

Collaborative Confusion Among DIY Makers: Ethnography and Expertise in Creating Knowledge for Environmental Sustainability

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ABSTRACT

Eco-oriented makers and grassroots subcultures experimenting with new technologies and ways to design sustainable futures are increasingly the subject of research. As activists address problems of environmental sustainability beyond institutional contexts, their work may appear vague, even confused, yet their activities are underpinned by intense and principled commitment. Working through their confusion, many DIY maker communities build new understandings about what 'sustainability' could mean. We argue that herein lie important resources for new knowledge and, further, that ethnography is the ideal way to track these processes of learning and knowledge production. The ethnographer participates in local confusion over values and the definitions of sustainability, but also about what constitutes useful knowledge. Supported by STS (and other) literature on environmental expertise, we argue that maker communities' own acknowledgement of this vagueness actually makes possible a position from which epistemological authority can be reasserted.

Keywords: DIY makers, activists, expertise, ethnography, sustainability

Introduction

There is much disagreement over what is and is not sustainable across environmental discourses, but the knowledge practices that dominate conversations about global environmental sustainability carry within them a set of hypothetico-deductive principles born of stereotypes of laboratory science. This approach to environmental sustainability has long been known to be inadequate. It even suggests confusion in the advancement of knowledge. But if confusion proliferates, as we believe

it does, this could be turned into a strength. The perspective we outline comes from empirical research into grassroots 'DIY maker' or materialist activist communities who self-consciously design more sustainable futures but do so amidst equally self-conscious confusion.

These groups are increasingly the subject of research. As they take on a mandate to "enact the future that others will subsequently live" (Suchman, 2011: 2), they challenge conventional

expert institutions while themselves embodying a distinct conception of knowledge and expertise. The idea that DIY makers are a radical challenge to conventions of knowledge production is partly problematic hype, yet worth analysing as a potential site of social change. We, an anthropologist and a design researcher both intermittently active in grassroots projects, argue that DIY maker communities are fostering epistemological renewal and, moreover, that critical ethnographic research can contribute to developing and sustaining this.¹ Our contribution is based on what is a dream situation for the researcher, the opportunity to work with highly reflective interlocutors who, like scholars, analyse and critique.² But maker-activist communities are often hesitant to offer advice and it is often unclear what has been learned in their practices, which makes their implications for socio-environmental sustainability difficult to articulate. The available (modern) vocabulary fitted neither makers' activities nor our efforts to make sense of them. Across all field sites we saw people coping with radical uncertainty, feeling their way to clarity in embodied, collective and hesitant ways quite at odds with prevailing conceptions of technical and scientific expertise.

Building on recent work in design research (Kohtala, 2017) and (activist) anthropology (Berglund, 2017), we show that although DIY maker practices are vague and even confused, they are underpinned by intense and principled commitment. We argue that the confusion can be productive and actually makes possible a position from which epistemological authority can be asserted. We reach this view from a dialogic, reciprocal and equal relationship with makers. Although we remain outsiders, our questions are similar but distinct from their questions and motivations. Under current conditions, such research is particularly constructive and timely. We draw on our own and others' empirical studies on DIY makers (e.g. Kohtala, 2016), studies on environmental activists (e.g. Berglund, 2001, 2016) and on STS and transdisciplinary research to develop the view that eco-oriented activist makers appear to (or have the potential to) contribute to knowledge production in ways that current policy and even research ignores or misunderstands (Hess, 2007, 2016; Smith et al., 2017).

We develop a suggestive concept borrowed from educational research, the 'dirt-way' of learning. Proposed by Rogers Hall and invoked by Geoff Bowker and Susan Leigh Star (1999), it refers to non-formulaic ways to solve problems. Hall's example concerned children's own methods for working out mathematical problems without following tutored methods: getting "the right answer the wrong way" (Bowker and Star, 1999: 321). Bowker and Star extended the notion to discuss how people develop innovative techniques to work around formal systems and structures. In the present context, the dirt metaphor conveys the ad hoc, dialogic and embodied way small-scale activist projects define and reach towards sustainability-supporting objectives.³ 'Dirt' here captures a critical STS insight about how knowledge is 'purified' in order to give it power, but it also points to human bodies, substances and experiences that will not be contained, something increasingly highlighted in relation to the future coexistence of humans and others (Abrahamsson and Bertoni, 2014).

We identify a 'dirt-way' of learning within activist communities, and (hesitantly) in ethnography also, where people encounter the world as made up of dirt – conceptual and tangible – that might turn out to be precious. Operating in the dirt-way involves considerable uncertainty and vagueness about aims, but this is combined with high commitment to learning. We suggest that the epistemological power this generates is crucial for maker activists, although we also recognise the rewards of conviviality and the emotional respite offered by places populated by like-minded people (Longhurst, 2015; Kohtala, 2017).

Before introducing knowledge practices around sustainability and noting some of their instabilities, we first briefly sketch out how knowledge and confusion appear in materialist maker-activist spaces. We then expand on why we believe ethnographic research can render the confusion inside maker communities as valuable and valid.

Introducing DIY makers

Materialist makers, crafters and builders, of artefacts, alternative energy solutions, food systems and production tools and technologies, are not just groups of hobbyists advocating for change

in their free time. They operate as collectives, designing their spaces, events and decision-making structures. Committed to re-configuring material flows and 'democratising' access to resources, tools and knowledge for sustainability-oriented aims, they align with what David Schlosberg and Romand Coles (2016) dub the sustainable materialist social movement emerging in industrialised countries.

Here our point of entry is the data collected for a doctoral dissertation (Kohtala, 2016) on digital makers in northern Europe, who experiment with digitally-controlled fabrication technologies, electronics and conventional crafts in shared, open-access workshops called fab labs and makerspaces (e.g. Walter-Herrmann and Büching, 2013; Maxigas and Troxler, 2014). While some subcultures in the digital-maker movement are marked by (and critiqued for) their techno-optimism, individualism and a tendency towards exclusion and elitism (e.g. Arieff, 2014; Morozov, 2015), others explicitly question unsustainable production and seek to redress inequality, material waste and values that promote passive consumerism (Hielscher et al., 2015; Smith A, 2017). In their endeavours and passions they are comparable with materially-engaged environmental activists in other times and contexts. What we have specifically noted in their workshops and events across northern and western Europe, is that these are often gathering places for other activists focused on urban agriculture, renewable energy, alternative currencies and postcapitalist modes of living (Kohtala, 2017; Berglund, 2016), as well as for projects like sensor-enabled beehives, water-saving showers, small-scale metal smelting furnaces, tools for recycling plastics and software for transparent collaboration. Using illustrative examples from both anonymous and named sources, in this paper we consider some emergent features of their practices rather than presenting the results of a bounded study.

The roots of these collectives lie in civil society and they can be framed as social movements (Hess, 2005; Schlosberg and Coles, 2016; Smith et al., 2017). Their politics is prefigurative and pragmatic more than it is oppositional; whatever varied forms they take, and however explicit their goals are, these groups are committed to

hands-on action, peer-to-peer governance and active learning. Being generally educated and not immediately vulnerable, they risk being dismissed, even by academics.⁴ Despite their marginality, or worse, frequent dismissal as utopian, they demonstrate tenaciousness and endurance and sometimes their expertise is recognised. Related to, for example, renewable energy, STS scholars have shown how active, inventive users have had impact in providing context- and use-based information relevant to manufacturing and approval standards (Ornetzeder and Rohracher, 2006; Hyysalo et al., 2013). Nielsen (2016) and Sørensen (2015) have argued that the early 'alternative technology' stage of Danish wind power development, marked by active cooperatives of turbine owners developing expertise through learning-by-using and sharing knowledge, were crucial to the later development and cultural acceptance of wind power.

Notably, many materialist-activist groups depart from the communities of grassroots innovators who focus on one theme, such as community energy (Bomberg and McEwen, 2012; Jalas et al., 2014). Instead they often organise under a shared identity with a suite of interests and varying objectives, defined ad hoc and often in contested ways. In Amersfoort in the Netherlands, the De War collective has organised art-based projects, citizen science initiatives and peer learning experiments to foster learning for environmental sustainability and self-sufficiency. In Helsinki, Finland, the arts and new media collective Pixelache changes its programme and themes from year to year depending on political circumstances and membership. What is constant is a counter-cultural standpoint from which to explore alternative economies, bio-art and bio-hacking, or protecting valued environments (Paterson, 2010). The annual festivals of both collectives (Koppeling and Camp Pixelache) are organised as 'unconferences' or 'BarCamps' requiring active co-organising from participants, often to their confusion. The festivals also feature workshops and lectures on peer-to-peer governance.⁵

Since materialist-activists do not specialise in only one issue (such as slow food or solar heat collectors) it raises the question of their status as knowledge producers: upon whom does the

'burden of relevance' lie (Marres, 2015). Even if assessing their 'impact' were straightforward, this would capture only features recognised by business-as-usual or, even more insidiously, reduce their contribution to the quick fixes of sustainability-as-usual that leave destructive regimes intact. If maker-activists outside highly resourced research laboratories and prototyping facilities are keen to engage with the complex issues such institutions pursue, this too is part of the dirt-way of learning: it is not for them as counter-publics to prove their relevance. Rather, it is for others to prove that the issues they pursue are somehow *not* relevant to how we live with and materially participate in science, technology and nature (Marres, 2015). Makers' dirt-way may not be the accepted, formulaic method of 'doing sustainability', but then doing sustainability is hardly uncontroversial with evaluative criteria for recognising it highly unstable (Skjølsvold, 2013).

In their efforts to do away with the negative environmental impacts of modern mass production and consumption, maker activists make visible some key paradoxes and tensions of doing *anything* in the unsustainable and palpably crumbling present. Benchmarking or judging their personal material sustainability or otherwise, as critics are wont to do, is of little account when everyone is entangled in unsustainable global circuits of goods and bads. Furthermore, scientific knowledge poses a problem: anyone with an environmentalist sensibility must attend to a universe of socio-technical as well as nonhuman dynamics, but do so through scientific knowledge that is at once reliable, inadequate and compromised (Lave, 2012). The most defensible position to take is experimenting with alternative ways of thinking and acting. Narrowed to a focus on grass-roots innovation, defined as bottom-up initiatives committed to values of social justice and environmentally sustainable developments (Smith et al., 2017), today's eco-oriented maker practices "point to possibilities", particularly "to the inability of incumbent regimes [...] to respond to demands for sustainability, community involvement, democratization and convivial forms of production and consumption" (Smith et al., 2017: 121).

We will argue that environmentally conscious intellectual work needs to recognise and valorise

the dirt-way. This may manifest in maker culture as pointless activity, as nuggets of valuable matter (resource rather than waste,) but also as the bodies so often discounted in Enlightenment epistemology. The need to operate in a dirt-way is born of not benefitting from an optimal situation, unlimited resources, all knowledge, and yet despite these problems, getting on with the work of experimenting and garnering knowledge with what is to hand.

Contingent concepts and messy practices

Both sustainability and expertise are slippery concepts, but despite the confusion surrounding it, 'sustainability' has continuing appeal. It is invariably associated with new forms of expertise – new study programmes in sustainability science, countless journals and endless conferences (Huu-toniemi, 2014). Sustainability as a concept may offer a boundary object, but beyond that it signals absence – unsustainability – or at best a goal, a kind of utopia.

Particularly in combination with expertise, sustainability points to core troubles in contemporary political dynamics with roots in the history of science. To generalise about a complex story that scholars continue to unpack, Science (capitalised) was elevated to the best possible knowledge available at the same time as modern habits and infrastructures became globally dominant. As STS demonstrates, heterogeneity and hesitancy in scientific practice was largely written out. The stereotype of expertise based in early modern experiences of the impressive power of Science, later bolstered by the confident modernism of the nineteenth and twentieth centuries, still has traction, no matter that science's histories, cultures and objects have always been more complex than this image suggests (Martin, 1998; Lave, 2012). Despite sometimes significant shifts, practices of knowledge making rarely change swiftly (talk of scientific 'revolutions' (Manzini, 2015) notwithstanding). Alongside the ideal of detached and politically innocent knowledge, there have always been fears about and hostility towards expertise (Nelkin, 1975). But recently the ancient "dilemma of expertise" (Nowotny, 2003) has worsened,

with climate change the iconic example of how experts offer promise yet fail to be the “immutable anchoring point outside the cacophony of politicians, social and economic interests” (Nowotny, 2003: 151).

Exposure to refutation, or openness, is an important source of legitimacy for scientific knowledge, as it allows claims that science is superior to other forms of knowledge, which appear dogmatic or merely traditional in comparison. Irrespective of how this openness is understood, the need for expert know-how to contain multiple and interconnected crises everywhere on the planet is irrefutable. Yet the trustworthiness of experts has suffered (Skjølsvold, 2013). Against this background, writing about the relationship between sustainability expertise and ‘the public’ feels extraordinarily fraught, but the tension goes back a long way. We can trace the seductions of external certainty, “whether enshrined in the laws of the gods, of geometry or of Nature” to the Ancients, e.g. Plato (Nowotny, 2003: 151). As expertise developed into a key institution of social order, experts became tasked with combining the needs of society (or other client) for predictive power with potentially endless scientific questioning – possibly leading to political paralysis by prolonged scientific analysis.⁶ Analytically, though, expertise can be distinguished from science, in that it involves the filtering of “information produced off-stage” (Strathern, 2006: 194) and so performing a kind of closure of knowledge. It must also “be able to understand the interlinkages that bind diverse practices, institutions and networks of ... actors together” (Nowotny, 2003: 152). As Maria Åkerman (2016) defined it, expertise consists in ‘meaningful simplifications’ (also Collins and Evans, 2002).

Maker expertise has these same qualities. New knowledge becomes relevant and alive through action, experience and hands-on experimentation and is contested internally. Pronouncements made externally, rare as they are, are usually hesitant. However, DIY makers have advantages when compared with experts serving the proverbial public good. These institutional agencies are normally invited to optimise, innovate and solve problems. Their authority comes from the promise to achieve this, their work grounded

in a technological conception of progress (Suchman, 2011) operating alongside a ‘techno-economic paradigm’ of environmental management (Kostakis et al., 2016). Maker communities in contrast are not held to account like this. They even appear to revel in the absurdity of such lofty aims.

One example are the numerous global maker experiments with wind and water turbines.⁷ As engineering projects, the turbines, usually produced in plastic on desktop 3D-printers, are decidedly non-optimised solutions. They come out of community change projects committed to social transformation through eco-technologies, and their knowledge emerges in collective and accumulative learning-by-doing that is based only on resources to hand (Kostakis et al., 2013; Light, 2014). Such maker expertise is then the expertise of *not* optimising a product, but rather keeping boundaries vague and responsive to others’ contexts and capabilities (de Laet and Mol, 2000). When ‘expertise’ is rendered visible in the tutorials DIY activists produce for each other, this highlights contingencies and offers work-arounds instead of rationalisation and standardisation. What we see here are dogged efforts to deal with and learn from the ‘dirt’ that seeps into bolt threads or causes printing filament to expand, gusts to quell and people to be faulty. It is *socio-technical* (and *sociomaterial*) expertise, built of the will to communally imagine, design and live a better future. And, we could say that DIY makers do this, not to get *away* from facts, but in order to get closer to them (cf. Latour, 2004).

Examples such as the wind turbine, like rapid socio-technical change generally, challenge popular models of the relationship between scientific expertise and sustainability. And yet useful environmental knowledge is often assumed to emerge from academia and then be used for, or applied to, policy (or other ‘interested’) purposes. This view is not just inaccurate (Weingart, 2011; Lave, 2012), it obscures the significant but under-acknowledged role of other actors. Early environmentalists (Jamison, 2001) and other movements often deftly combined technical and other specialist expertise with arguments for greater democratisation and openness, even if they felt uneasy at the borderlands of science and practical

campaign work (Yearley, 2005). Then there were the unspeakable technological disasters at Bhopal and Chernobyl in the 1980s, followed by publicly visible failures of expertise to protect populations in wealthy Europe (Weingart, 2011), which led to newly visible tensions around scientific knowledge and its application. As STS has demonstrated (e.g. Hess, 2007), environmental knowledge from ad hoc community protest to professionalised lobbying through ENGOS, has routinely and for a long time been created and disseminated as a form of oppositional knowledge, what Andrew Jamison (2001) has called 'green knowledge'. More prosaically, even numerous international treaties on environmental protection have originated in maverick or at least non-mainstream research (White et al., 2016).

Arguably, the rise of science and technology studies itself paralleled and supported (even emerged out of) the recognition that science was contingent and messy, thus making space for a new kind of critique of earlier techno-optimistic discourses. Through countless critical analyses, often informed by feminist (Star and Strauss, 1999; Haraway, 2008) and postcolonial insight (Lave, 2012), scholars showed how expertise performs social distinction and authority, and that the epistemic criteria for deciding which problems should be studied and how, have often been fickle (Lave, 2012; Hess, 2007). More generally, in the late twentieth century the production of authorised expertise was shown by detailed studies to have been shot through with politics and human fallibility.⁸ This led to discomfort with the political implications of STS (Collins and Evans, 2002), and the problems still need addressing. As we noted, they are exacerbated by policy makers' demands for proof of harm (that science cannot guarantee) and corporate requirements to protect the freedom to make profit, which together can paralyse regulation. If STS-based critiques of expertise can be seen to weaken the scientific (epistemic) case for taking action, the problem has certainly not gone away.

In the search for better ways to address wicked problems, across our fieldsites as elsewhere (Jasanoff, 2016), we see public participation and collaboration linked to a drive for 'solution finding' (Konrad 2012: 8), often understood as integrating

technical proficiency with 'social robustness' (Nowotny, 2003; Huutoniemi, 2014). Where policy supports vague sustainability and wellbeing goals, improvements are expected to materialise through better collaboration with diverse actors. Thus, in the urbanised, wealthy spaces where DIY makers mostly operate, knowledge practices around environmental issues, even among maker activists, are guided by multiple principles. These combine normative or goal oriented commitments to broadly modern or even Enlightenment principles of universal applicability and a value-neutrality, with commitments to advocacy and what Huutoniemi (2014: 6) calls a "more democratic and socially robust culture of knowledge production". As part of the democratisation of science, languages of networks and assemblages are also gaining popularity, signalling some acknowledgement of the embodied and situated nature of knowledge production, and a realisation that the human beings doing research are also part of the systems they study or, in a less scientific idiom, these vocabularies point at forms of togetherness that need to change. Within a detached modern epistemology this provokes discomfort. Among makers it appears to be celebrated.

We might say collaboration for DIY makers has less to do with now routine calls to enhance legitimacy through public participation, than it has with entanglements with multiple environment-altering forces, not least in the DIY-biology ventures often linked to the makerspaces we know (on DIYbio, see e.g. Meyer, 2013). These tendencies have been picked up in recent environmental humanities scholarship focussing on the messiness of dealing with more-than-human worlds (Abrahamsson and Bertoni, 2014). When imagined as horizontal networks, collaboration may appear more malleable and benign than it is, leaving the sharp inequalities at play in producing environmental damage out of the discussion. Sometimes it even happens that 'the public' is defined to include massive corporations or complex networks of decision making well beyond public accountability, 'collaboration' that covers experiments of which people may not be aware (Evans and Karvonen, 2014). And while almost anyone can be treated as a

knowledge maker in some circumstances, in a complex and unequal world where agnotology (socially constructed ignorance, Proctor and Schiebinger, 2008) is a useful concept, expanding the knowledge commons can seem like an abdication of epistemological authority. No wonder many yearn for tough action based on scientific certainty! The reality is, however, that knowledge proliferates, data explodes again and again, and yet little changes.

The dirt way in maker communities

Maker activists are challenging these dynamics. Their knowledge practices are recognised by many labels (DIY, lay, citizen, guerilla), yet they are continuous with other forms of legitimate knowledge production. In many respects makers resemble producers of science and technological expertise elsewhere, but what we find significant is that they clearly make their own decisions about how technology is designed and used and what problems are worth pursuing. As Carl Mitcham argued over two decades ago, the prevailing politics of innovation support “going along with the flow of various social forces and whatever inherent momentum is manifest in technological change” (Mitcham, 1997: 43). This process has then imposed socio-material demands on ever wider publics in an anarchic and crisis-prone way. We argue that this is not happening in makers’ collectives. Although what is going on there is initially difficult to fathom and even self-consciously messy, activists are developing expertise in democratising technologies and judging them with reference to stringent definitions of sustainability. The rapidly evolving, heterogeneous and diffuse phenomenon of environmentally oriented makerspaces is then reasonably straightforward to outline while our shorthand for the myriad processes going on in their efforts to reach towards sustainability, is learning the ‘dirt-way’.

DIY makers foster principled openness about the limitations of contemporary expertise even in connection with sustainability and transition. Above all, they further epistemic renewal away from conventions that build on hypothetico-deductive methods. Fab lab workshops are one example. They have been characterised as “real-

life laboratories” for experimenting together, with activities less judged by commercial success than social and ecological orientation (Dickel et al., 2014). Playful experimentation and the possible ways to fail that it entails, appear virtuous (Smith TSJ, 2017: 135). Yet at the heart of the experiments we do not find artefacts like wind turbines or bio-materials, but paths to transition to a postcapitalism where “peer production itself is a real-life-experiment in societal transformation” (Dickel et al., 2014: n.p.). Makers debate the endless compromises involved in making sustainable practices both more sustainable and more appealing. Their practices represent not only struggles against passive acceptance of how commodities, materials and power circulate, but confrontations with what qualifies as transformation or innovation.

Let us illustrate this with an example. One of the groups we studied started life as a university-funded short project called Waste-lab.⁹ The project involved experimental electronics artists, designers, design researchers, media researchers and waste management researchers from inside and outside the university. Its aim was collaborative, multidisciplinary explorations on waste streams, e-waste, overconsumption and sustainable solutions, in ways and means from lectures to experiments in a university makerspace.

As a project Waste-lab did not produce any tangible results or exhibit-able solutions, but it continues to exist as a group and an entity in its home town in northern Europe. Its longevity is largely due to its roots in an independent non-profit arts collective whose members fluidly move through the city’s various activist communities – from guerrilla gardening and dumpster diving to realising commissioned public art projects. Both Waste-lab and the arts collective have been among the most environmentally oriented experimental technology communities we have encountered in our work. They are also unusually and consistently critical of the substantial and often green-tinged, technological hyperbole around them.

Waste-lab’s coordinator was Ben,¹⁰ a researcher himself but so involved in coordination duties he had little time for research-like reflection. Ben made different uses of Cindy’s thesis research and

was grateful to have her as an external shield to reflect back the meaning of his efforts. This came informally all along the first year in small conversations. It came more officially when she gave a summary lecture as part of the project at the end of the first funded year. When Cindy's dissertation was published, Ben considered including it as a reference in funding applications for the collective, as proof of activity and impact.

In that important first year, the Waste-lab group met in the university makerspace several times to discuss a collaborative project: how do we together learn about waste? In what ways can this learning take place? How do we involve others in the process, and how do we communicate what we think is important? Some of the artists were extremely critical of the technologies in the lab, especially 3D-printers; others felt comfortable using them as tools for enhancing what they could already do by hand. Discussions on them revolved around appropriateness, but they were also complicated by the venue: some of the artists felt uncomfortable in the clean and tidy lab space that stifled ad hoc invention and creation, not to mention its association with an 'elite' university. It was an open discussion that went beyond black ("you're a luddite") versus white; we sensed that there is something in this digitally-enabled world and we could see that this is the future, but we did not know how to identify and sort out the possible dangers.

"I'd like to get a bit away from being dependent on technology to do this stuff", said one member, in the first meeting. Then she clarified, "It's alright for us to use technology because we're doing it right". Another member replied, "It is how you use it". Ben added, "The point is to have a space where people are encouraged to do it with others".¹¹ But what should the group do? What is the project *for*? And who should be involved? How can they animate and mobilise others in this ongoing conversation? One of the most critical members, Terry, said, "We could figure out something simple enough, so that when an enthusiast or non-enthusiast comes in, we could have (...) presentations, plus some kind of brainstorming sessions, or if we want to have this energy question, if we want to build something big regarding energy production, or something very small, a mesh of very small motors, if we start making small generators, wind and wind-up, cogs, gear systems, dynamos, designing gearboxes".

Three months later the group was still meeting and discussing these potential projects, but attendance was irregular and the group had not agreed on nor made visible progress on a collaborative project.

One day Ben and a Waste-lab member, Tom, were trying out a Waste-lab related design on the 3D-printer. Jack entered the makerspace and Ben joked that they were making something with "new waste". The rest of the day continued with sarcasm and jokes. Tom showed Paul an etched piece of sheet acrylic he had just experimented with in the laser cutter. Paul said with fake reverence: "it's coooooool. It's so coooooool". Tom replied, "It's clean, it makes this appearance of perfection. It's impossible to do this kind of stuff by hand". Paul said, "It makes humans obsolete". Ben and Cindy laughed. Tom continued: "Still, we have to make the images they print". Paul: "Why did I waste time going to art school?" Cindy reminded the group that she was audio recording. Continuing the sarcasm, Ben said, "Cindy is doing research on why we are bothering to make anything at all. Why are we bothering. When there's a good commercial system out there instead. Why bother". The group then went over to the 3D-printer, but the settings were not correct and the print was a fail. Terry said, "Now what are we going to do with that piece of waste?"

While there are several reasons why the group did not complete a project, the discussions illustrate the varied attempts to establish the relevance of their collective actions; to demonstrate their skills and their commitment to the problem of waste; offer critique but also show a willingness to learn; and work in a mode open to unknown future others with unknown resources. They also showed how members made use of the ethnographer's presence to reflect on the potential of the movement to foster new, empowering and sustainable modes of production.

Broadening out from this illustration, together with activists we too have been exploring, in a 'dirty way', the meaning of digitalisation and its relation to a future in the making. We know that members of the collective 'live' this future; they do not visit it occasionally as middle-class citizens might visit an allotment once a week. The arts collective ebbs and flows in terms of members and activities, but it consistently returns to questions of material flows and power in its cultural programme of

repair events, music performances realised with discarded electronics transformed into instruments, or workshops where reclaimed materials are turned into furniture.

Materialist makers often engage in repair and reuse; it matters how maintenance and repair work are seen, valued and facilitated or even prevented (in planned obsolescence). Even as their activities are accompanied by discussions of global supply chains or critical views on 3D-printers, they are always embedded in experiments with alternative ways to produce. In so consciously choosing what to focus their efforts on, they also extend their understanding and practices, in shared spaces, at festivals and online. In discussions, materialist makers are markedly reluctant to judge things as clearly good or bad (especially when speaking of proprietary software). Nor do they indulge in a rhetoric of progress akin to mainstream sustainability discourses where sustainable innovation becomes part of green cognitive capitalism. Rather, the new tools and technologies are evaluated with regard to their usefulness in understanding, deconstructing and then rebuilding anew the processes by which we make or grow and distribute things: the “de-composition and re-composition of everyday action” (Marres, 2015: 68) that is a hallmark of DIY making. Their collective material experiments are often deliberately incomplete and interoperable, intended to traverse contexts and embed themselves in multi-layered technology landscapes. Many explicitly want to work in vague and open-ended collaboration based on the resources to hand. The dirt-way to sustainability is thus a critique of the present, one that does not cripple action, is not beholden to notions of efficiency, novelty or optimisation, and takes in the dirt and messiness of bodies in their environments.

Groups like Waste-lab do produce reports for funders, which are recognised as official measures of productivity. Yet there is regularly a lack of clarity about aims and even about what is going on. These qualities make the longevity of such groups and the continuity of their efforts worth remarking upon. The knowledge that their openness allows to be incorporated, has partly to do with cultural and other locally contingent factors that influence the extent to which an inno-

vation may or may not reduce unsustainability. In this sense, makerspaces are institutionalising at a small scale what Noel Longhurst (2015) calls alternative milieu, protective spaces or niches where experiments in sustainability flourish due to geographical density and intensity. Longhurst’s case is the town of Totnes in South West England, but the dimensions of his alternative milieu concept apply here also, if implicitly: radical politics, new social movements, alternative (institutional) pathways, alternative spiritualities and alternative lifestyles (Longhurst, 2015: 186).

These features were in evidence, for instance in 2015, when a fab lab and innovation festival known as POC21 gathered together over one hundred maker-activists in Millemont, France. Their intention was to prototype their Proof of Concept (POC) open source solutions for a ‘fossil free, zero waste society’ in anticipation of the United Nations COP21 (Conference of the Parties) assembly. At the end of the seven-week prototyping period, their eco-innovations were put on public display at the Millemont chateau. But it was in the preceding prototyping stage that an intense experience of co-living gave participants an impactful learning experience. Up to one hundred people lived together in the castle creating an eco-village of self-organisation and ‘self-sufficiency’. Organisers, inventors and mentors performed all domestic duties alongside materialising their inventions. In practice, this meant teams working on circular, open-source solutions in the temporary fab lab and then pitching them to investors in between keeping the space organised and equipped. It also involved ensuring security (taking turns on night-watch) but also managing the requirements of the human biological ‘life cycle’ with its meals and dry toilets needing regular emptying and cleaning. When asked about POC21, participants first talked about the co-living experience and only then about the inventions.

These accounts resemble those of long-gone Euro-American back-to-the-land communities and back-to-nature writers, and should thus flag concerns over longevity and exclusivity as well as unanticipated future trajectories (Turner, 2006). Such concerns noted, participating in events like POC21 creates fluid geographies that sustain

longstanding networks of individuals who travel and collaborate across Europe, to host organisations (e.g. OuisShare, Paris and OpenState, Berlin), art and design groups, companies and consultancies, as well as the grassroots Open Source Circular Economy Days. This is itself a fluid network of networks: local materialist groups who come together to stage events supported via online activity. POC21 is for us an example of a typical commitment to sustainable materialism in the context of living and making decisions together. It also demonstrated willingness and ability to showcase this to mainstream audiences. Yet even as it borrowed from corporate innovation processes – mentoring, pitching – the organisers chose a collaborative camp as method, a dirt-way far removed from how mainstream green technology usually gets exhibited.

Such events are performative and therefore political, seeking to draw in new people and trying to get them to *participate* in new socio-material practices themselves. The illustration below is of an art collective that has organised regular transition-oriented peer-learning workshops on skills such as beekeeping. Two of its founding members also run a fab lab and DIYbio lab, where workshops and experiments can be conducted. One member has undertaken ‘square metre ecosystem’ experiments in the area around the fab lab to study flora and plants’ inter-relations as a hands-on and immediate way to understand biodiversity. The following is adapted from fieldnotes.

A new visitor to the lab has come to try 3D-printing for the first time. He asks Cindy what field she is from and when she says design, he asks if there are companies or processes for automating disassembly the same way the assembly of products is automatised. This gets her thinking, and they discuss current and emerging processes, design-for-remanufacturing opportunities and the supply chains of rare earth metals. The printer is free and the visitor goes to try to print his file. He tries on his own for some time, examining manuals and websites, and eventually goes to ask the volunteer lab manager for help. Soon the two founding members, Maria and Thomas, come in for their evening shift. Maria has brought in two bags of coffee grounds for growing edible mushrooms; the bags are marked with how many days old they

are. Cindy wonders in her fieldnotes if Maria has a log book where she writes these down, or if she documents the metre garden boxes in the same way.

She asks Thomas about their last festival. He says the festival and its self-organisation would need a more stable community, with people “stepping in”, self-selecting for tasks when necessary without a strict hierarchy, as they currently have in the fab lab. Initially, he explains, there is much enthusiasm for planning, the festival as with any other maker project, that tends to wane, despite best intentions, as other work, family and life commitments begin to intrude. “There’s a fairly high (...) turnover, people stepping in and then stepping out again. But some of them will stay. And from these people who stick and stay, slowly, a more powerful community arises, and that’s the pattern that I now see, that, in the beginning it’s all very vulnerable and you can be doubting whether there’s any sense in what you’re doing, except that the idea is tempting and also needs a lot of enthusiastic reactions. But still, it’s hard to get this done”.

We discuss whether they have had any major setbacks. Later Thomas returns to this idea: “Of course, the fab lab, to me, maybe is a bit of an exception because (...) it’s not that they experience severe setbacks, but it’s more that their development or growth or community development goes through a slower phase. Sometimes there’s this spark, this idea. It can be a workshop or a lecture that generates a lot of energy around one topic, and then you have a lot of meetings in a short period of time. That can lead to finding a next step of organising yourself, because it becomes a product or becomes a stage or a festival or a workshop or, could be anything. But something that has a shape of itself and has benefits for all these people involved. Sometimes you get stuck because you get into a hard phase of something that is not working out. And then we become less intense and people drift off and do other things. But most of the time I see this energy like simmering for a while; it could be months or even a few years, but every once in a while you meet these people and you recall, hey, we were working on this idea back then. How’s it going? Yeah, it was nice, and maybe we should pick it up again. Then, all of a sudden, something happens. Maybe there is a demand for a product or maybe there is demand for knowledge or maybe there’s

a technology development that facilitates some breakthrough. (...) A lot of these things do not have a plan to achieve A, B or C, but it is more a shared energy or a shared value that draws energy and that makes you come together. Sometimes you find a possibility for something, and you go ahead and then it becomes a plan, and sometimes, you all recognise that you should spend your energy differently for an unknown amount of time and until the next impulse”.

Later in the evening, Cindy asks directly about sustainability: “What do you see, with this whole fab lab, peer production, maker movement thing spreading quite fast, what are the danger points if we think of sustainability?” Maria replies immediately: “3D-printers producing lots of junk. Ours doesn’t produce much useful stuff but also uses PLA,¹² which is not so harmful, but those really big ones with the powder stuff, those are really horrible”. Thomas adds: “Also it’s not industrial-scale at all and not even household-scale so it’s, you know, it is spreading fast but still compared to – maybe we have 250 labs now, well, maybe it will be 2500. Then still it’s nothing. As long as they remain rapid prototyping places, you can point out a few things [...] that are harmful or could be better, but that’s missing the point, really”.

Cindy pauses to think about what Thomas thinks is the point. After a few seconds she asks: “How do you know when you’re going in the right direction?” Maria responds: “You never know. We know we are going in the *wrong* direction, after a while, but, no, we want to be free to try a lot out and not worry too much about the direction. Of course we know where we want to go roughly, but--”. Thomas adds: “No, I’m sure there’s some indicators. I think, if what you do meets both a lot of enthusiasm *and* a lot of criticism or scepticism, there’s something to it that’s worth examining. We have had all this discussion about, what’s your business model, and this can’t work out, this can’t be right, it’s not serious, and this place is a dump, and the machines that you have produce crap. You know? That’s all true, and at the same time, people are completely inspired by all the possibilities that are in the air, and that they breathe in and experience. This is, yeah. It means that at that moment, you enter something that has not been settled yet. So in a sense, that, I would say, is the right direction”. Maria continues: “I would say an indication of being in the right direction is that you

suddenly get people showing up that are really interested in it and that are also really interesting people. That’s one of the indicators. For us it’s usually hard to tell what we’re doing right to get those people, but sometimes, really nice people just suddenly emerge from I don’t know where and start participating in something and that’s a nice thing”.

Activists’ motivations are mixed as these illustrations show, but respond to a need to nourish both ethical and technical competencies, and they identify cognitive-capitalism-as-usual as inferior. What is happening – acknowledging a debt to Mary Douglas’ (1966) work on pollution – is something like ‘behaviour out of place’. Patiently waiting for serendipity and highlighting interpersonal experience would, in a scientific context, likely be counted as messy and awkward, better discounted or hidden.

Such being out of place, as person, behaviour or material, combines with abstract technical and scientific knowledge, as in this example, from yet another fab lab. The lab is managed by the entrepreneur-owner herself. The researcher was talking to the manager about a locally developed 3D-printing biopolymer filament with potential environmental benefits in terms of biodegradability and its biomass source (potato waste).

The manager explains: “This year we are investigating what the influence of recycling is on the quality of the PLA filament. So they are printing, and then scrapping misprints, and then extruding it again. Since it is interesting to be able to throw it away, but I think it’s even more interesting to collect all the prints that have gone wrong and then make new filament out of it”. Cindy replies: “I was talking to John in [another fab lab in another part of the country] on Saturday, and he said that some expert had said it can go through basically five processes. And then it just deteriorates too much. In the making of the filament, that is already three processes. So you can basically only try to reuse and recycle it twice more, but if you start from powder, then you can get a few more lifetimes out of it”. The manager replied: “We’re checking it right now. They’re printing all the tensile test parts. And they will tear them apart. Print new ones, tear them apart. Make filament, tear them apart. I’m curious, I think a lot of the quality depends on the

process, and how you are managing the process of the extrusion. And I think the material will really degrade a lot when you're using the in-home extruders. Or I'm curious how that influences the quality as well".

Similar work in new material development is carried out in universities and industry by people with the same expertise as our industrial design fab lab manager. Operating in an independent lab rather than a corporate environment or university research centre is her choice, and allows her to work with local artists and artisans, who provide different perspectives on and alternative ways to work with the new material, as well as alternative understandings of its environmental implications. They make sculptures of the potato waste filaments and bury them in the fab lab's back yard – to monitor, in a dirt way perhaps, the rate of biodegradability. This appears not to be at odds with her professional work with the filament manufacturer. In conversation, she is quite comfortable expressing her intellectual pursuits as a professional designer who also has an identity as an artist and maker. And both she and Cindy are comfortable in the confusion, which leads to more curiosity for both parties.

This is an example of a frequent experience we recognise where researchers and the researched are feeling their way through partly shared conundrums of modern expertise to reach new insight and better questions. Recent literature suggests in fact that situations proliferate where researchers and interlocutors somehow collaborate on conceptual work (Holmes and Marcus, 2012; Marcus, 2016; Escobar, 2018), and out of this new vocabularies are emerging that are helpful in positioning the activists described above in relation to the social and philosophical underpinnings of mainstream sustainability, ones that materialist makers' practices contest. We have in mind such varied places as innovation studies, environmental humanities and work aligned with the so-called ontological turn, indeed anywhere that researchers are discussing knowledge making as part of practices of consciously designing futures, but in disturbing conditions of likely danger combined with unacknowledged ignorance (Jasanoff, 2016).

Some of these vocabularies are based on a post-enlightenment ontology that considers sustainability scientists to have the most solid possible – if still incomplete – grasp of environmental problems and their dynamics, leading to multiple and, importantly, experimental pathways. Smith et al. (2017) is a typical example. Others (de la Cadena, 2010; Escobar, 2018) posit that the very distinction between environmental/natural and social/human is a European imposition. An illustrative example is given by Marisol de la Cadena (2010), of how human affairs can be affected by an angry mountain whose intentions nevertheless remain unknowable. In contrast to what attentive people in Highland Peru can learn about Earth-beings (angry mountains), mainstream expertise, including sustainability discourses, compromises the ability to learn about the world by ignoring knowledge practices marked 'different'. Recent research (Marres, 2015; Smith TSJ, 2017) also notes how the powers of strange, often unknown agencies, are similarly to the fore in DIY makers' knowledge practices, elicited through experimentalism and imagination. These bring in different collectives, including non-humans, "to find ways of going on in life, failing, and thus altering these ways of going on" (Smith TSJ 2017; 135).

Discussion: Collaborative confusion and ethnography

In conclusion, we reflect on the suitability of ethnography as a methodology that takes seriously both what people do and what they say about what they are doing. Ethnography may also be a 'dirt way' of studying the 'dirt way' of learning, an epistemologically strong methodology that confronts a messy reality (cf. Fortun, 2014).

Ethnography undoubtedly objectifies, allowing us to speculate on materialist makers' challenge to expertise as imagined today. As ethnographers we could also identify slippages between activist self-reporting and actual practices. Yet whatever else it achieves, ethnographic fieldwork puts two sites and their preoccupations in relation to each other (Strathern, 1999; Holmes and Marcus, 2012). Through the illustrations above, we have sought to capture situations where knowledge and ignorance jostle against each other, and

where spoken ideas are sometimes only barely grasped while countless other interesting things may be happening as well. Such situations are typical of social movement gatherings (Jasper, 2016). In fab labs, as she seeks to make sense of activists' change making efforts, the ethnographer participates in local confusion – over values and the definitions of sustainability – but also about what constitutes useful knowledge and for whom, or about how one might define time wasting. She learns in an embodied and thus also ethical way (Gibson-Graham, 2008), allowing her to rise to the challenge, as Kim Fortun (2014: 309) has put it, of how to live in “a world still gripped by industrial order yet also beyond it, technically, ecologically, conceptually”.

Fortun's concern there is academic debate on ontology, Bruno Latour's AIME project specifically, a conversation that still leaves so much of real importance 'off the radar' (Fortun, 2014: 310). In her critique of new vocabularies for narrating the troubled present, she also notes that “what can't be articulated isn't flagged ... a presumption that the habits of mind, language, and politics present to us today can themselves produce a different future” (Fortun, 2014: 315). Fortun's article does not feature the word 'expert', but her work is relevant not least because it demands honesty about what kinds of mess are problematic, for whom and for what reasons. In particular it points out how truths are created and defended in corporate labs and strategy rooms, “which link all too easily to regulatory science panels, which end up licencing hazards” (Fortun, 2014: 320). The epistemological grounds for such licencing, like getting caught up in industry-fuelled innovation trends (Mitcham, 1997), have never been strong. And this licencing shapes everyday life and planetary futures. Spaces of materialist activism foster knowledge practices and expertise that do not yield to this, nor to treating alternatives as mere utopian fantasy.

Maker knowledge practices echo aims towards the 'socially robust' knowledge of the science policy discourse discussed above, with participation by a range of stakeholders. However, freed of the demand for problem solving and its links to cognitive capitalism, makers are also freed of epistemologically dubious (if commercially or politically expedient) requirements such as fitting

in with existing incumbent regimes. They may even pursue paths strewn with ontological conundrums. Some of these may come from genuinely perplexing situations; some are historically produced consequences of habits of mind.

Building on what Marilyn Strathern (1999) has called the ethnographic moment, we have explored these options in shared activities and intense conversations with makers. The ethnographic moment refers to the overlapping but divergent questions of researchers and activists that themselves sometimes foster confusion, but the process also provokes sharper reflection. It helps prevent the collapse of knowledge claims into information overload or neoliberal nonchalance. As ethnographic knowledge emerges in the travel from human problems in the research field – in Strathern's case in the cultures of Papua New Guinea – to human problems generated in academic discourse, we are (or should be) alert to the possibility of different and possibly incommensurate criteria of intelligibility and value. Yet, as Strathern writes in the context of interdisciplinarity, each encounter “points to a fresh encounter in a terrain only uncertainly mapped. It is the obviousness of the uncertainty that is important here. The constant shortfall of knowledge that never gets beyond recognition spaces holds out the hope that one can always re-engage” (Strathern, 2006: 203).

In Strathern's (2006: 198) analysis, uncertainty keeps management (the search for a specifiable outcome, a closing down) at bay, and orients us instead to the proliferation of possibilities. Uncertainty can, as we indicated, also be an excuse for inaction, but maker communities, as we have also indicated, are motivated by a need for serious change. Furthermore, they are sustained in engagements pursued with scholars and others beyond, who are trained to problematise the social structural, political economic, micro-political, socio-material and techno-ecological and other discernible conditions that impinge on maker communities – as they impinge on all of us.

If expertise-as-usual is in trouble as it tries unsuccessfully to balance between a fictional appearance as 'pure' on one hand and the pragmatic need to acknowledge uncertainty and multiple entanglements on the other, one

widespread result is that the trustworthiness of experts has suffered. Expertise within maker-spaces is concerned with much more than problem-solving but qualifies as expertise in creating meaningful simplifications (Åkerman, 2016). Maker activists should thus be framed as experts, not 'outsiders', 'lay' or 'citizen' critics, but continuous with epistemic practices beyond. As they also indulge myriad varieties of 'dirt' that the inquisitive human – body, mind, history and expectations all together – can profitably draw upon, maker-activist communities also foster a particular confidence based on knowing that they are learning, that they are self-organising and that working this way is something they have to figure out. It confuses at times and can seem to undermine itself and the hoped-for future, as the passages above illustrate. But in bothering to continue, they have learned to identify what and who they need to realise a project, how to work within limits, how to deal with what emerges and things that just happen, and, importantly, to

identify what they do not want. Makers' expertise is developed collectively, as people converge on ideas worth pursuing that emerge with their own 'shape'; the way new forms of knowledge, symbols and practices emerge and gain traction here, is by collectives of makers experimenting with those ideas and materials in the dirt-way.

Indulging confusion collaboratively, through listening, experimental making and situated humour, leads ultimately to change, of people, processes and things. Whether we call this the dirt-way or something else, makers at least implicitly value it. We see it as something that should be recognised and valorised by academic researchers as well.

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Notes

- 1 Having worked together as academics and activists, we started to compare our experiences of ethnographic work with environmental social movements. Kohtala was fixing her data into a doctoral thesis. Berglund's work with environmentalists focussing on their complicated loyalty to tenets of modern science, goes back over 25 years.
- 2 We would like to extend our grateful thanks to the many people whose work has inspired us and this paper.
- 3 The concept of 'Adhocism' as a term arising from architectural criticism and popularised in the 1970s by Jencks and Silver (2013 [1972]) is also relevant here.
- 4 They certainly invite critical social and political analysis, but given their potential role in expanding collective imaginations, we follow Gibson-Graham (2008) in avoiding critical and judgmental framings of their experiments.
- 5 Note that *de war* in Dutch means 'confused' (Hielscher et al., 2015).
- 6 Endocrine disrupting chemicals are a paradigm case (Honkela et al., 2014).
- 7 A search for 'wind turbine' in Thingiverse, an online repository for designs for additive manufacturing (i.e. 3D-printing) on 8 February 2017, garnered 251 results.
- 8 Even in the field sciences that are most relevant to environmentalism, expertise operates heuristically while its authority remains tied to notions of laboratory-style procedure (Yearley, 2005).
- 9 Names have been changed. Descriptions are based on fieldnotes and quotations are taken from full transcriptions of audio recordings.
- 10 Names have been changed.
- 11 Do-It-With-Others, DIWO, is used in some maker communities to contrast with Do-It-Yourself, DIY.
- 12 Polylactic acid, a biopolymer.