, then the problem of scale or data is tamed as simply another representational manoeuvre – and we can focus on the everyday practices of creating these kinds of graphs and depictions of distributed and large-scale processes. However, digital data traced in these graphs and charts self-evidently does more than represent. Like all methods of empirical science, digital data models are a *world-making* as much as a *world-framing* phenomenon. If we want to attend to the realities of these representations – in terms of both the 'realities' that they trace and the realities that they produce – how should we best do this? Anthropological theory has constantly flipped back and forth between making claims about epistemologies and representations and making reality claims. However, digital data worlds themselves seem to rework a distinction between representation and reality. Unlike intentionally generated representations that frame, delimit, or reduce reality through the act of description, the digital data practices I have in mind have to grapple with a representational excess. By this I mean that the assembly of data from sensors, in models, and across sources, creates pictures or diagrams of relations whose meaning is unclear and whose significance demands ongoing interpretation. Digital data worlds are less the 'thin simplifications' of plans and maps (Scott 1998) than thickening complexities through which vernacular and expert data analysts must find a way of navigating. Given this, I suggest that if we are to participate in conversations about the implications of digital data, we need to find our way out of the trap of *either* treating data uncritically as direct signs of an underlying reality, *or* treating it critically as socially constructed representations. In what follows, I ask: is there a way of reconceiving the realities of digital data worlds? And if so, how might we go about doing this?

This brings us to a third problem: what I am terming here the anthropological commitment to *analytical agnosticism*. Even if we do manage to gain some partial, post-dualistic insights into the social and cultural dynamics of digital data worlds, the

question remains of what we should do with this knowledge and where we should do it. One of the strengths of anthropology is that anthropologists require of themselves and their peers an acknowledgement of the provisionality of all knowledge claims, including our own. This agnosticism is what enables the operation of ethnographic critique, holding at bay the assumed superiority or universality of disciplinary or institutionally sanctioned ways of knowing that often inform our taken-for-granted understandings of the world. By setting these to one side, we allow space for other voices and perspectives to appear. But this same demand for provisionality also makes the moment of action a difficult one to countenance, for action demands justification and justifications generally demand a closure of the provisionality that allows for difference to emerge as a possibility.

At the same time, digital data worlds often seem to demand calls for action, born out of not a commitment to a particular ideology but rather a more post-political form of action that emerges from engagements with data read as signs of reality (Swyngedouw 2010a; 2010b; 2011). Here I am thinking of the climate scientist who finds themselves an 'accidental activist' as they listen to the signals of their experiments in which they see themselves and the infrastructures of their lives implicated, or the big technology companies and governments who realize that digital systems have unforeseen ethical consequences. When a 'position' or 'perspective' is produced by a machine, or actions are assembled and sustained by hybrid human/nonhuman infrastructures, I suggest that this potentially changes the terms upon which reflexivity and relativism are founded. For no longer is the issue the status of 'our' world-view vs the world-view of an 'other'. Rather, a new issue has emerged, namely the possibility that it is not only world-views that are relevant now, but also data-worldings – a more uncertain and emergent landscape of complex relations that come into view in relation to digital data and its unfolding and call forth a need to remake meaning (Massumi 2010). This raises the stakes for the commitment to analytical agnosticism, for what does it mean to abstain from taking a position in the face not of human world-views but of digital data worlds? What, in the face of biased algorithms or alarming climate models, are we remaining agnostic towards? Is it not more important that we 'take seriously' the algorithm or the computer model than render it provisional to allow other perspectives from outside the dominant techno-political order to appear?

This essay proceeds, then, from this threefold problem of how to do anthropology in the face of the systemic, emergent, and at times uncanny relations realized by new streams and assemblies of data. Still wedded as I am to the capacity of ethnography to inform anthropological understanding, my answers to these questions begin with my own empirical ethnographic research with others who have been working with and responding to data about distributed and emergent phenomena.

The challenges posed by these data worlds came into view in my own research in relation to an attempt to do an ethnographic analysis of climate models and their political effects (Knox 2020). Climate change as it appears in climate models is a phenomenon which is materialized in data traces of carbon, temperature, energy, humidity, economy, and ocean acidity. Climate change as described by climate science is not a description of weather in the here and now, but a phenomenon composed out of data on climates of the past from which projections of climates of the future are derived (Edwards 1999; 2010; Lippert 2015; Löwbrand & Stripple 2011). Climate change's life in data means that definitionally it takes place in no individual location and that its relevance is located more in the future than in the present. People who engage with the

question of how to mitigate climate change thus engage not with phenomenologically present environmental processes, but with complex data models that recast everyday practices into a climatological register. One thing highlighted by an attention to climate change as a feature of data models is that just because climate change, as it is described in climate models, is never *here*, and not *now*, crucially this does not mean it is not *real*. Indeed, it is the alarming reality of traces of climatological change that have begun to shift climate change from a matter of scientific representation to a matter of public concern, moving people to think about and reflect on their material practices in the here and now in a new light.

In studying climate change as a phenomenon that manifests in and through data, and trying to understand the implications of data models for social practice, I have found myself forced to revisit and rethink long-running anthropological questions about what constitutes the real; the methods that we as anthropologists have of engaging with different kinds of realities; and the responsibilities that follow from the production of anthropological knowledge about these realities. It is to the central challenge that emerging forms of data pose to anthropological understandings of the real that this essay aims to respond.

In this essay, my focus is not on climate scientists or climate models per se, but on people whose practices have become framed and informed by climate change thus described. Specifically, the essay explores in the city of Manchester, where I did my research, how climate change as data model became grounded and experienced in people's engagements with the materiality of their everyday lives and how this proceeded through an ongoing and intimate attention to material relations made visible by data. In my research, this took the form of everyday engagements with environmental monitoring and energy data that operated as a proxy for measurements of carbon emissions and that served to link people to houses, energy infrastructures, political settlements, and planetary futures. Through an analysis of these practices, I derive a response to the questions posed above about the challenge of approaching digital data worlds as an anthropological problem, suggesting that one generative answer to this challenge might be to rethink data in the mode of the 'hack'.

Drawing on my experience of trying to understand the place of material sensors and energy monitors in people's engagement with an unfolding and distributed climate-changing world, 'the hack' emerges as a crucial concept. I propose the hack as a concept that has the capacity to denote a relationship with data that takes it not just as a stable representation that we need to deconstruct, but also as a means of engaging with relations that are imprecise and unknown and whose imprecision and unknowability become a frame for action. In this essay, the hack is taken not just as an ethnographic observation but also as a specific mode of practice that I use to reflect back on the practice of doing ethnography on digital realities. The final third of the essay moves the discussion away from an analysis of my ethnographic material to explore whether we might find in the practice of the hack a way of doing anthropology differently. Here I describe an experience of organizing and running a 'hack lab' as a form of ethnographic research. Far from disavowing a critical stance towards normative modes of action, I suggest that 'taking seriously' techno-political configurations in the mode of 'the hack' might offer anthropologists a useful perspective with which to rethink anthropology's place in the face of data relations, creating a form of anthropological practice appropriate to understanding the place of data as an increasingly central aspect of contemporary social relations.



Figure 1. Graph of temperature from Hive heating system.

Data ethnography

In keeping with the focus on the anthropology of digital data worlds, I want to start not with a person, or a place, an event or a story, but instead with three graphs. The graphs are being shown to me by Alison,¹ a Manchester resident who has been monitoring the material properties of her home in preparation for energy efficiency work that she hopes to have done on the house in coming years. Alison is talking me through her experiences of monitoring the physical and energetic properties of her house and the different feeds of information that she uses to gain insights into her home environment. We are seated at her kitchen table, laptop open in front of us, and she opens the graphs one by one.

The first graph (Fig. 1) offers a dawn of bars, warm at first, then cooling to lime green, before darkening to deep orange and a long evening glow. This is yesterday's living room, as relayed by the thermometer of Alison's HiveTM heating system. Signals have been sent from the hive in the living room to a server via Wi-Fi and broadband to British Gas. The bits of information have then been dragged back into the kitchen where we are now sitting, and displayed on the computer screen. On the screen is a graphical read-out which Alison has captured and annotated for the various people to whom she has shown this data. There is no indication of the causes of the changes in temperature, so she has labelled the effect of her heating system on rising heat, and noted the effect of the sun on keeping the front room warm throughout the day.

The second graph (Fig. 2) that Alison shows me offers a multi-layered depiction of data. Down at the base of the data cut-through is the outside world – a feed of information from a weather service describing outside temperatures for the Manchester suburb in which she lives. Jagged intervals, first arrayed like a path along a valley, then step upwards as the afternoon sun warms the air, reaching a 12°C peak before stepping carefully, gradually, back down into the night. Laid upon this bottom stratum, in green, is the living room again. Here the room is depicted in energetic glory with information from an independent temperature sensor providing a more lively picture than the Hive data flow, with a sort of a rollercoaster feel as the heat falls at first, only to be caught by the thermostatic control of the central heating, which, then boosted by the radiated sunlight from the south-facing window, lifts the room up to a comfortable 20°C. As Alison describes how the sun moves on its inevitable course around the house, the temperature seems to enter into a cat-and-mouse game of boiler vs cold, hiccupping along until bed

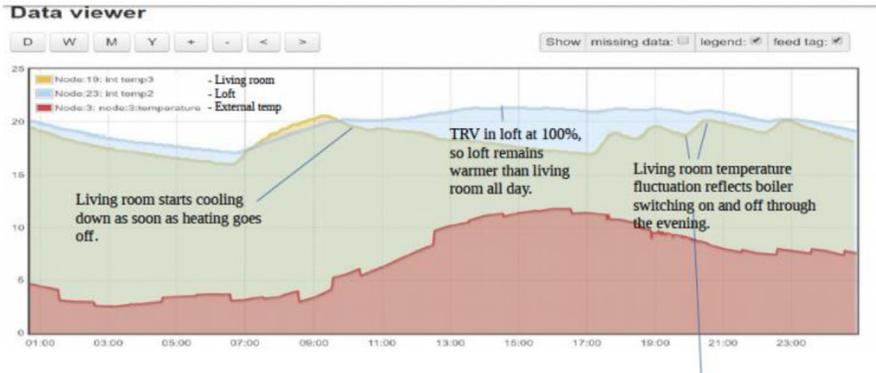


Figure 2. Graph of temperature from open energy monitor.

settles things down and the temperature is allowed to fall back to its early morning low. The final stratum has the aspect of a gentle swell in blue. Here insulation does its work, keeping the loft of the house, which also has its own temperature sensor, well apart from jagged landscape of the cool outdoors or the fluctuations of the downstairs room.

The final graph (Fig. 3) comes from Alison’s user profile on the website of the energy company OVO. Here the cybernetic system of house and world and heating is replaced by a simple on/off, aggregated into towering heaps of energy used over time. Alison is a ‘super-forum user’, and has agreed with OVO that meter readings from the smart meter they installed can be sent back to them at five-minute intervals rather than the daily readings that come as standard. They learn about her habits. She learns too. Each



Figure 3. Graph of temperature from OVO energy company.

five-minute accrual of kilowatt hours of gas, or the pounds and pence that gas costs, can now be tracked, mapped, and interrogated. Alison can see when her heating is working hardest, and from this she can learn new things about her house, its costs, her life, and the world in which she lives.

Alison is not a typical smart meter user. Schooled in software engineering, and invested long term in transforming her home to make it more energy efficient, her sensibility to her house and the data feeds that now come from various sensors is that of someone who is comfortable with data analytics and driven for personal and political reasons to use this data to inform changes to her environment. Now semi-retired, she has both the time to turn her attention to her home and the need to do so as she is spending many more of her waking hours there. She lives in a part of the city with a vibrant social network of liberal environmentally conscious people, and so her desire to live a more ecologically sustainable life is also validated through her interactions with many people around her.

Alison was one of several people I spoke to about energy monitoring. Drawing on her monitoring experiences and that of others, I suggest that, far from providing a stable description of the world upon which decisions can be made, data from monitoring devices was experienced by those I met as something rather different. Data here was not simply descriptive or informational – not an ‘immutable mobile’ (Latour 1986) – but rather became actively constitutive of an experience of living in an environment characterized by complex, extensive, and often unknowable relations. Responding to this unfolding complexity, those who found themselves being required to engage with data as a way of proceeding in the world found themselves creating questions as to what might be a socially appropriate way of organizing and relating. It is this kind of data relationality that I term here the practice of the hack.

Data relating

I first met Alison during a ‘meet-up’ of people who were part of an energy co-operative on the topic ‘Making the most of data! Understanding performance through bill/monitor data’. We met at a city centre bar, where we sat around tables to discuss our energy data. Some, like Alison, had printed out their graphs and spreadsheets. Alison had annotated hers and added a list of more general observations about the experience of energy monitoring underneath the graphs. Others had brought their data in on their laptops and some needed to connect to Wi-Fi to access it directly from their energy supplier’s website. The meeting was an opportunity to make sure that the spreadsheets were properly configured, to learn from others about different kinds of monitoring (both digital and analogue) that were possible, and to talk about the difference that data made to people’s experiences of engaging with the techno-politics of environmental change – from finding insulation installers, dealing with energy companies, to finding effective ways of tackling ever-rising carbon emissions.

Leading the discussions about how to go about analysing energy data was Tom. Employed in his day job as an acoustic engineer, Tom is a self-taught expert in home energy monitoring. Ten years ago, he began to transfer meter readings from his gas and electricity meters into a spreadsheet in order to get a better sense of the energy he and his family were using. What started as a relatively limited exercise in energy accounting has since become a public act of energy politics, Tom’s energy monitoring informing not only his own energy use but also local, national, and European policy discussions on energy and climate change and an international network of followers on Twitter.

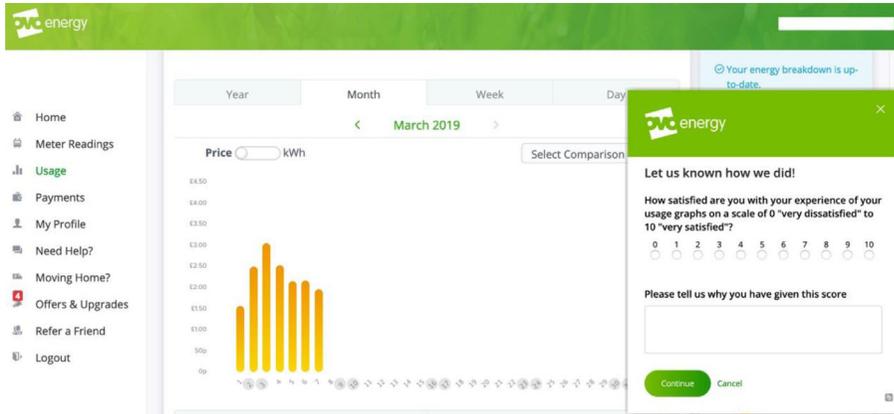


Figure 4. Pop-up box asking for user feedback on author's OVO energy account.

Before this meet-up, I had already gone to talk to Tom at his home, largely because of his reputation among others I was doing research with as someone who knew a lot about home energy monitoring. During my conversations with Tom, he conjured an image of himself as a kind of energy detective. Data created puzzles that Tom found himself needing to investigate. Data on his home seemed to open up more and more questions which he set out to answer by further monitoring and through conversations with others interested in his monitoring activities. This included other members of the energy co-operative of which he was a member, environmental activists, monitor developers, bike shop experts, friends, and colleagues.

This effect of monitoring data was similar for others I spoke to. Data was not so much a consistent source of information about how people's houses were performing, but was rather a prompt for conversations, a trigger for questions, and an impetus for understanding complex relations that cut across professional, institutional, and social boundaries. During my interview with Alison, I discussed with her a new feature on the OVO website that auto-generated a profile of energy using 'habits' from the signals from the smart meter. She was sceptical about the conclusions this algorithm came to about how much energy was being used in categories such as 'standby', 'entertainment', or 'refrigeration'. When I went to my own OVO account as I was writing this essay to remind myself of the categories that were being used, a pop-up box appeared (Fig. 4), as if anticipating the argument I am making here, asking me if I was satisfied with my experience of usage graphs on a scale to 1 to 10, and to ask me to tell them why I had given them the score!

A similar relation with data was also articulated in other conversations at the meet-up. Alison had brought with her the graphs described above, as well as an A4 sheet of paper with some further reflections on things that occurred to her as she was putting the data together. On the A4 sheet, she listed 'some of the things I've discovered through monitoring':

Some of the things I've discovered through monitoring are:

- That the front room heats up far more slowly than the living room – both external walls have hard to fill cavities, and the double glazed bay window is approaching 30 years old.

- That I wake up with a cold nose in the night if the temperature drops below 13 degrees.
- That heating the house up to 17 degrees on work day mornings is comfortable for me.
- That setting a minimum temperature of 15 degrees overnight helps ensure this.
- That for watching TV in the front room, I still need a blanket, even when the temperature is hovering at around 19 degrees.

Rather like in the Quantitative Self monitoring community described by Dawn Nafus, Gina Neff, and Jamie Sherman (Nafus 2014; 2016; Nafus & Sherman 2014; Neff & Nafus 2016), data here was a sensitizing practice that had made Alison attend to things about her house and her body that she had not previously dwelt on. Following this list, Alison then provided a list of things that she has ‘tinkered with’ in the course of her energy monitoring, including the heating schedule, the radiator settings, and the location of her thermostat. The sensibility that monitoring produced towards her environment also extended to a sensitivity to devices that do that monitoring.

Alison had highlighted these things and circulated them in advance of the meeting because she was interested in talking with other people at the meet-up about whether they had experienced the same. She described her response to data not in engineering or managerial terms but in more tentative language of ‘things I’ve discovered’ and ‘things I’ve tinkered with’. Others at the meeting came with a similar range of semi-formed reflections, examples, and questions, ranging from how to detect the movement of air in the house using the smoke from a joss stick, to queries about how data is transmitted between different devices and what communications protocols are used. The relationships that were interrogated in these conversations were undisciplined, transgressing boundaries between science and engineering, IT and energy, devices and blankets, bodies and numbers.

What data seemed to produce, then, for these people was not so much a representation that stabilized a picture of the reality in which they lived, and which in turn informed decisions about how to behave differently, but rather a collection of signals that called out for new kinds of engagement. Data did not so much reveal truths as reveal ambivalences that necessitated collaborations like the meet-up, or negotiations with companies and technology providers to make sense of the ‘reassembly of the social’ that they effected. The capacity of data to not only describe but also demand the creation of new relations means that data seemed to do more than work within the parameters of already-existing, habitual forms of participation with existing social groups. Rather, it enabled the constitution of new social relations that opened the world up for people in new kinds of ways. Here, what was important was not simply tweaks to the habitual rituals and practices of everyday life, but an opening up of individual practice that required a questioning of the taken-for-granted cultural and social parameters within which people were living, a questioning that I suggest is productively captured in the language of ‘the hack’.

Hacking energy

Many of the people I spoke to who were actively monitoring their energy use had been involved in face-to-face events that had used the language of the hack to capture the form of interaction and practice that these data-orientated interactions encouraged. Some of those whom I spoke to attended a regular monthly technical meet-up called EcoHome Lab, where they had learnt how to build their own energy monitors, discussed

the use of these energy monitors, and expanded into other topics such as how to use batteries or how to build their own air quality monitor.

EcoHome Lab took place monthly at a maker space called MadLab. MadLab describes itself as ‘a grassroots site for innovation’, its mission being ‘to help people make things better, together’. On its mission page, it elaborates its philosophy:

We believe that the best way to understand fast-paced technological innovation is by getting involved, through experimentation and play. In particular, MadLab is an advocate of hacking – taking things apart, figuring out how they work and re-purposing or re-imagining them. This is a principle we apply to everything we do, whether it’s designing new digital devices and services or finding improved ways of working with our partners and communities.²

EcoHome Lab was understood both by its organizers and by their friends at MadLab to be very much aligned with the latter’s philosophy. It brought together programmers, hardware developers, and people involved in ecological activities to fashion their own bottom-up technical interventions to tackle environmental issues. Building these technical objects had the effect of ‘white boxing’ energy infrastructures (cf. Corsín Jiménez 2014b) and helped people better understand systemic social and environmental change in often unexpected ways.

EcoHome Lab was not the only energy-related event that worked in this way. In 2013, another event had been run at MadLab where people had been invited to ‘hack the DECC 2050 calculator’. The DECC 2050 calculator was a tool developed by the Department for Energy and Climate Change to model the effects of different policy choices to tackle climate change on economy and society. Users of the calculator could enter in their choices for how to reduce carbon emissions and the calculator would illustrate the likely implications of each intervention (Fig. 5).

At this event, people interested in climate change, energy, and policy had met civil servants who had been involved in the design of the calculator tool and together they had worked to try to break apart its assumptions in order to improve it – both in terms of its technical operations and in terms of its capacity to positively influence policy around climate change.

In 2017, two more energy-focused events were organized that were also explicitly framed in terms of hacking. The 2017 annual ‘Hack Manchester’ event brought programmers together for an intensive twenty-four-hour technology hack and asked the energy co-operative, the Carbon Co-op, who also ran EcoHome Lab to provide

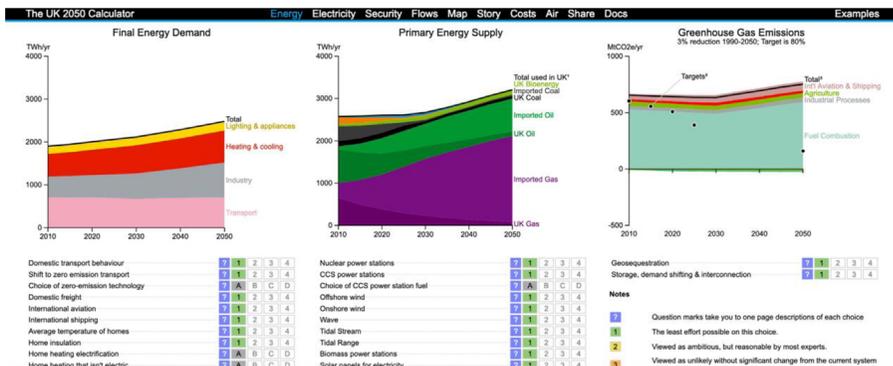


Figure 5. Screenshot of DECC 2050 calculator (classic edition).

one of the challenges for the event. In response, the Carbon Co-op came up with a challenge where programmers at the event were asked to design an energy information display. The same year, a very different event – a conference to discuss changes in energy infrastructure – was organized, with the title ‘Hacking the Future of Energy’.

The hack, then, in this setting, was a way of describing a form of interaction that took place in a semi-public gathering, in which things – be they policies, technologies, theories, or concepts – would be taken apart, figured out, and repurposed or reimagined. This is somewhat different to the way that hacking has predominantly been discussed to date in anthropology. In recent anthropological work on hacking, the hacker has been a term used to denote someone who is involved in forms of computer programming and particularly the reverse engineering of programming for the purposes of espionage, crime, or vigilantism. Christopher Kelty and Gabriella Coleman capture this well in the preface to a special issue of *Limn* on ‘Hacks, leaks, and breaches’, where they write:

‘[H]acker’ clearly means many different things – from adolescent boys to criminals on the ‘Dark Web’ to nation-state spies. And one might add: from makers of Free Software to certified information security researchers to cool television characters like Eliot Alderson, to wardens of privacy and promoters of encryption to those helping secure the work of journalists and dissidents (Kelty & Coleman 2017).

‘Hackers’ here means many things but it does not seem to mean people tinkering in rather mundane ways with the interface between sensors, data, and devices in their homes.

Whilst data, digital networks, and computation offer a technological plane of affinity between Kelty and Coleman’s hackers and our data subjects, the idea of the hack in the cases I present here denotes something rather different to what they describe – both as a form of practice and as a claim to expertise. For Kelty and Coleman, hackers are people who playfully and creatively deploy the logics of computer coding to craft interventions. Coleman writes in her book *Coding freedom* of how ‘the tension between individualism and collectivism, in particular, is negotiated through the extremely well-developed and common penchant that hackers have for performing cleverness, whether through technological production or humour’ (2013: 94). She also elaborates elsewhere that hacking is a performative form of liberal, often techno-libertarian political ideals (Coleman 2009; 2010; 2011; Coleman & Golub 2008). Whereas Coleman’s hackers are therefore experts who performatively express their superior technical expertise through craftiness, humour, and play, those with whom I spent time enacted hacking as a much more modest, tentative, and collaborative practice of questioning and unfolding realities through data. To ‘hack’ energy data involved an explicit attempt to do away with hierarchies and to demonstrate the necessity of collaborative modes of learning how to become effectively attuned to opaque and changing infrastructures. Hackathons or hack labs were not just sites for an open and participatory form of technology design but were also beginning to be seen as organizational forms through which social transformation might be achieved.

There is a clear parallel between what I am describing as hacking and design practices existing across various fields of activity that have been described in anthropology under the umbrella of ‘prototyping’ culture. In the attention to open source information sharing, the development of open hardware, and the production of new kinds of artefacts that might have the potential to draw forth new social

formations, these practices of hacking captured many of the same preoccupations and cultural assumptions as those explored in descriptions of prototyping advanced by scholars like Christopher Kelty, George Marcus, Alberto Corsín Jiménez, and Adolfo Estalella (Corsín Jiménez 2014a; 2014b; Estalella & Corsín Jiménez 2017; Kelty, Corsín Jiménez & Marcus 2010). Like prototyping, the hack as a mode of practice created its understanding by actively creating material propositions or interventions into the field of distributed relations that data was tracing out. These interventions could be technological (the open source energy monitor, the DECC 2050 calculator, the Hive thermostat), political (policy propositions), ludic (games), numerical (gathering data in a spreadsheet), or artistic (staged art/activist interventions), but they all used intervention as a way of simultaneously *acting on* and *producing new knowledge* about opaque, complex, and emergent digital data worlds.

However, as I spent more time participating and engaging in the mode of the 'hack', I began to understand it as a practice that was less about designing prototypes that might ultimately be taken up as future models for general social and technical practice. Instead it was better understood as a critical, materialist, post-disciplinary mode of critiquing and deconstructing existing social relations and material infrastructures. If prototyping focuses on the production of provisional artefacts that would be put into circulation as experiments orientated to the making of a possible future, hacking was more of a disruptive, analytical practice, orientated to the reordering of complex technical infrastructures. Rather than bringing design preoccupations to the fore, what hacking seemed to offer was a means of doing a critical social and cultural analysis through the collaborative deconstruction of contemporary socio-material infrastructures that were self-evidently composed out of and revealed by data. As such, I shifted my understanding of hacking from an activity primarily concerned with experimental design to one that was preoccupied with the radical possibility of seeing otherwise – a realization that opened up an unexpected bridge to the practice of anthropology.

Like anthropology, the hack was an attempt to see the world differently. It was an act of conceptual deconstruction through material participation and one that required listening to different viewpoints and technical practices on their own terms. Like work informed by science and technology studies and ethnographic studies of infrastructure, it was also tolerant of the crossing of boundaries between the social and the technical, investigating social problems through attention to technical artefacts and framing technical challenges in terms of their social implications. In the hack as a practice of material deconstruction, people seemed to have devised a way of productively engaging with data realities, appreciating them as both socially constructed *and*, simultaneously, real. This introduced the possibility that the hack might offer a form of practice through which we as anthropologists might rethink our own conceptual and methodological relationship with data. Was there a way, I wondered, of not only doing an anthropology of the hack, but also learning from it to hack anthropology itself? What could anthropology look like if it were to not only analyse, describe, or critique the practice of the hack, but also embrace it as an alternative way of producing anthropological insight in the face of relational complexity foregrounded by digital data infrastructures?

Hacking anthropology

In the summer of 2018, I had the opportunity to put these thoughts into practice. As I neared the end of my research on energy monitoring, I talked to some of the people I

had been doing the research with about ‘impact and communication.’ Although at this point I had not begun to think explicitly in the language of the hack, it nonetheless seemed entirely logical, when Jonathan Atkinson, project manager of the Carbon Co-op, suggested that one option could be to organize a ‘hack lab’ to continue and extend the research. Jonathan told me that he had wanted to do a hack lab for a while but had not had the chance. For him, it would be a way of extending work that the Carbon Co-op were already doing to unpack and understand energy systems by stimulating investigations and ongoing conversations about the relationship between energy, infrastructure, data, and equity. For me, the suggestion was intriguing. Could this be a way of experimenting with a form of research which moved beyond the stable distinction between world and representation in which I felt trapped? I wondered what we might learn through this form, both about ‘the hack’ as a practice and about the complex and changing world of digital energy infrastructure.

We therefore set about organizing the hack lab. As we began to put the event together, it turned out that the hack lab was not a fixed or clear format for any of the organizers, but one that came into being as we looked at other examples of hack labs and hackathons and spoke to people who had attended these kinds of events. We applied for funding and the funding we received also helped determine how it was structured. The hack lab that we eventually designed took place over a weekend in November 2018. It was conceived and organized by myself, Britt Jurgensen, a community practitioner and performance artist, Jonathan Atkinson, and Laura Williams, also from the Carbon Co-op. The title of the event was ‘Hacking the Future of Energy: How Can We Make the Future of Energy More Equitable?’ – a question that was posed as a direct challenge to potential participants to engage with a highly technical, data-informed energy infrastructure as a problem of collective social life. People were invited to apply through a mail-out to our networks and a Facebook advert. The advertising for the event was targeted at community energy activists, technical experts, people working in energy industries, and social scientists, and participants were asked to say either what idea they would like to work on, or what they thought they could bring to the discussion in terms of skills, interests, or enthusiasm for getting involved in a just energy transition. There was to be a prize of £2,000 for the winning team with the best solution to the challenges of energy equity.

As an intervention into digital data worlds, the event description specifically invited people to respond to the digitalization of energy infrastructure with suggestions for technologies, projects, or experiments that would capitalize on these changes to make energy ‘more equitable’. The call for participants set out the terms of the hack:

The generation, distribution and supply of energy is changing with more renewables, battery storage and developments in smart metering and smart grid technology. These changes create the opportunity to rethink who energy is for and who controls it. New technological tools and changing sources of electricity might enable alternative ways of managing, sharing, buying and distributing electricity. What would this look like? And what would the social effects of such a system be?

It also specifically requested that people consider their response as a critical engagement with technological systems and their propensities, stating that: ‘Open source standards and systems, solar generation, EV charging, battery storage, DIY renewables, Blockchain technology, social enterprises, co-operative platforms – all these elements may have a role to play in your idea.’³

This framing for the event emerged out of collaborative research I had been involved with into energy monitoring and its extended implications for grid operators, electric vehicle manufacturers, solar panel developers, communities, and policy-makers. It intervened by inviting people to respond, with me and my research partners, to the landscape of relations that was emerging and appearing through my ethnography of/with energy and carbon data.

The event started with two presentations from external speakers that put forward propositions as to the socio-technical challenges of a changing and digitalizing energy infrastructure told from the perspective of social science, energy justice, and sociology. Following these presentations, people pitched their ideas for how they thought they could intervene in the energy system and five teams were formed. On the second day, the teams worked intensively on their ideas. People shifted teams as ideas fell apart and other ideas were strengthened. A 'slack channel' was set up to run alongside the event – gathering resources, photos, tweets, and video clips into a stream of information that people were encouraged to interact with. Facilitators reminded people of the question they were meant to be answering. Thea Nguyen, an anthropology student, took notes and photographs of the event. On the third day, there were just three teams left, and they pitched the proposals that they had worked up to a panel of judges. Comparing the proposals against a set of criteria, a winning team was chosen. The winning team were a group who proposed to create a proof-of-concept model for an open source peer-to-peer energy trade. This was a technological proposition which held in place fragile threads connecting the possibility of open and direct exchanges of energy between householders; the creation of a form of economic activity without excessive accumulation; and the creation of an incentive for more people to become involved and invested, both emotionally and financially, in a future without fossil fuels. The proposal was to create a data model which could prove that a single transparent exchange of electricity was possible between a citizen in one part of the country with a solar panel on their roof and a citizen in another part of the country in need of power. In imagining how to re-channel power so as to make renewables more viable, and in doing so reconnect people in new ways, the winning project was not only proposing a technological solution to a problem of energy transfer, but was also proposing a means of reimagining and redescribing the socio-technical relations through which climate change was manifesting and through which both climate and society might be reshaped.

There is much more to be said about the event, but for our purposes here, I want to bring the essay back to the three challenges of studying data realities with which I began to consider how designing an event in the model of the hack offered a response to some of the ethnographic challenges of doing research in/of digital data worlds.

First, the problem of method. One of the challenges that ethnographers face is how to speak back to the scalings of digital data infrastructures. By definition, the ontological presence of globally interconnected digital data worlds as mega, global, transnational entities, or what Timothy Morton (2013) has called 'hyperobjects', means they exceed that which can be studied ethnographically. Yet spending time talking about and participating in the data practices of people who were monitoring their energy and houses and asking questions about these relations revealed that the hack, as a mode of engagement, has the potential to operate as a scale-transforming practice. To hack one's own energy bills and to post the results on Twitter was to open up the domestic home as a site not just of local energy practices but also of public participation in energy and data infrastructures. In hacking energy data, inviting others who might be located

in the same city, or on the other side of the world, for their reflections, the hack did not create sites of participation that scaled relations along a trajectory of local to global wherein an ethnographer might need to place themselves, but rather assembled entities of different orders around an issue. What matters in the act of hacking is not the forging of relations of alliance with proximate others, but a practice of gathering and sifting, shuffling and reorganizing, in order to work out where social and material alliances are possible and where they are likely to fail. The hack does not so much create a microcosm of the world that can be imagined so as to be scaled up, but instead creates a cluster around which more and more people, things, and ideas can accrete. Success in the model of the hack is not a prototype that provides a scale model for a technological future, but an artefact, project, or idea around which the world is gathered and, in the process of that gathering, remade. Ethnography in the mode of the hack, then, offers a form of understanding that is not about finding out what a particular group of people are doing in a particular place and why, but about discovering, through a 'staging' of relations, the possibility or impossibility of different forms of relating. Ethnography in this mode does not seek to represent all of the different existing views on the world, but rather seeks to understand how views and worlds are made, formed, reinforced, and dismantled.

This brings us to our second challenge, which concerned studying processes that do not bifurcate neatly into a world and a representation of that world but continually 'fold' into one another. The hack offers a relationship to representation that is instructive for anthropology, for it shifts representation from the end-point of a process of knowledge production to the starting point upon which a process of understanding proceeds. In hacking data, we saw that data was not the end-point of a representational process. Data traces could be representational, but they could also be unstable signifiers. Signals could be errors, statistical inferences could be wrong, measurements could be improved upon, data infrastructures could always be 'inverted' (Bowker 1994). Treating data not as a text to be read but as a thing to be 'hacked' shifted representation from a form of description to a site of action.

In recent years, there have been other anthropologists who have begun to explore the virtues of a form of anthropology that takes place in this moment where representations become a site for action rather than claims for truth. Sarah Pink and colleagues have been exploring how to develop design anthropologies that seek to shape the future, rather than just describing the present (Akama, Pink & Fergusson 2015; Pink & Salazar 2017; Salazar, Pink, Irving & Sjöberg 2017). Building on the ground laid by anthropologists such as George Marcus (1995; 2000), Michael Fischer (2007), Paul Rabinow (Rabinow, Marcus, Faubion & Rees 2008), and Douglas Holmes (Holmes & Marcus 2005; 2008), the collaborative ethnography collective COLLEEX has also begun to explore how to do ethnography that is more interventionist and collaborative in its design (Estalella & Sánchez Criado 2018). Similarly, Alberto Corsín Jiménez's work to reflexively develop an open source architecture for urban participation and for anthropology publishing also arguably operates in precisely this mode of ethnography as hack that I am outlining here (Corsín Jiménez 2017). In each of these cases, ethnographic understandings are recast not as stabilizations and settlements but rather as propositions that both emerge out of and enact a critique. As propositions, they invite a response but they do not determine from whom or from what that response might emerge. Responses can take the form of opinion, of nonhuman reconfigurations, of data glitches, or even of silences or gaps.

This brings us to our third challenge, which is that of analytical agnosticism and a critical attention to difference. If anthropology in the mode of the hack is not a stabilization of truth but rather a proposition orientated to the possibility of change, then what does this do to ethnography? Where data hacks are concerned, the answer to the proposition (a statement, a technology, a game) demands a collective rather than an individual response. Propositions become the impetus for devising forms of social organization adequate to understanding the problem, gathering people and things as resources to map out and address the contours of the ‘thing’ with which they are confronted. Unlike conventional ethnography, where an intervention might be deemed to fix or position the ethnographer as coming with an immutable position, might intervening in the mode of the hack not help relieve our ethnographer of the demand that all actions require justifications, and all justifications must be seen as truth claims? In the mode of the hack, an intervention would no longer require that the ethnographer decide in advance of acting whether they were assuming a particular truth or making a demarcated truth claim that would position them in such a way as to close down other ways of seeing. Instead, ethnography in the mode of the hack offers an alternative status for ethnographic knowledge. Here an intervention is not pre-justified but rather deploys evidence in a way that says: this is my ethnographic evidence that I have crafted to tell the best story I can – what do you know that might disrupt or extend that? The question posed in this way invites an answer without prejudice to the kind of evidence that could be brought to bear on the issue thus described. The hack therefore creates the possibility of opening anthropology up beyond a conversation between anthropologists, and beyond current discussions of how anthropology might be refashioned as a practice of design, allowing our own interpretations to be troubled, disrupted, and questioned by people with other stories, data, or materials to bear on the problem that we propose.

When technical projects are so often dominated by propositions that emerge from questions of engineering, a proposition that emerges from ethnographic, anthropological, or sociological sensibilities not only adds the ‘social’ back into technical projects, but also creates an alternative set of questions about what ‘the problem’ even is. Rather than asking how can we improve the carbon-intensive energy system revealed by climate models, the hack lab proposed the question: how can we make the energy system more equitable? Far from assuming that equity, fairness, and equality were unproblematic or transparent concepts, raising them to the status of a proposition (i.e. that the energy system is unequal), rather than an afterthought to a project aiming at technical functionality, meant that the question of what equality looked like in the face of a changing climate and changing energy infrastructure, or even if it was a good thing, became the focus of collective discussions over the efficacy of the solution. An engineer who participated in the event began the weekend by very vocally stating that he couldn’t see what the fuss was about and in his view there were simple technical solutions that would resolve inequality in the energy system. On the second day, and deep into discussions about how to navigate geographical boundaries and regulatory controls over the transfer of both electricity and data between different people, different organizations, and different parts of the country, he expressed surprised frustration at just how complicated it all was. Yet rather than end with the conclusion that ‘it is complicated’, the format of the hack moved this observation onto the question of how to make these complicated relations anew. Critique and creation here proceeded hand-in-hand.

Conclusion

In this essay, I have tried to explore what an anthropology of data worlds could look like if we were to explore the hack not just as an incidental discovery of a contemporary, even neoliberal practice of competitive experimentation (Jones, Semel & Le 2015; Powell 2016), but also as a model for doing anthropology in the face of digital data worlds. We are living in unsettling times. Border-transgressing processes – from globalization to migration, climate change to technological hybridity – dominate social relations, undercutting explanations and re-modulating knowledge. Anthropological responses to this emergent, unsettling relationality have often tended to ground the abstractions of data by filling in the gaps with ethnographic descriptions of the local social processes from which data traces are abstracted. I am not advocating doing away with more familiar modes of ethnographic knowledge production, but I am arguing that adherence to this way of producing understanding risks putting limits on what we understand ourselves as legitimately being able to do and know as anthropologists. Faced with digital data worlds that pose ongoing challenges to the relevance, transportability, and translatability of ethnographic understanding of issues ranging from climate change to artificial intelligence to post-truth politics, I have argued that the hack might offer an opening to a different kind of anthropology.

In some ways, anthropology in the mode of the hack makes more central what ethnographers have always known: that knowledge production is collective; that truths are stabilized as a result of social practice and not as a result of their inherent ‘truthfulness’, but that neither are these stabilizations disconnected from the substance out of which they are made. Hacking anthropology is meant as an opening to new questions about how contemporary anthropological knowledge might be formed, a call to consider whether we might do better in acknowledging its own capacities for socialization and the role that digital data might play in this process. It is proposed as a way of attuning us to questions about where our representations sit within ecologies and materialities of knowledge. In order to engage with digital data worlds, it is clear we need new ways of redescribing what anthropology is and what it can be. Otherwise anthropology risks becoming an anachronism, an authorially powerful study of discrete cultures, an extractivist project that aims to stabilize world-views and align them as so many parts of a global human ecumene. Pushing back against this, hacking anthropology, far from closing down anthropological thinking into a single world-view that silences others, proposes a way of acknowledging the material relationality of all knowledge, including anthropological knowledge. Building on the understanding I have gained from others about what it means ‘to hack’, I have suggested how we might redesign our methods so as to make more explicit the invitation to others to join us as we attempt to understand the anthropological implications of unfolding data realities.

NOTES

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¹ All names of research participants who were interviewed for this research have been pseudonymized. For research collaborators who participated directly in the co-design of the energy hack event, and who I consider research partners rather than research subjects, their full names have been given and they have not been pseudonymized.

² See <https://www.artscatalyst.org/artist/madlab> (accessed 21 January 2021).

³ See <https://carbon.coop/portfolio/hacking-the-future-of-energy/> (accessed 22 January 2021).

REFERENCES

- ABRAM, S., B.R. WINTHEREIK & T. YARROW (eds) 2019. *Electrifying anthropology*. London: Bloomsbury.
- AKAMA, Y., S. PINK & A. FERGUSSON 2015. Design + ethnography + futures: surrendering in uncertainty. In *CHI 2015: Crossings*, 2015, 531-42. New York: Association for Computing Machinery (ACM).
- ANAND, N., A. GUPTA & H. APPEL 2018. *The promise of infrastructure*. Durham, N.C.: Duke University Press.
- BOWKER, G.C. 1994. *Science on the run: information management and industrial geophysics at Schlumberger, 1920-1940*. Cambridge, Mass.: MIT Press.
- COLEMAN, E.G. 2009. Code is speech: legal tinkering, expertise, and protest among free and open source software developers. *Cultural Anthropology* 24, 420-54.
- 2010. The hacker conference: a ritual condensation and celebration of a lifeworld. *Anthropological Quarterly* 83, 47-72.
- 2011. Hacker politics and publics. *Public Culture* 23, 511-16.
- 2013. *Coding freedom: the ethics and aesthetics of hacking*. Princeton: University Press.
- & A. GOLUB 2008. Hacker practice: moral genres and the cultural articulation of liberalism. *Anthropological Theory* 8, 255-77.
- CORSÍN JIMÉNEZ, A. 2014a. Introduction: Special issue: Prototyping cultures. *Journal of Cultural Economy* 7, 381-98.
- 2014b. The right to infrastructure: a prototype for open source urbanism. *Environment and Planning D: Society and Space* 32, 342-62.
- 2017. Auto-construction redux: the city as method. *Cultural Anthropology* 32, 450-78.
- EDWARDS, P.N. 1999. Global climate science, uncertainty and politics: data-laden models, model-laden data. *Science as Culture* 8, 437-72.
- 2010. *A vast machine: computer models, climate data, and the politics of global warming*. Cambridge, Mass.: MIT Press.
- ESTALELLA, A. & A. CORSÍN JIMÉNEZ 2017. Ethnography: a prototype. *Ethnos* 2, 846-66.
- & T. SÁNCHEZ CRIADO 2018. *Experimental collaborations: ethnography through fieldwork devices*. New York: Berghahn Books.
- FISCHER, M. 2007. Culture and cultural analysis as experimental systems. *Cultural Anthropology* 22, 1-65.
- HARVEY, P., C.B. JENSEN & A. MORITA (eds) 2017. *Infrastructures and social complexity: a companion*. London: Routledge.
- HOLMES, D. & G.E. MARCUS 2005. Cultures of expertise and the management of globalization: towards the re-functioning of ethnography. In *Global assemblages: technology, politics, and ethics as anthropological problems* (eds) A. Ong & S.J. Collier, 235-52. Malden, Mass.: Blackwell.
- 2008. Collaboration today and the re-imagination of the classic scene of fieldwork encounter. *Collaborative Anthropologies* 1, 81-101.
- JONES, G.M., B. SEMEL & A. LE 2015. 'There's no rules. It's hackathon.': negotiating commitment in a context of volatile sociality. *Journal of Linguistic Anthropology* 25, 322-45.
- KELTY, C.M. & E.G. COLEMAN 2017. Preface. *Limn* 8 (available online: <https://limn.it/articles/preface-hacks-leaks-and-breaches/>, accessed 21 January 2021).
- , A. CORSÍN JIMÉNEZ & G.E. MARCUS (eds) 2010. Prototyping prototyping. *Limn* 0 (available online: <https://limn.it/issues/prototyping-prototyping/>, accessed 21 January 2021).
- KNOX, H. 2020. *Thinking like a climate: governing a city in times of environmental change*. Durham, N.C.: Duke University Press.
- LATOUR, B. 1986. Visualisation and cognition: drawing things together. *Knowledge Society: Studies in the Sociology of Culture Past and Present* 6, 1-40.
- LIPPERT, I. 2015. Environment as datascape: enacting emission realities in corporate carbon accounting. *Geoforum* 66, 126-35.
- LÖVBRAND, E. & J. STRIPPLE 2011. Making climate change governable: accounting for carbon as sinks, credits and personal budgets. *Critical Policy Studies* 5, 187-200.
- MARCUS, G.E. 1995. Ethnography in/of the world system: the emergence of multi-sited ethnography. *Annual Review of Anthropology* 24, 95-117.
- 2000. *Para-sites: a casebook against cynical reason*. Chicago: University Press.
- MASSUMI, B. 2010. The future birth of the affective fact: the political ontology of threat. In *The affect theory reader* (eds) M. Gregg & G.J. Seigworth, 52-70. Durham, N.C.: Duke University Press.
- MORTON, T. 2013. *Hyperobjects: philosophy and ecology after the end of the world*. Minneapolis: University of Minnesota Press.

- NAFUS, D. 2014. Stuck data, dead data, and disloyal data: the stops and starts in making numbers into social practices. *Distinktion* 15, 208-22.
- 2016. *Quantified: biosensing technologies in everyday life*. Cambridge, Mass.: MIT Press.
- & J. SHERMAN 2014. This one does not go up to 11: the Quantified-Self movement as an alternative big data practice. *International Journal of Communication* 8, 1784-94.
- NEFF, G. & D. NAFUS 2016. *Self-tracking*. Cambridge, Mass.: MIT Press.
- ONG, A. & S.J. COLLIER 2005. *Global assemblages: technology, politics, and ethics as anthropological problems*. Malden, Mass.: Blackwell.
- PINK, S. & J.F. SALAZAR 2017. Anthropologies and futures: setting the agenda. In *Anthropologies and futures: researching emerging and uncertain worlds* (eds) J.F. Salazar, S. Pink, A. Irving & J. Sjöberg, 3-22. London: Bloomsbury.
- POWELL, A. 2016. Hacking in the public interest: authority, legitimacy, means, and ends. *New Media and Society* 18, 600-16.
- RABINOW, P., G.E. MARCUS, J. FAUBION & T. REES 2008. *Designs for an anthropology of the contemporary*. Durham, N.C.: Duke University Press.
- SALAZAR, J.F., S. PINK, A. IRVING & J. SJÖBERG (eds) 2017. *Anthropologies and futures: researching emerging and uncertain worlds*. London: Bloomsbury.
- SCOTT, J.C. 1998. *Seeing like a state: how certain schemes to improve the human condition have failed*. New Haven: Yale University Press.
- STAROSIELSKI, N. 2015. *The undersea network*. Durham, N.C.: Duke University Press.
- SWYNGEDOUW, E. 2010a. Apocalypse forever? Post-political populism and the spectre of climate change. *Theory, Culture & Society* 27, 213-32.
- 2010b. Impossible sustainability and the post-political condition. In *Making strategies in spatial planning: knowledge and values* (eds) M. Cerreta, G. Concilio & V. Monno, 185-205. New York: Springer.
- 2011. Depoliticized environments: the end of nature, climate change and the post-political condition. *Royal Institute of Philosophy Supplements* 69, 253-74.
- TSING, A.L. 2005. *Friction: an ethnography of global connection*. Princeton: University Press.

Hacker l'anthropologie

Résumé

Cet article donne un aperçu de la manière dont le hackage informatique pourrait représenter un modèle pour la recherche anthropologique face aux relations distribuées que les données digitales mettent en évidence. L'argument s'appuie sur un travail de terrain auprès de citoyens et de militants qui tentent de comprendre et d'exploiter les données produites par des moniteurs et des capteurs d'énergie. À partir de leurs expériences, l'autrice suggère que la pratique du « hack » aide les individus à naviguer parmi les données dans les relations sociales. Menant une observation des pratiques de hack tout en formulant une proposition méthodologique, elle met son ethnographie au service d'une réflexion sur le défi anthropologique que représente l'étude ethnographique de processus perceptibles uniquement à travers des données numériques ou digitales. Dans le but d'explorer la valeur du hack pour l'anthropologie, l'article présente l'exemple d'une tentative de réaliser un travail ethnographique à la manière du hackage. L'autrice conclut en s'interrogeant sur la manière dont cette pratique pourrait nous apporter de nouvelles solutions, pour comprendre les implications anthropologiques des relations systémiques et émergentes qui sont à la fois révélées et refaçonnées à travers les données.