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## Technologies Within and Beyond Practices

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### Introduction

The incorporation of material entities as integral elements of social practices, or as inextricably bundled with them, is a significant development in theories of social practice (Reckwitz, 2002a,b; Schatzki, 2002; 2010; Shove et al., 2012). As Reckwitz (2002a) notes “‘artefacts’ or ‘things’... necessarily participate in social practices just as human beings do”. Reflecting a similar idea, Shove et al. (2012) describe materials as one of three broad categories of element that are actively integrated when a practice is enacted. Yet materiality is diverse; and additional material roles in the life of practices beyond their status as direct constituents of performance have received less attention. This chapter aims to characterise some of these more indirect material-practice relationships by exploring two examples of automated ‘machines’: central heating and fully automated factories.

My intention is two-fold. Firstly, I hope to extend the conceptual tools for positioning technologies of different kinds within accounts of practice. In so far as practice theories focus on what human-bodies do, they may be limited when it comes to a wider consideration of what humans do collectively *beyond* their bodies; that is, through technological systems that carry out processes at varying degrees of distance, in time, space and awareness from the activity of people. Typically, these extended relationships are not recognised if technologies are only or mostly conceptualised as tool-like elements implicated in the ‘practical’ doings and sayings that define practices. Such interpretations become increasingly problematic as new forms of digitally automated and autonomous technologies come into use. A broader view is also required if we are to represent and analyse changing patterns of resource use, especially energy, which enables various forms of automation.

Secondly, I argue that other ways of conceptualising technologies and their dynamic relations to and within practices are important in analysing social change, more generally. In principle, materials and technologies are highly significant for how practices develop and change over time, not only as ‘elements’ of practice but in other ways as well. In broad terms, technologies have dramatically altered the nature, range and qualities of the contemporary ‘population’ of practices by reducing and reconfiguring the contributions and qualities of human participation, how such practices are reproduced, and whether and how they persist, evolve or dissolve. The concept of automation, for instance, indicates the potential for machines to ‘take over’ work that was previously carried out by people. In other words, some technologies appear to be important for how practices persist and change without directly ‘participating’, as elements, within their performance. How can these relationships be represented? And what is their significance for analysing the dynamics of practices?

To explore these questions, I start by examining how technologies have been positioned within theories of practice. The idea that practices are comprised by elements and that they change as these elements and their inter-relationships change has been central to developing understandings of social change in terms of practices (Shove et al., 2012). Although valuable, I argue that such conceptualisation of materials and of their role in change is limited. In the second section, I provide an example: I consider how automated machines are powerfully implicated in modulating another mechanism by which practices change as ‘populations’ of practitioners change. In the third section, I extend the example of automated production to the contemporary phenomenon of ‘fully’ automated factories, and also draw on a contrasting example of automated central heating, to conceptualise a variety of relationships between automated technologies and practices that form interconnecting constellations of practices and materials. In the fourth section, I reflect on what might be distinctive about the dynamics of such machine-practice relationships.

### **Materials as Elements of Practice and Beyond**

The idea that “‘artefacts’ or “‘things’”... necessarily participate in social practices just as human beings do’ (Reckwitz, 2002a; 208) is largely derived from the ideas of Latour, and others within Science and Technology Studies, who argue that action is ‘distributed’ between people and objects (or ‘non-humans’) such that ‘implements... are actors, or more precisely, *participants* in the course of action waiting to be given a figuration’ (Latour, 2005: 71, original emphasis). In incorporating this line of thinking, Reckwitz (2002a: 221) remarks that ‘[T]he things handled in a social practice must be treated as necessary components for a practice to be “practiced”’. Yet they are not the only components, as indicated in Reckwitz’s (2002b: 249) much cited definition of a practice as:

‘a routinized type of behaviour which consists of several elements, interconnected to one other: forms of bodily activities, forms of mental activities, “things” and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge’.

Drawing on this general idea, Shove, Pantzar and Watson identify three broad kinds of elements (material, competence and meaning), which constitute practices when actively integrated by practitioners (Shove and Pantzar, 2005; Watson and Shove, 2008; Pantzar and Shove, 2010; culminating in Shove et al., 2012). These elements define the practice as an entity distinct from other activities, act as a set of ‘resources’ that organise the practice, and are themselves constituted through instances of engagement in the practice (performances). Through this recursive interplay, practices come into being as links between elements are established through performances, evolve as new elements and/or new interlinkages are (per)formed, and disappear as links are broken. That is, practices change as the elements of which they are composed change, or as relations between these elements is reconfigured.

However, when viewed as ‘things and their uses’ or as ‘things handled’ material elements are conceptualised as tools or implements. Indeed, the concept of the *active* integration of elements,

as performed by the practitioner, tends to focus on materials that are directly mobilised, attended to or manipulated in practical activities. But as Rinkinen et al. (2015: 1) remark, objects are encountered and engaged in multiple relations beyond ‘enactment of social practices’. It seems other kinds of materials and relationships figure in the lives of practices, too.

Arguably, the category of materials, or material elements, in the plural is also problematic by its apparent reference to discrete and bounded physical entities, ‘encompassing objects, infrastructures, tools, hardware and the body itself’ (Shove et al., 2012: 23). Yet also referred to by Shove et al. (2012) as materiality, this category is reasonably interpreted more broadly: to represent the inherent materiality of doing and saying including structures in and on which this takes place, aspects of the environment like air and water, as well as less tangible phenomena such as sound and heat. As a dimension or aspect of practice, materiality involves but is not necessarily synonymous with, the material entities that are present or necessary.<sup>1</sup> Specifically, the *relationships* and interactions between entities, such as bodies and technologies, might also be considered as part of the materiality of practices.

Yet the conceptualisation of materiality *within* practices is not my departure point. Instead, I focus on relationships that appear to matter *beyond* performance, at least, of single practices. This is the case with automated machines that carry on forms of ‘activity’ that are distanced, in different ways, from the flows of human activity, and as such would normally be absent from an account of materiality *in* practice. Accordingly, the potential roles of such materials in giving form and shape to practices and to the mechanisms by which they change is also not fully captured by a discussion of ‘material elements’.

In this respect, Schatzki’s (2002; 2010) framing of materiality as material arrangements that are linked to, but conceptually distinct from, practices is of interest. Here, practices and material arrangements each provide a context for the other and are accordingly bundled together, persisting over time in interlinked patterns. Whilst ‘practice-arrangement nexuses’ (Schatzki, 2010: 130) or ‘bundles’ (Schatzki, 2012) are not dissimilar from Shove et al.’s (2012) notion of practices (Schatzki, in press), the concept of material arrangements is not restricted to the materiality of practice performances. This allows Schatzki (2012: 4) to list a number of other ways in which ‘practices effect, use, give meaning to, and are inseparable from arrangements while ... arrangements channel, prefigure, facilitate, and are essential to practices’ through relations of causality, prefiguration, intelligibility, intentionality and constitution (Schatzki, 2010; 2012).

From this perspective, artefacts like machines have a certain default independence from practices, even though they are necessarily linked to them in a variety of ways. The challenge therefore comes not in thinking about *whether* the automated processing undertaken by machines is related to practices, but *how*. Specifically, are other interrelations, beyond co-

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<sup>1</sup> One might also argue that such artefacts or physical entities are themselves not *only* material, but also constituted through meanings, capabilities and processes. I explore a related ‘relativistic’ notion (Ihde, 1990) that artefacts can only be defined in relations, rather than as things in themselves later in the chapter.

constitution, salient in positioning and understanding such machines in practice theoretical accounts, especially those concerned with processes of change and stability? And how are these relations performed through bodily interactions? This is implied since, to Schatzki, as to Shove and colleagues, the actions involved in practices are ‘bodily doings and sayings... that people directly perform’ (Schatzki, 2002: 72).

It is worth noting before proceeding, that for purposes of clarity, and despite my comments above, I continue to refer to machines as examples of ‘materials’ following the established understanding of this category as one of physical entities, including artefacts. More specifically, I understand machines to be examples of technologies, again understood as artefacts (Mitcham, 1994) and, in particular, ones that in any given historical period ‘materialise’ relatively new adaptations in design, techniques or tasks.

### **Modulating Human Participation: When Machines ‘Take Over’**

The account developed by Shove et al. (2012) has more to say about what is involved in the conduct, reproduction and dynamics of practices than is captured in the language of elements alone. Specifically, in addition to changes in the elements of practice, and their interconnections, they note that practices also change as the populations of practitioners who sustain them change, and as the connections between practices change (Shove et al., 2012; Watson, 2012). Some connections between practices are formed as elements circulate between them or are competed for; but not all connections are of this kind.

For instance, Shove et al. note that ‘the contours of *any one* practice – where it is reproduced, how consistently, how long, and on what scale – depend on changing populations of more and less faithful carriers or practitioners’ (2012: 63, emphasis in original). In other words, who undertakes a practice, and how, has implications for how that practice changes from within, through the creation and circulation of variety (thus the configurations of elements). In addition, if practices can be seen to colonise ‘peoples’ time and energy’ (Shove et al., 2012: 65) these are important ‘resources’ by which practices connect to each other, for example, through forms of competition and collaboration. In simple terms, time spent ‘energising’ one practice cannot be spent on others, with the exception of multi-tasking and blending of multiple practices (Shove et al., 2012).

It is therefore important to reflect on the ways in which forms of participation are modulated and mediated through material relations, and therefore how they might figure as a source (and also an outcome) of change. For example, Shove, Watson, Hand and Ingram (2007) describe how the re-design of materials as inert as radiator fittings or varnish enables people with less-specialist skills and experience to use an apply these products. This is important for who can get involved in home improvement and hence how DIY and professional practices are reproduced. Equally, ready meals and pizzas are forms of technology that modulate and in a sense delegate the competencies involved in making dinner, and thus influence who cooks at home, and what it means to do so. Moreover, with the development of digital technologies, there is increasing debate, and also concern, about the re-distribution of knowledge and service work to programmable machines in post-industrial economies (e.g. Ford, 2015).

Indeed, there is no shortage of narratives that explain or foretell dramatic social changes as a result of new or different technologies. Machines, as contrasted against tools, have been the focus of much of this debate (e.g. Hegel, Marx, as discussed by Heilbroner, 1967; Mumford, 1934; Illich, 1973; Schumacher, 1989). The following account is provided by Leder in an endnote to his book 'The Absent Body' (1990: 179-181), drawing on Tondl's (1974) categories of technology. It is characteristic of a widespread understanding of the significance of machines, but is also notable for its focus on the body.

Tondl (1974) outlined three broadly chronological stages of technological development in which the 'body-implement relationship' differs (Leder, 1990: 179). The first phase is an era of 'tools proper' that are wielded and powered by the body. Through skilled use, such tools become habitually incorporated into experience in an 'embodiment' relation, defined by a diminishing awareness of the tool itself, as a focal object. Tondl's second phase of technology is characterised by machines, which are devices powered by non-human energy sources, originally 'natural' ones such as water and animal power and later mechanical power. People are still involved in working with machines, but in a very different way: they guide and control machines but do not provide the motive force. This places the body into a mode of 'background disappearance' (Leder, 1990: 180), having a supporting relationship to the machines whose 'needs and rhythms' provide the 'pattern for the work' instead of those of the human body. The third phase is one in which 'automated machines' carry out many of the control functions for themselves, through monitoring and regulation. Leder suggests 'direct bodily involvement is even further reduced... primarily because it has been put out of play' (1990: 180).

In this account, three categories of technology are defined by their interplay with humans, and specifically by whether the body 'powers' them and/or 'controls' them. It echoes Mumford's (1934: 10) typology of technology in which the 'essential distinction between a machine and tool lies in the degree of independence in the operation from the skill and motive power of the operator'. As Mitcham (1994: 168) notes, this is a key shift since: 'as the machine becomes increasingly independent of direct human energy input, it becomes not just a static object but the bearer and initiator of operations or of special physical, chemical or electrical processes'. In other words, whilst tools are 'handled', or otherwise controlled directly and thereby 'participate' in the activities that comprise social practices, machines denote a degree of autonomy from direct bodily power/energy and intervention. As machines are developed and deployed, there are exchanges between human and technological 'participation' in work. In essence, Leder's account is of the progressive 'taking over' or 'delegation' (Latour, 2005) of previously human roles by or to technologies resulting in the effective reformulation (or even dissolution) of former production practices.

Before turning to consider this outcome in more detail in the next section, it is worth noting that such general narratives should be treated with caution; and this is no exception. Firstly, the idea that the transfer or 'delegation' of work from people to machine (or vice versa) are ever directly or successfully achieved must be tempered. As Latour (2005: 70) warns, the term delegation should not be taken to imply that people (as *Homo faber*) are fully in control of what technologies do, or that they deliberately hand over certain aspects of work and responsibility to them (machine or tool). Instead, and as Ruth Schwartz Cowan (1989) argues in her analysis

of the changing nature of female domestic work over the 20<sup>th</sup> century, technologies designed to automate and ease (house) work, have had unintended consequences, often introducing new forms or standards of work of their own. Moreover, not everything that technologies do is a replacement or substitute for human effort. Technologies are often useful in practice because of the way they *extend* the capabilities of human bodies and the possibility for human action (Kline, 2003 [1985]; McGinn, 1991; Wallenborn, 2013).

Secondly, the distinction between machines and tools is not an essential feature of the artefacts themselves; but rather an outcome of their (changing) relationships within practices. For instance, Ihde (1993: 34, quoted in Verbeek, 2005: 117) argues that ‘once taken into praxis one cannot speak of technologies “in themselves”, but as the active relational pair, human-technology’. Since practices involving an artefact, or its ‘contexts of use’ vary, technologies have more than one definition; a concept Ihde (1993: 20) describes as ‘multistability’. Yet ‘contexts of use’ also imply relations between technology and other materials, such as those that are stored, provide power or are powered, and other mutual transformations. Thus, in addition to tool and machine, Mumford (1934) distinguishes further types of technology: utensils (pots, baskets) and apparatus (dye vat, kiln) both of which affect chemical transformations, and utilities (roads), including those that are powered (railway, electricity), to which Mitcham (1994) adds structures (buildings).

Nevertheless, it seems that through the progressive transformation of work practices, automated machines have powerfully modulated who participates, and how, and thereby whether certain practices persist or disappear. So let us return to the question of what happens to the relationship between machines and practices, when the machines ‘take over’.

### **Machine Relations: Conceptualising Dark Factories and Central Heating**

In this section, I consider how to conceptualise programmable, automated machines in relation to practices, with the help of two examples. Firstly, I extend the example of automated production to the contemporary prospect of *fully* automated factories. Known as ‘lights-out’ or ‘dark’ factories, they require no routine on-site involvement from human workers, thus such facilities can be unlit and unheated, and offer an extreme example of how humans are ‘put out of play’ in work that continues by other means. Although reputed to exist in 2016 (for example, a Phillips factory in the Netherlands that produces electric razors, and a FANUC factory in Japan that builds robots for automated production lines), and although, more commonly, it is only certain aspects of production processes that are fully automated rather than whole sites, I use this as an emblematic example of situations in which practice (involving human participation) has ostensibly been ‘replaced’ by machines. This implies that such machines are no longer elements, at least not in the same practices of production, since these particular practices have themselves expired.

My second example is of another technology designed to operate independently of ongoing input on the part of active practitioners: central heating. The operation of central heating systems is not necessarily accompanied by or contingent upon the heating-directed activities of people; nor is central heating a necessary component of the many other possible practices that are, at times, performed in heated spaces. In other words, there is a sense of decoupling or divergence between the heating ‘work’ carried out by central heating systems and the flows of human activity that transpire within the same automatically heated sites.

The question, then, is how are these ‘machines’,<sup>2</sup> both of which independently carry out transformations on other materials (fuels, water, air, components and other ‘raw’ materials), to be analysed in a system of thought organised around practices defined as distinctly bodily doings and sayings? If these operations fall outside the scope of practice-based analyses, then a lot of what constitutes the social world through the progressive accumulation of ever-more complex and ‘intelligent machines’ (Schatzki, 2002: 179) may be lost from view. For understandings of consumption, particularly of energy as used to power all sorts of social-material processes and practices, along with the many other resources that are transformed as a result, this would be deeply problematic.

Below, I consider several ways in which such technologies may be figured in relation to practices. Firstly, they can be positioned as part of interconnected agglomerations of practices, in which, secondly, people and technologies are mutually ‘engaged’ in various ways and which are, thirdly, organised by reference to cross-cutting end-oriented processes.

#### *Extending Practices: Systems and Constellations*

If bodily doings and sayings in dark factory production and central heating are reduced, and routinely removed, do (former) production and heating practices dissolve and disappear? Or are they still carried on by the machines? There is a distinction to be drawn here: it is fully consistent with Shove et al.’s (2012) framework, and with Schatzki’s theory of practices (2002; 2010), to claim that the processing machines undertake is not *in itself* a practice, if there is no bodily activity that is a part of this process. This suggests that, indeed, *some* production practices may disappear as production tasks are automated. But this is not to say that such automated processing is not still *part* of a practice or sets of practices or, in Schatzki’s approach, adjoined or bundled to them.

The concept of practices might be ‘extended’ to include the operation of machines that share or take over the same tasks as human practitioners but which occur at some temporal or spatial distance from a range of human-enacted activities. For instance, Schatzki (2010: 137) refers ‘to the practice of warming houses’. This is a collective and dispersed definition of practice in which no single performance or practitioner carries out *the* practice of heating houses at any one time. Rather it is achieved across the distributed activities of builders, engineers, planners, plumbers, safety regulators, window and insulation fitters, energy companies as well as the

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<sup>2</sup> The boundaries of these ‘machines’ as artefacts is not straightforward, yet if defined as complex collections of artefacts of different kinds that share certain tasks or roles, reference to central heating systems and factories as single machines makes more sense.

efforts of inhabitants to understand and configure systems, as they ‘set things up’ (Schatzki, 2010: 129).

From this point of view, there might not be much difference between thinking about automated machines as part of a wider set of practices, as opposed to being part of a single (but broader) practice. However, the former is preferable if we choose to work with a ‘tighter’ definition of practices, and if we reserve this term to describe activities that are meaningful and identifiable to their practitioners. This strategy gives us more opportunity to think through what these less-than-direct relationships between practices and technologies mean for analysing change.

To conceptualise larger sets of practices, and the forms of interconnection that characterise them, a number of concepts have been suggested. For instance, Shove et al. (2012) differentiate between bundles and complexes of practices, depending upon how interdependent and necessary are the interconnections between them. Kemmis et al. (2012) formulate inter-practice relationships in terms of ecologies of practices, whilst Watson (2012) refers to a ‘systems of practice’ approach. In contrast, Schatzki (2002; 2010; 2015) provides a multiply interconnected account in which practices are linked to other practices, arrangements to other arrangements, and practices to arrangements, the latter forming bundles. Bundles connect to other bundles forming constellations, which together form a plenum, ‘an immense maze of interconnected practices and arrangements’ (Schatzki, 2015: 16).

Positioned as elements that circulate and play roles in multiples practices, materials (just as with other elements) are important in conceptualising how practices relate to one another. For instance, they might be shared or competed for. In addition, the products of one practice often serve as inputs to others, forming the basis for sequences and other temporal connections (Shove et al., 2012; Nicolini, 2012). In such ways, ‘material systems’ like infrastructures coordinate and configure connections between practices in ‘a trellis-like framework through and around which the combining and loosening of practice complexes occurs’ (Shove et al. 2015: 10; see also Shove, 2016). In fact, reconfigurations in the ways that practices connect, bundle together or compete, is one of the key mechanisms identified by Shove et al. (2012) through which social change occurs. Conceptualising materials as elements helps to recognise and follow these dynamics. So can automated machines be positioned as elements within systems of practice? Or might such materials also play other roles in these systems?

In the case of dark factories, just as with central heating, we can identify a range of related practices in which the factories, their component machines, and the inputs and outputs of their processing (raw components and products) might represent elements: in the activities of managers, engineers, mechanics, designers, marketeers, delivery drivers and so on. So whilst the practice of directly operating the production machines on a day-to-day basis may have disappeared, there is a whole system of other practices that remain firmly interconnected with the now fully automated machines. Below, I consider how these connections might be analysed by reference to an extended notion of the production process.

At the same time, it seems that the dark factory and its machines do not feature in associated practices in the same ways; in some, such as management practices, the machines might not

have any direct or immediate material role in enacting such practices. Similarly, in the case of central heating, despite the range of practices that enable the operation of such machines, their primary significance resides their ongoing detachment from practice. Thus, to situate automated machines *as elements* of potentially multiple practices is only a partial answer to the question of how to conceptualise them. Questions about the nature of these relations remain, and if anything, are deepened by bringing into view the variety of practices to which central heating systems and dark factories connect. This observation is not unique to automated machines, but the examples are useful for exploring at least some of the variety of roles that technologies may play. So before returning to the question of how to conceptualise systems (or constellations) in which central heating and dark factories are embedded, it is important to further consider what roles these technologies may play in them.

### *Human-Technology Relations*

To do so, I turn to Ihde's (1990) phenomenological analysis of the relations between humans and technologies as implied in praxis or action. He outlines three major kinds of relationships: a) mediation, in which humans relate to the world via technologies, as tools or perceptual extensions of the body (embodiment relations) or through which the world is represented (hermeneutic relations); b) alterity relations, in which technologies are acted upon and interacted with; and c) background relations, in which technologies shape experience by remaining in the background. In fact, Ihde uses the very example of central heating to illustrate the latter:

‘...there is some necessity for an instant deistic intrusion to program or set the machinery into motion or to its task. I set the thermostat; then if the machinery is high-tech, the heating/cooling system will operate independently of ongoing action.’

Ihde (1990: 108)

Central heating systems imply a close interaction between bodies and the technology but one that is not necessarily dependent upon ongoing practices. The purpose of automated central heating is to promote the experience of physical, bodily comfort, but to do so automatically, that is, to minimise the time and timing of any attention required. Thus, ‘in operation, the technology does not call for focal attention’ but as an ‘absent presence, it nevertheless becomes part of the experienced field of the inhabitant, a piece of the immediate environment’ (1990: 109).

Ihde (1990) argues that such relations are relative to practices, and as noted earlier, artefacts can exist in more than one kind of relation. Thus, when the central heating system breaks down, or when it is programmed or installed, it is the focus of attention, it is worked upon directly and the technology and its processes are in full view (in a focal, alterity relation). Incidentally, when engaged with heating in this manner, a plumber might act on the heating system with a spanner; and if very skilled, the spanner withdraws from his/her attention, becoming an extension of his/her body in practice (an embodiment relation).

Dark factories are similarly figured in sets of practices that define them differentially as machines to be acted upon, tools to be acted with, or part of the background field of other practices. Yet the relationship between operator-bodies and fully automated factories is one of more thorough decoupling, not just backgrounding. Other practices do necessitate bodily co-presence at the factory and direct manipulation, as in the case of engineers maintaining the machinery. But it might be argued that the absence of operators per se from the core process of production implies that such a process is itself largely ‘bracketed off’ from practice and in so doing ‘black-boxed’ as if it were a single technology or artefact in its own right. Thus, although a dark factory is more than one machine it may be figured as a singular entity in certain human-technology relationships.

Intriguingly, relationships between dark factories, and practices like management, design or marketing, become rapidly complex: they are multiply mediated by other technologies, and practices, and may be thought to exist between groups of people (organisations or ‘corporate bodies’) rather than single human beings. In addition, some of these relationships with materials are not themselves necessarily material: or rather, in this case, they don’t involve the material substance of the factory directly. In Schatzki’s (2012: 4) terms ‘thoughts and imaginings’ about dark factories must be an aspect of design and management practices, and they (intentionally) link together these practices and material arrangements. But do thoughts and imaginings qualify as *material* elements of the performance of these practices?

Whilst this is an intriguing question, I wish simply to note some of these additional ‘modes’ in which technologies might be ‘engaged’ in practices: as acted on practically or in thought, as acted with or through, and as acting in the background. I also wish to underline the point that these are relational roles that for any one technology may be more or less apparent from moment to moment, within and across the different practices that ‘surround’ them.

#### *Extended Processes: Patterns of Temporal Relations and Material Flows*

In thinking about the systems of practice in which central heating and dark factories are situated, a discussion of the extended range of potential human-technology relationships suggests that such systems are materially inter-connected through more than the circulation of the material elements of performance. Following Schatzki, I will refer to these agglomerations as constellations, that is, as interconnected nets of materials and practices. In taking this approach I still consider practices to be constituted through elements of materiality; yet I wish to also show how materials are inter-connected to one another in flows and complex interactions which may be decoupled from performances, the very fact of which conditions the sequences and other connections that form between practices. Let me elaborate.

Even apparently passive objects *do* things when they are not being actively mobilised in practice at a particular time. For instance, roofs are useful precisely because, once set up, they do not need to be attended to in order to keep out the rain. Such ‘passive’ material interactions include storing, channelling or providing surfaces, and may apply to clothes, teacups, buildings, and so on. The fact that things tend to remain ‘set up’ in absence of human interaction is also significant: that furniture, equipment, roads and so on remain where they are put thereby holds space open in which practices can readily take place, at another time. Practices are therefore

connected to such material arrangements and interactions temporally, that is, in various intermittent sequences that might involve setting up, monitoring, maintaining, and putting away.

The same is true of relationships between materials that involve active, energy-demanding processes such as the sculpting, welding and mixing that might take place in dark factories, and the burning and pumping that central heating systems perform. In this regard, heating systems are much like automated production factories in that ‘they carry on, overtaking the formal roles that, at one time or another, have been assigned to them’ (Rinkinen et al, 2015: 12). For example, as Rinkinen et al. (2015) explain, there are significant differences in ways that small-scale wood-fired heating processes organise human inputs compared to those associated with automated central heating systems (Jalas and Rinkinen, 2013). Both require attention but in very different ways, and both follow and reproduce quite distinctive rhythms. In other words, there needs to be a way of accounting for the temporal ordering associated with automated heating or production systems that extend beyond the machines involved and that include various forms of remote or indirect involvement in multiple practices.

In some ways, this is a question of how practices and material arrangements mutually impose order on each other. This is evident in Schatzki’s conceptualisation of mutual patterns of causation between machines and practices:

Whenever humans build machines that something other than human effort powers or use living organisms and things for their purposes, the causal contribution to and significance of these entities (and arrangements thereof) for human coexistence is either set up by or otherwise relative to human practices (actions, ends, projects).

Schatzki, 2002: 117-118

Just as practices articulate ends, the achievement of which is likely require at least some temporal and material ordering; certain materials, in their dynamic relations with others, also impose order on the timing and duration of related practices. This might include ‘natural’ biological processes such as thermoregulation, sleep and eating/digestion and fermentation. Also, according to Leder (1990) automated machines generate temporal demands in relation to the practices required to set-up, maintain and control them. Where such mutually shaping patterns emerge in relation to shared ends, it may be helpful to refer to an ‘*extended process*’ that is organised across the constellation of practices and materials, and that is itself formed by virtue of these inter-relations. Thus defined, extended processes are characterised by sequences of activity and material interactions that are temporally and teleologically ordered, referring not just to the operations of automated machines but to what they help achieve *as part of* constellations. Central heating and automated production (of particular products) are good examples.

In sum, a concept of extended processes (or something similar) may be useful for thinking about how some constellations are organised, how they are reconfigured and even, potentially, reproduced on an ongoing basis. For example, if taken as a unit of analysis, we can analyse how production or heating processes change over time, or how they vary, with the inclusion of

different kinds of technologies or practices, and as certain practices disappear and as others emerge. When analysing change, the qualities of these extended processes are important for understanding changes in the temporal and material relations that connect constellations, how such relations and constellations are stabilised, maintained and adapted, and the modes of engagement between humans and technology they call for.

### **Shifting Constellations: The Distinctive Dynamics of Automated Machines?**

In positioning central heating systems and dark factories within larger sets of practices, I have considered a number of relations through which these automated machines relate to practices (and other materials), in addition to their role as direct material elements. This includes temporal-material patterns and intentional and background relations. In this section, I turn to consider some of the implications of these, now extended, relations for analysing processes of change, again drawing on the examples of central heating and dark factories. In this, I am particularly interested in what might be distinctive about how automated technologies and related practices co-evolve.

I briefly consider five speculative ideas: a) that these dynamics might resemble those associated with the elements of single practices; b) that patterns of human and machinic involvement change across constellations in ways that reflect processes that connect them; c) that processes in which automated machines are embedded might be more stable than those achieved only through practices; and d) that they might also be more readily standardised, e) change more rapidly, and f) that such constellations might become an irreversible yet background-like condition of society.

#### *Elements of Systems*

Just as technologies might be situated as constitutive elements of practices, they might also be considered as necessary aspects of the existence and continued reproduction of sets of practices. In arguing that socio-technical systems of mobility can be reframed as systems of practice, Watson (2012: 493) refers to 'systemic elements – including infrastructures, technologies, rules, norms and meanings – which those practices constitute and maintain'. Thus, the idea that single practices change as their elements change can be extended to systems of practices. Importantly, this may apply in the case of elements that are not directly constitutive of, or shared by, all the practices within a system. For example, relationships between practices within a system may be reconfigured by the technological development or redesign of elements of one central, or highly interconnected, practice. Equally, elements may change as the system changes: not only in physical form as objects are redesigned to reflect the ways they are used, but also in the sense that meanings and functions develop as practices, and the relationships between them, change. In effect, this positions automated machines as interpretively flexible and co-evolving technologies-in-use (e.g. Hand and Shove, 2007) in relation to a system of practices, rather than any single practices that involve their direct physical manipulation.

#### *Elements of Constellations: Reconfiguring Temporal-Material Patterns*

In a similar way, it makes sense to think of automated machines as elements of processes that are organised across constellations. With the introduction of automated machines, cross-cutting interconnections are reconfigured in ways that matter for types of human and machinic

participation and for the temporal and material organisation of the whole constellation (here bounded by the processes of production or heating). For instance, automation might involve the re-allocation of person-hours from one practice to another within the constellation, for instance, shifting ‘work’ from tasks of machine-operation to those of programming and monitoring remotely sensed feedback. This may require quite different skills, with the result that populations of suitably qualified practitioners may also change. In addition, more extensive automation may have further consequences, perhaps entailing changes to delivery schedules or the types of materials used as inputs.

Beyond the ‘immediate’ constellation – i.e. the production process itself - other adaptations may follow across a wider sets of practices. For example, automation may render some populations of previous, or would-be, practitioners redundant, thus ‘freeing up’ time for practices in other constellations. Economic and political changes associated with mass automation are at least partially associated with the re-allocation of time between different sets of practices. And in the case of heating, for example, time not spent collecting fuel and preparing fires may be used for other pursuits, perhaps resulting in less seasonally distinct schedules of activity.

#### *Persistence and Stability*

In principle, a largely machinic ‘extended’ process is likely to evolve differently to one that is largely performed by human practitioners. We might expect such a process to be more stable compared with situations in which practices are continually reproduced through human performance and are consequently subject to ongoing if minor variation. Human performances occur across different spaces, times and settings and this is widely understood as a means by which practices change from within, albeit slowly (Warde, 2005; Røpke, 2009; Shove et al., 2012).

In contrast, certain material arrangements and technologies sustain the stability and durability of practices over time in part because of their physical durability (Latour, 1991; Gieryn, 2002). Thus much like buildings, which do not have to be continually re-performed in practices, even if they often are re-interpreted and re-configured (Gieryn, 2002), it could be argued that fully automated technologies provide something of a stabilising and structuring context to the practices that connect to them, and within the constellations in which they are embedded. For instance, and at a minimum, a process that requires no human intervention presents a different set of challenges for managers caught up in the wider flux of economic, political and industrial changes as compared to situations which involve large numbers of workers with particular skills.

#### *Standardisation*

Processes that are largely undertaken by machines can be engineered in ways that seem infeasible for processes that are enacted by people, no matter how ‘rationalised’, well-regulated or ‘mechanical’ they are. This suggests that automated systems may be amenable to higher degrees of standardisation. As others have observed, heating and air conditioning technologies are inextricably implicated in global circulations of standardised expectations and actual conditions within buildings (Shove, 2003; Healy, 2008). In part, it was the development of

machines that could automatically maintain a set point temperature that first raised the question of what indoor temperatures should be like. The scientific process of specifying comfort parameters has subsequently provided a rationale for the promulgation of air conditioning systems that can reliably deliver these fixed conditions, whatever the weather.

### *Rate of Change*

In contrast to the prospect of stability, it is also plausible that a largely machinic or automated process is more amenable to intentional re-engineering or reconfiguration and rapid change than a process that largely depends on human performance. As Schatzki (2013) notes, it is not just technologies that lend durability to social life, but also slowly changing competences and understandings. From this point of view, software updates and new robotics might well outstrip the speed of change in bodily competence. Moreover, by reducing or removing the temporal and material challenges of coordinating and organising human work, such as operating conditions (light, heat, safety), shift patterns and working hours, it may be possible to re-imagine and re-organise extended processes in different ways.

### *Irreversibility and Transformation*

As indicated above, production processes, in particular, appear to be transformed through processes of automation. One consequence is that it becomes increasingly difficult, if not impossible, to ‘reverse-engineer’ these processes of production and return to forms of work powered only by the human body. This may not be the result of any one moment of automation, but rather an outcome of successive sequences of automation and transformation such as those which enable the range of products, infrastructures and even foodstuffs that are common today.

The irreversibility of what were once apparently negotiable distinctions and delegations between bodily and machine-centred work is deepened as competences change: just as new skills, for instance, in controlling and making automated machines emerge, others are lost. More broadly, the economics of work adapts and shifts as ‘work’ time is reallocated and re-evaluated, as competences change and as the ‘working’ population is re-defined. This adds to a sense of deepening inter-dependence between fully and partly automated production processes and the wider net of constellations in which they are positioned, as both co-evolve. Economic and social organisations predicated on advanced automated production processes emerge, as these processes and systems become part of the more materially durable fabric of society, much like buildings or roundabouts.

### **Discussion**

It seems obvious that practices, technologies, bodies, and other material and immaterial flows are intimately and variously related in ways that shape and are shaped by each other. It is hardly contentious to claim that they co-evolve. However, it is more difficult to differentiate and conceptualise the kinds of relationship and modes of change involved in this co-evolution. To date much of the discussion about how practices emerge, transform and disappear has focused on objects that are manipulated and used. Thus conceptualised, technologies are seen as one of several interlinked elements of practices between which a number of recursive dynamics can be traced, including connections to other practices. As others have noted, this is not the only way in which material relations figure in the dynamics of practice, meaning that it is important to

‘unpack’ and differentiate between the distinctive roles that different materials and arrangements play in practices and their dynamics (Shove, this volume; Shove et al., 2015; Rinkinen et al., 2015).

In this chapter, I have furthered this discussion by focusing on relationships between practices and automated machines. Such relations are marked by the relative absence and decoupling of human practitioners rather than being defined by forms of inter-linkage and co-participation. At the same time, I have shown that such machines are indeed embedded in wider sets of practice, and that when viewed in these terms, entire factories might be considered as technologies-in-use at a more aggregate scale. Even so, modes of ‘engaging’ with or relating to fully automated technologies differ significantly from direct interactions with tools that are handled. This suggests that different dynamics may operate in constituting and transforming the constellations in which automated machines are embedded, as compared to processes that are reproduced through active human participation. The implications are ambiguous: it seems that machinic arrangements are at once seemingly more stable and at the same time more open to intentional re-design than processes that are reproduced by multiple, variously skilled bodies.

At a more general and equally speculative level, a distinction between tool and machine-based relations points to two primary modes of social reproduction: one of practices and one of ‘extended processes’, as sets of procedures organised around a particular project or end. In many cases, practices and processes overlap. Where projects involve machinic and other material processes, the roles of things are heavily interconnected and co-ordinated with and by doings and sayings. However, through more sophisticated forms of control, learning and interconnections with other machines, some machinic operations become increasingly independent, only requiring setting up, adjustment and maintenance: activities which are typically concentrated amongst a smaller group of practitioners.

The practical, political implications of such generic shifts are uncertain. However, the bracketing off, or decoupling, an increasing array of (ever expanding) processes from the realm of human-centred practice suggests that the dynamics of at least some areas of practice depend upon the operation of ever more complex material structures and infrastructures. Moreover, as sophisticated, digital control technologies are integrated with complicated mechanical procedures, as in the case of fully automated factories, the boundaries of technological artefacts may be re-constituted. As they get ‘bigger’ such technologies cannot be ‘used’ by single bodies, nor can they be interacted with directly – though they are clearly worked on and ‘used’ but in a different more distanced sense. In addition, through their routine operation, they stand in something like a background-relation to larger systems of practice, simultaneously constituting and reconfiguring them in subtle and indirect ways.

Attending to these kinds of practice-material relationships is challenging. It calls for a willingness to simultaneously think beyond the body, and to consider to a range of relationships less familiar than those of direct manipulation and perception, whilst, at the same time being able to account for the ways in which these less-than-direct relationships remain anchored in the bodily doings and sayings of which practices are composed.

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