

Part 1

Introduction



Chapter 1

To live in a materials world

Adam Drazin

*The atoms of men have already spent infinity
as part of something else and all your human fudge
is the passing of a thread through the surface of a light.*

(Jack Underwood, 'Death Says')

Imagining a materials world

The importance of materials in the social imagination has risen and fallen historically at particular times, and especially in reaction to enlightenment ideas of knowing and dominating a material world through the power of mind and body (Küchler, Chapter 15, this volume). The enlightenment and industrial revolution eras tended towards homogeneity of a few materials in society, based on abstracted measurements and functions, while by contrast medieval alchemy and the Romantics each celebrated a diversity of materials and material transformations. The modern technical capacity to turn lead into gold at a molecular level, for example, would be at a conceptual level no surprise to a medieval alchemist. Ours is therefore not necessarily the first era when matter has been seen as potentially 'vibrant' or 'living' (Bennett 2010). In the following chapters, we flesh out the reasons why materials demand special attention at the current social moment in history and explore what ethnographic or socio-cultural studies of a material look like. These studies provide examples of the ways in which society tries to find ways to perceive and scrutinize materials, examine the cultural implications of changes in materials uses and shifts in the kinds of materials used, outline how notions of use itself have changed (Küchler, this volume) and give examples of the networks and structures that can arise around a specific material.

This introduction argues that a paradigm shift of knowledge can occur, in which one sees the world as comprised of materials more than of objects (Brown 2004). This perceptual act I consider to be the 'materials world', a sub-set of the more commonly used term 'material world'. I argue that the materials world, as well as being deliberately evoked in academic acts or when learning about materials in places such as materials libraries, comes to be evident at particular moments in everyday life. There are times in many ethnographically observed contexts when a transformation occurs between perceiving surroundings as an agglomeration of forms or seeing them as an agglomeration of substances.

Tim Ingold draws on James Gibson's work to describe a world of materials, which conceives of flows and material properties coming to the fore:

Supported by the ground, the inhabitants of Gibson's account are not so much composites of mind and body, participating at once in the material world and the world of ideas, as immersed in a world of materials comprising earthly substances and the aerial medium. (Ingold 2011: 116, citing Gibson 1979: 16)

Materials in practice have no absolute ends, only transformations (Hahn and Soentgen 2011: 30) in which some aspects always remain while others change. A materials world is one in which all is potentially a resource, a world of potentially endless making and resistance to making. The materials world is hence fundamentally uneasy, and to imagine it is often an act of problematization as much as explanation. It is not necessarily a question of existing or even becoming in the world in a fluid sense, or that materials form a part of cosmology. Some communities such as hunter-gatherer communities may be best described as existing in such a state of becoming, with a highly developed capacity for materials knowledge and perception of their surroundings, as Ingold evokes. There may also be places such as craft studios where acts-of-making can be contained and controlled. However, in many instances the materials world is unexpected, and in an ontological sense can be deeply disturbing. Many materials demand some kind of social control because of their uneasiness. Materials are experienced at best like exciting curiosities, slightly disfigured, and at worst like gaping wounds in the fabric of social life, when the perceived separation of the noumenal and the phenomenal (Küchler, this volume) collapses. Materials as social phenomena happen not only when wood becomes a table, or paper becomes money, but when your table is wood, your money is paper, and your body is flesh.

Materials libraries and the materials world

'The world is a materials library', commented Zoe Laughlin as she showed us, a group of anthropologists, around the library at the Institute of Making in London. She was implying that the experience of visiting her library should not be simply a visit, an experience that begins and ends at the door. It should be a lasting personal change, enabling an enduring potential paradigm shift in one's knowledge and perception. Rather than the library being an echo of the world, into which one goes in order to find answers, it is here rather a lens through which one perceives the world differently and potentially changes it.

At the time of writing there are a growing number of materials libraries in London, in the United Kingdom and in the world. Miodownik (this volume) details many. They do not all have Zoe Laughlin's philosophy, but they are all vehicles for thinking about materials: what materials are, why they are important and how we come to know them. Each has its own philosophy in other words. In the London area, institutions that incorporate what might be termed a materials library, and which I visited in 2011–2014, include the Institute of Making, the sustainable materials library at Kingston University, the design materials library at Central St Martins and the economic botany collection at Kew Gardens. Many museums meanwhile have a strong consideration of kinds of materials in the ways their collections are organized, such as the Victoria & Albert Museum, the British Museum, Science Museum and the Horniman Museum with its large textiles collection, to mention but a few. Several commercial enterprises present themselves as materials libraries in London shops, as well as online.

The idea of a 'materials library' promises a great deal. Like the original Alexandrian conception of a 'library' as a bringing together of all knowledge, one has the impression that somewhere there must exist a large, imposing building or room, within which samples of the entirety of creation's substances has been brought together. You can imagine finding every kind of substance across the globe and through history in a materials library – adobe clays and reinforced concrete, silicon wafers and plastic polymers, liquid mercury and silk and walnut wood and flesh and bone and water and . . . and . . . and . . .

The ideal materials library does not exist of course, perhaps because it is the world itself. It is rather like Borges' story of a map, which, in becoming an absolute representation of the world, is at last the same size as the world. Even if one considers an individual object, the perception of the substance from which it is made, as independent from the thing itself, is an act of fragmentation. Substance and form are not separate. Brown (2004) compares objects in this

fashion to windows, shapes through which one begins to glimpse some part of what things are actually made of.

But nonetheless the ideal materials library is being evoked in a range of institutions and places, each with its own kind of formulation, self-conception, history and physical organization. Visiting a materials library, incorporating the moment when you encounter the curator and are brought into a space, is a moment of discovery of the library alongside the materials themselves. Visiting such a place produces many questions, and I will describe some of my own such visits.

In October 2012, the Institute of Making was in the process of moving its materials collection, but Zoe Laughlin had drawn out a set of materials which were intended to show our visiting group of anthropologists what the library contained. The display area being constructed for the library was planned in a way to deliberately reduce the possibility of categorizing the samples, so that it would be difficult to reduce them to 'types'. The Institute proposes that we can make great strides in knowledge by taking an experimental approach to materials, engaging physically and playfully with them. In this way, and not by trying to pre-define certain uses or even presuming that pre-determined properties are limiting, we may find all sorts of new uses for materials, things they can do, as well as new structures and combinations of materials. The Institute was thus planning to use open shelves for its exhibits, and a system of electronic tags to track down samples as they move around. The library catalogue is not according to substance, use, appearance, or property, but simply numbered in order of acquisition. Other information about the material is to be found in the catalogue under this simple numbered sequence.

A visit to the Economic Botany Collection at Kew is an entirely different experience. With a group of students, I entered a modern, concrete building and descended a ramp into the noticeably cooler, temperature-controlled collection space. A huge warehouse-size hangar greeted us, with row upon row of collection shelves (see Figure 1.1). This looks like a proper materials library. At the end of each row, a large circular handle enabled the curator, Mark Nesbitt, to move the huge sets of shelves and enter in between. He explained how the Economic Botany Collection is not a materials library in the 'strict' sense. It originated in the aspiration to explore how plants from across the world might be exploited commercially. The hundreds of shelves house specimens that take many forms. Old victorian jars, labelled in spidery handwriting, accompany plastic trays, bundles of leaves and flowers, large bulbous black growths and long pieces of wood or bark. The items in the collection, which could be called specimens or materials or samples equally, are organized mainly by botanical genus. This means that for some parts of the collection, they look similar – a genus of plants



Figure 1.1 In the Economic Botany Collection, Kew, with Mark Nesbitt. Arrays of collected samples demonstrate the concept of 'materials'. Photo by Adam Drazin.

where most members take the form of trees means a row of comparable wood samples. In other parts, a plant genus may include tree forms, small shrubs, or flowers, and may have a bewildering diversity of forms.

Three key points need to be made here. First it is not clear what a 'materials library' is in an abstract sense, because they are all different, although you do know it when you see it. They are attempts to 'materialize' what a library is, and simultaneously an experience of knowing. Second, it is not completely evident what a 'material' is. Third, and importantly, materials are more evident in the evocation of transformations than of stasis. Transformations here occur of different kinds.

Materials libraries then are 'discovered' as much as 'made'. Many institutions have historically held collections organized, intentionally or unintentionally, according to the kinds of substances they comprise. Clothing collections and museums comprise fabrics, sometimes according to type. Design and art exhibitions may be divided up into products of stone, ceramics or wood. Archaeology commonly works with categories of substance. Hence the Kew Gardens economic botany collection has only recently come to be seen as a 'materials' library. Likewise, when Jakki Dehn in Kingston began to collect



Figure 1.2 In the Sustainable Materials Library, Kingston, with Jakkie Dehn acting as a human 'mediator' to the collection. Photo by Adam Drazin.

together samples of sustainable materials, her aim was primarily to help students think about and work on sustainability (Figure 1.2). Subsequently, this collection too came to be recognized as a 'materials' library, but the term 'materials' in that instance makes no sense without the qualifier 'sustainable'. One exception might be Margaret Pope, currently of Central St Martins, who has been a pioneer in this field, deliberately establishing and maintaining a materials collection for designers when she was at the Royal College of Art beginning some decades ago.

The negotiability of the term materials is likewise related to the perceptual paradigms of discovery and making. Everything comprises materials, and at the same time in any particular moment certain things are recognizable as materials while others are not. For many engineering contexts, fabrics, for example, are not evidently materials. A material may be cotton, for example, while the weave of the cotton is not the material itself but the structure. By contrast, in a design school such as Central St Martins (Figure 1.3), items such as corrugated cardboard, netting or chipboard comprise materials in the sense that they are resources for design work and design thinking. Some things, in some contexts, are seen as composites or mixtures of two or more materials, while in other contexts they are themselves seen as a unified material.



Figure 1.3 In the Design Materials Library, Central St Martins, London. The materials invite physical engagement. Photo by Adam Drazin.

Hence different materials libraries present different things as ‘materials’. The fact of the existence of this thing called a ‘materials library’ is itself a defining framework for what lies within. Asking ‘what is this material’ is a question that must run in parallel with ‘what is this library’, or, ‘what is knowledge of this material?’ I suggest that the growth of these types of collections globally – London is only one place in the world where this phenomena is developing – is indicative of a widespread shift in the ways that professional cultures are perceiving and relating to material culture.

If both materials and libraries are so evasive to define, how is it that these places actually manage to put them on display? What do we see or experience when we see a material? Often, we see a transformation – by which I mean here a material demonstration of a change. For example, some exhibits manifest a material through a negotiation on uselessness and usefulness. If you want to take an object and present a material, then a broken object does the job much better. Fragmentation is also achieved in ‘samples’ and ‘swatches’, such as rows of square pieces too small to be used for anything.

Transformation can be addressed in different ways. In Kew, at the Economic Botany Collection, individual exhibits are often arranged in arrays or sequences. For example, the notion of 'rubber' may at first seem to be adequately presented by a piece of rubber. However, it is more effective to present several pieces: a ball of raw rubber as historically collected in the Amazonian forest, followed by pieces of processed rubber and jars of sap, followed by artefacts fashioned from pieces of rubber, such as early hot water bottles. Some of these artefacts represent the kinds of experimentation people undertook when exploring the range of possible uses of rubber – for example, rubber wall tiles, which never emerged as viable commercial products. In this sequence, neither a hot water bottle nor a large hard black ball of stuff really communicates the idea of rubber. The sequence of processing and transformation, through which you can imagine the material changing form, and to a certain extent substance, is much more effective in conveying rubber. In this kind of context, if rubber exists, it does not wholly exist as a thing but rather as the idea of a material process. The process is one which is particular to that material, with material properties which only become apparent in processualized moments of action and reaction. To a certain extent, in this area, the material-as-process has referents and placeness. The processing of rubber comprises a global and historical journey evoking specific sites.

This means that materials do not necessarily have consistency, even of substance. A fibre such as cotton may undergo significant processing from the moment of harvesting from the plant, to taking form as clothes. It has not only changed in terms of the structure of the fibres, but has been washed and treated in ways which affect the substance itself. And yet it remains the material 'cotton' throughout.

Another mode of manifestation is by transformation between forms, in a way which expresses the meta-transformation between form and substance. For example, the idea of cork is represented in the Institute of Making through pieces of cork, which are 'raw' bark from cork oak trees and from which corks for bottles have been punched (Figure 1.4). The implicit transformation in this object conveys the idea of 'cork' as material. It combines a sense of the work of processing, with a transformation of utility, a commentary on the natural, as well as a transformation between form and formlessness. On the one hand, you have a lump of something that is not really 'cork' per se, but rather is a piece of tree bark from a cork oak. On the other hand, you have a bottle top. Straddling these two forms and in between them you can apprehend the substance as an alternative to form. Trees are cut down and bottle tops briefly used, but materials persist.



Figure 1.4 In the Institute of Making Materials Library. A sample that transforms between 'corks' and 'cork oak bark' demonstrates the material 'cork'. Photo by Adam Drazin.

In some sense, the act of going into a library and coming out is being constructed as an act of transformation between form and substance. Within the library, materials exist. Outside the library is a world which by implication has form. But as a learning experience, the purpose of going into the library is to be enabled to perceive and understand this world which has shape in a different way. As well as deepening knowledge of particular materials, their properties and behaviours, and as well as perhaps 'finding' a material you can use, one is also educating oneself through the capacity for a knowledge paradigm shift.

Materials libraries can be more about knowledge paradigms than about getting to know materials. In this sense, they are about ways of getting to know the world through materials, which necessitate getting to know the world as materials. One expectation people have in visiting libraries is that they will acquire knowledge: knowledge of specific, discrete kinds of materials, easily-identifiable, separable, fungible materials, which have definable and measurable properties which can be learned about. And, that they will acquire skills, the ability to better match

certain kinds of materials to certain kinds of uses. Of course, in visiting libraries you do acquire knowledge and to a certain extent new skills. However, the curators of many such libraries do not themselves, surprisingly, subscribe to a single paradigm of a world which you can simply get to know and understand. Counter-intuitively perhaps, the person who engages in knowing the world as comprising materials is not necessarily a skilled figure, a person characterized by their skills in knowing materials or in making but rather a figure who becomes schooled in knowing the problems of materials better.

Hence the work of evocation of a 'materials world' is difficult and not necessarily what you might expect. It is however important work. The problem in some ways can be seen as the opposite of what confronted people dealing with the digital revolution around new information technologies since the 1990s. Appreciation of the digital in sociocultural terms used to be severely hampered by immaterial parallelism – ideas of cyberspace, or parallel domains of experience, somehow unrooted from material existence. Notions of an overdetermined 'digital world' led to idealist utopian and dystopian interpretations about how digital technologies might liberate people from social and material bounds. In fact, digital technologies are profoundly material (Miller and Horst 2012) but are easy to imagine as immaterial. Studies of materials face the opposite problem in many ways. Imagining the materials world is difficult, because one simply cannot see the wood for the trees except through deliberate acts of distanciation.

What notions of transformation can we use to help us to perceive and study materials? One might think that Heidegger's (1978) discussion would be useful here of the difference between a tool that is *present-at-hand*, lying on a table, and *ready-to-hand* when it is being used. As the tool is taken up, a perceptual shift occurs where the tool comes to be unconsciously a part of the embodied craftsperson. Heidegger is illustrating a perceptual shift by reference to tools, hence rendering the material world as tool-like. Hahn and Soentgen (2011) consider this kind of appropriation as important to appreciating what materials do in society.

While transformations between ready-to-hand and present-at-hand are relevant, the materials world can also present a somewhat deeper problem. If we want to work with wood, we can use a saw to experience and make the wood; or we can use a screwdriver to engage with the metal of screws. How are we to perceive the screwdriver or the saw as themselves materials? I do not wish to attempt to 'explain' the materials screwdriver in terms, for example, of the fungible way it uses materials with particular properties or in terms of our prior knowledge of metals and wood or that by using the thing we experience it in an embodied way. A different order of anthropological thinking is required here

to account for materials. We live at a time when the screwdriver may shortly no longer be made of metal and wood, but different materials. The things that are currently put together using screws may be made of materials that do not require screws but attach differently.

These kinds of changes are happening all the time. I myself am currently having to force myself to use the range of colourful silicone cooking utensils in the kitchen, which seem to me things that should immediately melt if I place them in an oven or in contact with a hot pan. I feel more secure with metal utensils. I experience difficulties washing clothes, as the types of textiles and their combinations proliferate. To be able to perceive and understand the material, as well as form, can be tricky.

Such materials shifts are happening in textiles, biomaterials and in other domains. What we wish to do in this book is to heighten our ability to problematize the screwdriver and its context through imagining the materials world. It has always been to a certain extent inadequate to conceive of material things as tool-like; it is doubly inadequate to see them as forms. We wish to, not so much propose other ways of understanding, but in the main to try to elaborate on this materials problem. The imagination of a materials world is not necessarily an act of explanation but can be an act of problematization, a challenge to the inevitability or given-ness of the *composition* of the world. What is the problem of materials exactly, in instances where the material comes to the fore?

I now present the bones of an approach to a social science of materials (or, more specifically, an anthropology of materials), which means recognizing their transformational aspects. I also outline how the chapters of this volume illustrate and help us constitute the imagination of the materials world.

The study of materials and society

This book suggests that an 'anthropology of materials' comprises the empirical observation and interpretation of the sociocultural implications of those moments when a transformation between form and substance is manifest.

This suggestion means moving away from some alternative propositions. Materials need different kinds of approaches from objects or things. The book proposes that the anthropology of materials should not be exclusively, or even predominantly, about moments of making. We wish to move away from approaches which would simplistically elide acts of knowing and of making (which often overlap, but need not be similar), and of approaches which consider the material world itself only in terms of praxis or embodiment. Our work takes a

materialist approach, but does not consider there to be one materialist approach (certainly not only a Marxist materialism, a vitalist materialism nor only an approach to materialism orientated towards consumer society discourses), but a plurality of potentially conflicting materialisms, which nonetheless encompass praxis and discourse as subdomains, since both practice and discourse have material form. The implication of this is that explorations of materials and materiality are best employed in social science as vehicles to problematize ideas of knowing and doing rather than knowing and doing being vehicles to understand the material world better.

The social life of materials implies a wholly different phenomenon from the social life of things (Appadurai 1986). While the social life approach is one of the most significant contemporary approaches within material, it is aimed primarily at understanding objects rather than materials. The social life of materials is much less about biographies, birthless and deathless as materials are, and rather about types of transformations (see Frow 2004). The 'life' of materials concerns questions about how materials are 'vitalist' (Bennett 2010), what they do and how they have effects, how they have meaning, how they are known and what social and cultural forms happen through and around them.

This volume is divided into subsections that explore what happens around moments of transformation between form and substance.

On materials innovation

The first section presents some historical overviews and theoretical viewpoints on materials from different disciplinary points of view. We begin with Graeme Were's study of *harakeke*, or New Zealand flax, which sets the scene for what a social study of a material may look like. The story of *harakeke* (or, New Zealand flax) incorporates many elements that can be seen to typify why materials are interesting. For more than a century, *harakeke* has been the subject of attempts at innovation, of technical change and of cultural contestation. *Harakeke* has been the focus of repeated attempts to use and develop its fibres in ever-more interesting and exciting ways. It is a potentially organic replacement for fibreglass, ideal to make, for example, a surfboard. It is also a face cream or a piece of clothing. It is also a traditional 'treasure' of Maori culture, something claimed as traditional property and collective intellectual property. The chapter demonstrates how binarisms, such as modern versus traditional, culture versus science and success versus failure, can be simply dissolved or seem irrelevant in the face of a social study of a material. Were situates the notions of innovation and discovery within long-term historical frameworks, moving beyond them to

an analysis that draws on Gell (1998) to examine the agencies involved in and around New Zealand flax. He proposes a type of analysis and understanding that develops the 'material expressivity' of a material.

Following this 'typical' materials and society study, Andrew Barry's chapter then draws on human geography to expand on some alternative ways in which one can consider this phenomenon of what might be loosely termed a popular chemistry, a culture of materials that is beyond professional scientific circles. Barry offers here one of the prime paradigms that we can use to study materials by considering pharmaceutical molecules as 'informed materials'. He thus opens up a range of new possibilities for the social study of materials, bringing into the equation the ability to work not only with actually existing pharmaceutical substances, or the social relations around them, but the various ways in which the conceptualization of those relations happen. In the understanding of materials, he proposes, we should in most cases not see ourselves as inventing materials. Rather, we should consider the work as discovery or innovation (the same notion that Were situates culturally and historically in Chapter 2). Barry's critique of invention (which is extended by K uchler in the conclusion) highlights the large philosophical baggage that the idea implies, and he shows how if we talk of invention, or innovation, we in doing so infer presuppositions as to what relations between people through things comprise. If we recognize at least some materials as 'informed', they are seen to be part of a potentially immense scaffold of knowledge and communication between people.

If Andrew Barry offers us an alternative voice from within human geography, Mark Miodownik offers us one from engineering. For some years, Miodownik has been a strong advocate for more profound academic attention to the study of materials in society and culture. His contribution here is to begin to frame the problems of materials. He specifies two of the most important challenges that materials present us with, which are both essentially extensions of his central point that materials do not definably exist except in terms of the scalability of matter. First, we have the problem of how to know materials, whether through forms of scientific empiricism based on deduction and experimentation or through artistic empiricism based on experience. We know materials not in one way, but through conflicting knowledge paradigms. Within materials science, materials emerge somehow in the panoply of different scalarities within the structure of substances – if one is studying crystalline structures, then the 'material' is about how crystalline structures and atomic compositions interact; while if one is studying molecular forms, the 'materials' may seem to comprise the range of ways similar molecules may be structured. Hence even for a scientist, or perhaps especially for a scientist, materials do not exist in a reliable fashion.

Second, Miodownik highlights the problem of multiplicity and complexity. The sheer breadth of the topic of materials is astounding, from every aspect of the material world, from steel girders to jeans to the foam on baths, to scents and senses, to just experience. And every aspect of materials descends into ever-more complicated subdivisions, such that one has no sooner started to study concrete than one must study concretes. Materials comprise one of those topics that grows and proliferates at a pace faster than one is able to study it. We will always feel as if we are lagging behind. But this is no reason to deter us; rather it is what makes materials interesting to study. By way of signposting the methodological ways forward, as well as sociocultural studies of materials, Miodownik advocates materials libraries and artistic work as ways to help understand materials.

In the last chapter of our introductory section, David Howes brings us back to anthropological territory. One of the implications of Were's and Barry's arguments in particular is that we find it increasingly difficult to maintain distinctions between professional and popular knowledges developed around materials, and Howes' chapter travels the contemporary territory between these two, from product development testing centres through the commercial networks to consumption. The spread of notions of experience and of the senses into commodity branding and sales signifies a move towards understanding of goods as conveyers of material properties.

Howes' argument as regards the sensory turn in anthropology provides a brief outline of one of the most significant approaches to materials that anthropology has to offer. In Howes' work, people are veritable vehicles of sensation, entities that move through the world soaking up experience. This emphasis on the sensory aspects of humanity, an emphasis that is not necessarily a universal but also produced by contemporary corporate and scientific cultures, contrasts with the kinds of emphasis that Were evokes of knowledge and agency. By throwing light on the science of sensory evaluation, Howes unpacks fixed ideas of material properties, and especially challenges the idea that intrinsic properties in materials are their most important features. Instead, he develops the 'extrinsic properties and associations' around materials. In doing so, he evokes the 'metaphysics of association', which Barry discusses for informed materials, and yet Howes places much more emphasis on the social context than does Barry. 'Sensory experience is social experience' is one of the main lessons we learn.

All four of these theorists in our introductory section are seeking alternative knowledge paradigms in order to think about materials. At first, they may appear very similar, because they share the same target. All are critiquing the idea of materials as fixed, definable, with measurable and specifiable properties and

open to a process of 'invention'. Of course, no one questions that it is certainly possible to work with materials in a positivist, scientific fashion, but these thinkers are questioning whether such an approach is adequate. Where they differ is in the alternative approaches which they advocate. With differing emphasis on agency, knowledge, making and doing or experience, together these thinkers offer a wide spectrum of possibilities to advance our critical approaches to materials in society. The implications of their work is that in response to the complexity of the materials world we begin to consider more widespread, historically informed network-type analyses of the assortment of transformations and relationships that occur around materials – networks that can be infused with material knowledges and experiences of properties. These four chapters situate our approach to materials as strongly concerned with various dimensions of embodied cognition: knowing, remembering, communicating and imagining.

Exploring transformations from substance to form

The notions of making and craft are at the heart of a lot of contemporary work on materials. Some authors posit craft as fundamentally moral and potentially an economically and politically redeeming activity (Sennett 2008). While we think too much emphasis on making and crafting can be limiting to understanding materials, in the sense of being unbalanced, it is certainly important.

Laurence Douny's chapter gives us some insights into the wide-ranging implications of the consideration of the world as a kind of immense resource of materials for potential acts of making. Douny is an anthropologist who has been working for some years on various different materials within West African life and is known for her provocative thinking about the cosmological pervasiveness of materials. In Dogon areas of West Africa, the study of silk reveals how silk and the properties of silk infuse many states of being. As a material, something called silk can be found in many different locales – gathered from the environment as cocoons, within a range of stages of making processes and in finished artefacts. Understood as a carrier and conveyer of a particular kind of power (*daoula*), silk material is at the heart of many processes of social becoming. The silk is not only subject to techniques of making but enables those techniques as well, and Douny proposes that a focus on the *properties* of silk, its visual *sheen*, can help us to transcend these dualities. This comprises one of the most complete studies in existence of the idea of 'sheen' and its social relevance. The ways in which the sheen of silk comes to be a part of clothes and artefacts constitutes 'material aphorisms' or truths. The material comes to constitute moral values and legitimize social relations.

For many people, perceiving the cultural nature of silk in West Africa may be easier than perceiving how plastics in their own homes may be subject to very similar, and equally glorious, cultural processes. Tom Fisher is a well-published expert on plastics within design and design history. His arguments about plastics are comparable to Douny's, in that he suggests that 'they provide the material ground for a plasticity out of which individuals may fashion themselves'. While the process of 'becoming' may be different from West Africa, the sentiment is similar. Fisher's arguments for the constructiveness of plastics are in some ways controversial, for they run against the current of arguments about plastics' association with inauthenticity, which McKay (this volume) also discusses. The celebration of 'plastic utopianism' in a 'plastic age' rings very true.

The third chapter on transformations from substance to form, and on ways of making, also concerns fashion. Urmila Mohan's work defies any idea that fashion culture must be the domain of the purely human, or is secular. Materials in her work can be essentially, profoundly religious. Here she studies a workshop environment in which people make clothes for iconic deities in a temple in Northern India. Far from being a passive template on which social relations, identities, consciousnesses and beliefs are imposed, the materials used are here constitutive of such phenomena. Mohan develops Warnier's (2001, 2009) notions of material consciousness and material religion to understand this situation.

These pieces of research all indicate moments of transformation from substance to form, within the wider constitution of social and cosmological orders. The materials are considered important in very different ways in each case however: for example, an actual materialized power in Dogon areas, contrasts with a 'dematerializing ontology' in Hindu India, which downplays the material as a separate phenomena from spirituality.

All three studies challenge some of the common assumptions of what materials are and show how cultures of materials differ. Some approaches would situate materials as significant purely for how they facilitate making, or craft, and as objects for people to work their magic upon through intentional acts. By contrast, these three studies are more cosmological than they are ontological, representing materials rather than people as the prime conveyers of ideas. The social relations surrounding the materials (Sennett 2011) are pre-eminent in this research, beyond individual work, and it shows how materials can produce an exaggerated sense of value around objects.

Exploring the subversion of form by substance

The central section of the book examines moments of less certainty, in which the truths that materials convey are not channelled into the made forms that people and communities necessarily intend. Rather, they examine those times when legitimate forms are undermined by their deliberate or unexpected reversion into substances, and social orders can seem similarly challenged.

Peter Oakley, an anthropologist at the Royal College of Art in London, examines the promotion of a 'new' material, fairtrade gold, a gold proposed as materially constituted in a different fashion from other kinds of gold. However, Oakley shows how a material can present many contradictory meanings and paradigms. Some of the contradictions around gold may occur among different groups, while other contradictory thoughts can be held consecutively by one person. At the same time, at another level, the immanence of gold presents an integrity that resists attempts to categorically differentiate gold into types.

Oakley's work demonstrates how an inherent tension exists in the treatment of gold in particular. Fairtrade practices of tracing provenance come into conflict with the historically established practices of gold traders who use mass-balancing methods in perceiving gold. The attempt to rethink or reimagine gold ultimately fails against what people are used to doing with gold, revealing a gulf of thought and action.

Deirdre McKay (et al.)'s work also evokes a sense of uneasiness as the concept of *plastik* in the Philippines is made evident in plastic artefacts that aspire to be art. McKay emphasizes how value is here not only being imparted by the agency of makers, or by skill, or by the form of artefacts but also by the undeniability of the material of which things comprise. Far from being a material that can be taken for granted, plastic is shot through with uneasiness wherever it appears, questioning authenticity, art, value, individual identity and class identity. As a material that epitomizes certain aspects of Filipino identity (just as Fisher suggests for modernist identities), plastic is a problem as the material of poverty, problematic in attempts to aestheticize it or use it in art and problematic in its deployment for middle-class or classless purposes. Plastic beads are here also disturbing in that, through use of plastic, the material itself comes to the fore. Rather than being beads, these objects suddenly comprise evidently of 'stuff'.

Different materials will lead social research in very different directions. If one material leads to an ethnography of identity, another leads to religion, and yet another to power. Filipe Calvao's discussion of diamond-trading rooms in Angola means consideration of global macro-issues, the 'imagined representations of the global market', witnessed within small rooms. Diamond trading is founded on

assumptions of how the intrinsic material properties of a diamond have value. In practice these truths about diamonds are negotiated, accessed through certain technologies and terminologies, and implicated in trades that, ultimately, are about a lot more than a particular diamond. Calvao reminds us of how global orders such as capitalism may themselves depend on how particular materials are valued and perceived. To consider 'diamond' as a substance with particular properties and in particular terms, in spite of the variability of individual diamonds, is to help produce a potentially global set of hierarchies and orders. It is no small statement to assert that diamond is a potentially valuable substance.

These three studies are all evidence of what ethnography may do, and observe, which other methodologies may not. This is hard-won fieldwork, for which these researchers invested time, work and patience to place themselves in the situations and among the communities which they describe. Literally years were spent on these pieces of fieldwork.

Materials are, in all three of these studies, rendered as somehow foundational of a social order and of a particular way in which the world 'should' be. At the same time, however, the properties of a material itself are in point of fact not reliable and consistent, but negotiable. Those moments in which things are scrutinized for their substance are, in point of fact, often destabilizing. Such acts of scrutiny are of wider relevance. The issues of tracking and tracing are presenting themselves to us ever more frequently, for example, in food scares in which one slab of beef is not the same as another, but the modes of acquisition and purchase of meat depend on material commensurability. It is profoundly disquieting that what you thought might be one material might suddenly turn out to be something else entirely.

Since, as we have seen, materials do not exist in a universal sense, but as a cultural, perceptually scalable and comparative category of understanding of the world, the different approaches indicated by Oakley, McKay and Calvao also present us with potential ways of defining and approaching materials. We could consider a material to be defined by its particular, unchanging properties – as with mass balancing for gold. We might alternatively consider the provenance and biography of a particular mass of stuff – such that, for example, free range organic meat might be a different material from meat from cage-reared animals, or British wool might be a different material from New Zealand wool. Alternatively, as McKay suggests, we might see a material as a cross-cutting meaningful category, interconnecting the consideration of the world as a resource for value, and artefactual forms.

In sum, what this section does in the main is show the potentially disruptive agency of materials in moments where substance subverts form and a sense of harsh reality emerges into the social consciousness.

Exploring ecologies of materials

As the first three sections of the book suggest, the study of materials necessarily comprises the study of relations and associations, which constitute the transforming and transformative life of materials. The fourth section of the book contains studies that move beyond particular transformations in particular contexts, to examine wider mappings of processes, relations and associations around materials; in which the sense of life around materials (their agency, effects, vibrancy and reactivity) build into wider social phenomena. What are the implications and contextualizations of materials' social lives? We call these 'ecologies', which is a fairly loose, metaphorical use of a biological term for the study of life-in-context. Strictly speaking, an ecology implies the sum total of living relations around one material, while if you look at the intersections of interrelations of many materials, it is a materials ecosystem.

In Chapter 12, we explore an example of a legislative and disciplinary regime that responds to an emergent materials world within the United Kingdom. Sustainability is a powerful and undeniable modern imperative, at the forefront of many peoples' concerns about materials. Whatever one thinks sustainability means, it has become a key measure to evaluate the world we live in. Sarah Wilkes' critical commentary on cultures of sustainability and regulation demands that we consider not only 'materials innovation', but what happens next? And she asks questions that are crucial for the many professionals and disciplines involved with materials at the present time. Wilkes demonstrates how sustainability is interesting not only because it can have a range of potentially conflicting meanings but also because it is part of the general attempt to conceive of the slippery and evasive notion of materials per se. Conceived of as a question about the world, sustainability proposes a materials world paradigm, and Wilkes' work synthesizes many of the issues raised in preceding chapters, and shows how these issues are not just philosophical, but actively being addressed in everyday life. The world of goods is coming to be perceived as an interconnected chemical and energy-constituted 'environment', and there is an increasing pressure to regulate and legislate for situations in which the substances that surround us may be harmful or simply out of place. Materials in 'the environment' are considered in terms of their effects on the young, the elderly, the weak and the 'exposed' and reinforce normative mappings of social power, capacity and privilege.

Chan Chow Wah meanwhile presents an alternative history of materials and the senses, which reveals the ways in which cultures of fragrance and scent intersect with colonial and postcolonial global mappings. The history of fragrance is commonly written as a unitary, global human universal, much as Howes notes in

Chapter 5. This history is in fact here revealed as a Western or European history, but the Chinese experience presents the possibility of an entirely different history. The pertinence of this alternative is testified to by the ways that Chinese companies have managed to supersede the marketing-led behemoths of Unilever and Procter & Gamble in the Chinese bath products market, through the scents in their products.

The topic of fragrance is especially interesting, because it is testament to an instance in which the properties of a material (such as soap) are demonstrated to be detachable and negotiable. Soap and scents are different materials in the industry. The possibility of a movement between form and substance, the existence of materials in other words, is what makes properties detachable. Chow Wah's work instantiates points made both by Howes and by Barry. The kinds of substance used for fragrance, which infuse soap products, are perceived to be intrinsic, semi-magical 'essences'. But these essences are chemicals, which are manufactured, traded and negotiated along their own networks. A trade in fragrance materials is also to a certain extent a trade in possibility and Platonic ideals of things, as well as a trade in the senses themselves. Moving far beyond the localism of earlier chapters, Chow Wah is also exploring a global web of materials whereby the mass-manufactured chemical 'blanks' of material properties are commandeered, shipped, reshaped and sold and appropriated en masse across many different places and social locales. The scale of such a materials-based network is immense, and its cultural implications profound.

Lastly, in Chapter 14, our final ethnographic study, Fiona McDonald's work concerns the mnemonics of the senses that happen around woollen blankets, providing a highly politicized reading or mapping of historical processes. Colonial encounters across the world have through history been contextually associated with blankets made from wool, and are evoked by the particular sensation of the blanket. Contemporary artists deploy the properties of such blankets to manifest, and then reappropriate, such political commentaries. She shows how it is the experience of the material, and especially the particular sensoriality associated with it, that enables people to locate themselves within history. The materials paradigm here functions to historicize and politicize the self and self-consciousness. More importantly, she stresses the capacity of materials to reveal, to clarify and to challenge social relations, especially historicized ones. The blankets that she studies, within an art context, are in some ways social life made manifest. In this sense, their political role is highly nuanced, a point which Susanne Küchler expands in more detail in the conclusion.

These three studies of materials ecologies, or of networks of the social lives of materials, build the points that previous chapters have made into understandings

of wider social contexts. Materials ecologies offer for us new kinds of social forms and structures. Sets of relations and institutions based around a material or a property are closely linked to notions of social change, and related pressures towards social control, discipline and regulation. There is also the consideration that those moments when materials come to be evident in the world compel the exercise of authority and the mobilization of those people and entities who would see themselves as being in control.

In the concluding chapter, Susanne Küchler brings our discussion of materials back to the themes of innovation and invention, which Were broaches in Chapter 2. She traces the changing ways in which materials in general have been perceived and evaluated, especially within the European tradition. The moment when materials are seen as potentially 'useful' is the cultural equivalent of dynamite, and ushers in a whole new era of conceiving materials as designed, an era when the burden of utility lies not with objects, but with the substance of which they are made. Her analysis is an antidote to the euphoric optimism that sometimes surrounds materials innovation. The notion of 'materials-by-design' may indeed usher in more crafting and making, but does not necessarily imply greater sustainability nor necessarily a move away from our undeniable reliance on minerals and petrochemical materials.

Situating the study of materials and society within a history of ideas, Küchler makes us aware of the contemporary era in which we live, the cultural moment within which the putative materials revolution is happening, and she leaves us with questions that demand a response.

Raw no more: The social study of materials

All of the various studies of materials and society in this volume manage to look at particular transformational moments when materials come to be evident. While we could do a study of materials in the world in general – attempt to actually see the world in its entirety 'as a materials library' – the remit of such a study would be impossible, and its academic benefit questionable. Some focus is necessary. The remit of a good social study is typically delineated by a material and perhaps a related community, locale or activity. All of these researchers are not so much attempting to *explain* materials, as wrestle with the ways in which they are problematic. Their methodologies for this achievement are varied, including combinations of using historical approaches, looking at networks, contrasting conflictual and contradictory viewpoints, considering the cosmology and power of materials, looking at the techniques and technologies of perceiving materials,

analysing materials as categories of knowledge and focusing on property and on certain material properties.

Disturbing and disruptive as they are, materials provoke responses. Materials happen at moments when the material world manifests purposelessness, inviting us to rush in with intentions to fill the void. Materials happen – are perceived – at moments of the genesis and destruction of forms that are familiar to us. And yet they have effects as if they act, and not only as ‘smart’ materials. Their shifting qualities manifest in every object and person the slow evidence of quick or gradual ruination, substances changing over time to subvert the consistency of the social world. In a materials world, we are all incipient creations and ruins.

As Wilkes comments, among many materials scientists, ‘materials are no longer thought of as raw, physical matter’ (Wilkes, this volume). It is tempting to retain the fiction that inherently uneasy materials are ‘raw’, acultural and unsocialized stuff. All of the authors in this volume resist this temptation and attack the myth of *rawness*. First, we challenge the mistaken notion that materials are more ‘natural’ than objects. This comprises an ideology of ‘nature’ that has been attacked and deconstructed for some decades with anthropology, most pertinently within thinking on gender (see Strathern and McCormack 1980; Bradley 2000). For those who think ‘ideology’ to be too strong a term, it may be more true to say that nature exists as a social fact not scientific fact, and that materials are especially subject to being constructed as ‘natural’, and hence acultural until appropriately processed into a particular form.

Second, we challenge the misconception that materials are antithetical to information. Andrew Barry undermines this idea most strongly by pointing out that materials are ‘informed’. Chow Wah’s discussion of the globalized trade in fragrances closely evokes the same discussion. In other chapters, materials are presented as things that are, in Gell’s (1998) sense of the term, ‘cognitively sticky’. Materials are carriers of a range of forms of information. They may, in different instances or contexts, convey data, imagination, meaning, knowledge, beliefs and truths.

A third pillar of the mythology of *rawness* relates to skill. Skill is an increasingly important topic of academic study, and rightly so (Grasseni 2007; Ingold 2013). However, the study of skill, crafts, and artisanal knowledge can detract from the appreciation of what materials can do. Skill is not distributed equally in a community, and it often does not function to make materials evident. Good craftsmanship often defies or conceals materials. A focus on skill, and craftsmanship can exaggerate peoples’ knowledges above objectified knowledges (Bourdieu 1990), including siliconized information (Horst and Miller 2012). Skill

therefore, while important, is not sufficient and entire in itself. Materials should not be considered as only resources for skills to be exercised.

The mistaken notion of the rawness of materials therefore arises from a number of specific presumptions. Traditionally, social studies of knowledge, practices and even of material culture, have each not quite taken enough account of materials. Because of this, materials have often been seen as all the 'bits left over' in social life, once you have studied ways of knowing, ways of doing, and the forms of artefacts and objects. In fact, to some degree, materials comprise all of these fields of social life, and this is beginning to be recognized.

Beyond 'things': Reimagining stuff

Those people near the top have the power to make things durable and to make things transient, so they can ensure that their own objects are always durable and that those of others are always transient . . . Only if one remains within severe cultural and temporal confines can one sustain the commonsense belief that rubbish is defined by intrinsic physical properties. Step outside these limits and one sees that the boundary between rubbish and non-rubbish moves in response to social pressures. (Thompson 2004: 295)

We can return to the problem of perceiving the screwdriver as materials. In the development of material culture, the engagement between materials and minds has traditionally been seen to be the form, or shape, of objects and artefacts. Frequently it is making and doing that have been seen as the point of articulation between minds and materials. Hence the study of 'stuff' has come primarily to be understood as production, making, crafting, creating, designing, consumption, accumulation, appropriation, of objects. We need to add to these understandings in the social study of materials, because they are not sufficient. We need to reimagine stuff in frameworks other than form and praxis, and particularly through examining transformations of stuff.

As several of us have observed, especially Miodownik and Küchler, the enlightenment provided a primary moment of intellectual fracture around how materials and minds engage. Looking back at, and reflecting on, this enlightenment moment, a great deal of social science effort has been directed to critiquing the notions of the Cartesian mind and of the material world as simply the object of human understanding and control. A significant moment in this respect was social constructivism's rise from the 1960s, and its related approaches, critiquing the idea of knowledge as a fixed body of truth, and rather highlighting processes and activities of making knowledges. Its influence has been widespread, but it

has not been good for the social study of materials. In some ways, constructivism simply takes the idea of doing in all its specificity, and imports it wholesale into the project of knowing. Knowing is 'like' doing or making. As a critique of abstracted knowledge, constructivism has been very successful and influential but has also detracted from the rearticulation of minds and the material world.

A slightly different trajectory has seen from the late 1970s a range of approaches to embodiment using the idea of the body to reposition how knowing, doing and materiality intersect. One highly important aspect of this movement has been phenomenological approaches, which interpret moments of knowing as situated moments of experience. More recently, the work of Ingold (2011, 2013) has continued to focus on this area. What is emphasized in his more recent work is the ways in which making is itself a process of knowing, through experiencing. Materials can facilitate a consciousness of this engagement. As Oakley says of gold, 'the interpenetration of what is thought and what is done became startlingly apparent as FT/FM gold was found to be excluded from large swathes of manufacturing practice' (Oakley, this volume).

One can consider knowing-as-making or making-as-knowing, but we would also emphasize that there is more to materials than this and rather focus on materials as problematizing ways of knowing. The problems of knowing are not necessarily the problems of praxis, because materials themselves do perform cultural kinds of work, and they are especially kinds of informational or knowledge work.

There are many ways of knowing. By this, we do not mean only different cosmological paradigms or 'social worlds'. One can know, believe, experience, discover, invent, mean, dream, imagine, learn, question, guess or sense. Information may take many corresponding forms: knowledge, data, truth, meaning and so forth. In this volume, the researchers have adopted many tools, methods and routes towards researching materials. They look at cosmologies (Douny, Mohan, Were), networks (Oakley, Were, Wilkes, Chan), techniques of perception (Howes, Oakley, Calvao), categories of meaning (Howes, Fisher, McKay, Douny), subjectivities (McKay, Mohan, Fisher, Barry), histories (Miodownik, Were, Barry, Chow Wah, McDonald) and properties (Howes, Chan, Douny). All of these tools are ways into examining material transformations and the associated social implications.

The imagination of the materials world in these studies draws attention to the possibility of certain kinds of social transformations, implicit in the tensions that the exposure of materials reveals. As they sensorially enable appropriation, materials also can defy and undermine ownership. They are the manifestations of material properties, and the means to ascribe efficacy, and yet they challenge the

boundaries of property relations. The making evident of formlessness in materials can reflect a sense of unboundedness in social terms. As a student commented during a visit to a materials library, reaching for an intriguing sample, 'materials tempt you in – like bubble wrap'. In this respect, the idea of properties and of property are frequently placed in oppositional dialogue: When the thing is seen to 'naturally' have the property, where does that leave an object's owner? The property boundaries of materials are not yet naturalized or normalized. Property relations are frequently challenged by materials (Calvao, this volume).

Materials can underlie and naturalize established social orders and hierarchies (Wilkes). But when they come to be made evident, they can expose these orders. Thompson (1979) long ago suggested that dominant elite groups are often those who are able to define what is 'rubbish' and what is not, expressing the disturbing dependence of power on rubbish. Douny makes comparable points in talking of moments when the silk and sheen of West African women's clothes shines through: 'These woven aphorisms allow women to express themselves in implicit ways that enable them to subvert or contest, but also as a self-reminder and sign of adherence to social moral values and status' (Douny, this volume).

By way of a concluding summary, the materials world can be profoundly, ontologically, disturbing and uneasy. In the extreme, materials have no births nor deaths but emergences and re-emergences in reconfigurations of matter. They have no absolute death, but become different. They can be unreliable – while forms endure, the materials comprising them decay. They challenge social mores, boundaries and hierarchies. They can be purposeless, useless and pointless. Does rock have purpose? Materials challenge property relations, relationships, ownership, identities and extended personhoods based on objects and forms. They do not possess a defined biography or 'social life' (Appadurai 1986; Kopytoff 1986). And yet, in the current moment of celebration of materials, these qualities of the materials world stand in profound opposition to the human hope for discovery, innovation, progress and social mores in materials.

An 'anthropology of materials' explores moments of manifest transformation between form and substance and their sociocultural implications. It involves particular knowledge paradigms and shifts in perspective. It explores the world seen as assemblages and compounds of properties, more than assemblages of objects, seen and appreciated culturally and locally. It looks at the interface between subjective sensory experience and the ascription of objective properties to the material world. It is cosmological, involving an appreciation of how things are constituted, and exist, as they are. It is reflexive, in that it also considers how we as humans are constituted, how we exist, and evokes how we might not exist. It necessitates a long-term viewpoint on the existence of matter. It lastly

considers the significance of social and cultural ecosystems of matter, more than the constitution of an individual object as made of matter.

The following chapters, each in their own way, elaborate on aspects of these points.

References

- Appadurai, A. (1986), *The Social Life of Things: Commodities in Cultural Perspective*. Cambridge: Cambridge University Press.
- Bennett, J. (2010), *Vibrant Matter: A Political Ecology of Things*. Durham, NC: Duke University Press.
- Bourdieu, P. (1990), 'Objectification Objectified', in *The Logic of Practice*, pp. 30–41. Stanford: Stanford University Press.
- Bradley, R. (2000), *An Archaeology of Natural Places*. London: Routledge.
- Brown, B. (ed.) (2004), *Things*. Chicago: University of Chicago Press.
- Frow, J. (2004), 'A Pebble, a Camera, a Man Who Turns into a Telegraph Pole', in B. Brown (ed.), *Things*, pp. 346–361. Chicago: University of Chicago Press.
- Gell, A. (1998), *Art and Agency*. Oxford: Clarendon Press.
- Gibson, J. (1979), *The Ecological Approach to Perception*. New York: Lawrence Erlbaum Associates.
- Grasseni, C. (ed.) (2007), *Skilled Visions: Between Apprenticeship and Standards*. New York: Berghahn.
- Hahn, H. P. and J. Soentgen (2011), 'Acknowledging Substances: Looking at the Hidden Side of the Material World', *Philosophy of Technology*, 24: 19–33.
- Heidegger, M. (1978), *Being and Time*. Oxford: Wiley-Blackwell.
- Horst, H. and D. Miller (eds) (2012), *Digital Anthropology*. Oxford: Berg.
- Ingold, T. (2011), *Being Alive: Essays on Movement, Knowledge and Description*. London: Routledge.
- Ingold, T. (2012), 'Towards an Ecology of Materials', *Annual Review of Anthropology*, 41: 427–442.
- Ingold, T. (2013), *Making: Anthropology, Archaeology, Art and Architecture*. London: Routledge.
- Kopytoff, I. (1986), 'The Cultural Biography of Things: Commoditization as Process', in Appadurai, A. (ed.), *The Social Life of Things*. Cambridge: Cambridge University Press.
- Laughlin, Z. and P. Howes (2012), *Material Matters: New Materials in Design*. London: Black Dog.
- Merleau-Ponty, M. (2002), *Phenomenology of Perception*. London: Routledge.
- Miller, D. and H. Horst (eds) (2012), *Digital Anthropology*. Oxford: Berg.
- Sennett, R. (2008), *The Craftsman*. London: Penguin.
- Sennett, R. (2013), *Together: The Rituals, Pleasures and Politics of Cooperation*. London: Penguin.
- Strathern, M. and C. McCormack (eds) (1980), *Nature, Culture and Gender*. Cambridge: Cambridge University Press.
- Thompson, M. (2004 [1979]), 'The Filth in the Way', reprinted in V. Buchli (ed.), *Material Culture: Critical Concepts in the Social Sciences*, 3(2): 292–303. London: Taylor and Francis.
- Underwood, J. (2015), 'Death Says', *Happiness*. London: Faber & Faber.
- Warnier, J.-P. (2001), 'A Praxeological Approach to Subjectivation in a Material World', *Journal of Material Culture*, 6(1): 5–24.
- Warnier, J.-P. (2009), 'Technology as Efficacious Action on Objects . . . and Subjects', *Journal of Material Culture*, 14(4): 459–470.