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The Social Life of Materials

Studies in materials
and society

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Preface: Materials transformations

Adam Drazin

Why conduct ethnographic studies of materials and society?

What disciplinary approaches are there to materials?

What anthropological approaches are there to materials?

What terms and terminologies can be used?

Why conduct ethnographic studies of materials and society?

We may be in the midst of a materials revolution, a historical moment of innovation and change in the diversity of materials available to us, and in the constitution of the materials which already surround us. Professional fields such as materials science, engineering, manufacturing and design are feeling the impact of this revolution at the moment, which could compare with the digital revolution in its implications. It is however not only a revolution in science but a social and cultural revolution.

As they have emerged into public consciousness, it is increasingly being realized how important materials are to many dimensions of policy, economics, ethics and the public sphere in general (Hudson 2011). This is for several reasons, which concern the macro-politics, the micro-politics, and the experience of materials. At a global level, certain specific materials have come to be crucial ingredients in modern technologies. Mobile phones and touchscreens, for example, depend upon iridium and other very specific substances. Many such materials have very limited sources in the world, or even a single source. Frequently, these sources are located in zones of political and economic disturbance, or places where there is a risk of war or revolution. The world's contemporary dependence on certain materials heralds repetitions of historical cycles of conflict. If we recall how in recent years global conflicts have

been linked to global dependence on, and interests in, oil and petrochemical materials, then why should not similar conflicts happen in future around other comparable materials? Materials usage is not politically or economically neutral and especially in material monocultures.

Materials do not only have macro-politics and geopolitics, but micro-politics. They are one of the media through which corporate involvement in everyday life can be felt. Corporations are beginning to own certain kinds of substances, those which it can be claimed have been either 'created' or 'discovered'. It is not only products and things which are 'owned' in our lives, but increasingly the stuff itself of which things are made. Some companies (as David Howes notes in this volume) are also tightening their grip on materials through their branding of, and intellectual property ownership of, certain sensations and senses.

Moving away from private corporations, materials have also become more of a focus for NGOs and social movements. The aspiration for something called sustainability has grown ever more powerful in everyday life and made people more aware of materials. As more people profess to consider and examine their worlds in terms of sustainability, they perceive more clearly the materials and substances of which the world comprises.

In terms of individual experience and imagination, this moving territory, ranging from uniform 'grey goo' to exciting rainbows of possible substances, can be problematic. A putative materials revolution means that a person can no longer be certain of what things are made from. If you have ever washed something at the wrong temperature, printed the wrong ink onto the wrong paper, used the wrong kind of flour in a recipe or melted new kitchen implements and then felt that this was a mistake on your part, then you will have experienced a changing materials world. Our capacity to fulfil tasks and live up to our responsibilities to others can depend upon knowing how substances behave. Materials innovation reveals and challenges those doxic material mappings we carry around with us and makes us reconsider experience.

In materials innovation, there is a particular gap between the conception of a material, existing as raw 'stuff', and the moment when it comes to be a part of life as something used. Materials, new or old, can be seen to 'succeed' or 'fail' in this sense (Küchler, this volume). Very many materials have not yet succeeded, the kinds of materials that are exciting laboratory oddities. In some ways, we are experiencing a political divide around materials. On one side are those who favour monocultures of mass-produced, known materials. On the other side is a strange coalition of different groups who celebrate materials diversity through science, art, laboratory work, crafts, design, historical discovery, localism or simply playfulness.

The subject of materials is a pervasive one, not one which can be easily relegated to specific domains of life, or contained behind certain boundaries. People are constituted in materials. Information is constituted in materials. Objects are constituted in materials, some more evidently and some less, from televisions to touchscreens to jeans to wedding rings to bricks. In this sense, the study of materials transcends the study of any individual material. It is a field that reaches into questions of ontology and being, epistemology and knowledge.

However, materials have historically proved an evasive topic of study for social science. Often, materials have seemed un-social, the raw stuff from which people would be able to shape cultural and social life, but in themselves not cultural. Materials have been subject (and victim) of the worship of pure nature. In this volume, we relocate materials. In social terms, they are no longer 'raw'.

There is therefore a need for an academic ecosystem of diverse ideas and approaches around materials. Social studies of materials and society, as are to be found in this volume, are just one of the diverse ways in which we need to look at materials. They amount to a socially empirical approach. There is the risk of being over-dependent on laboratory-based and studio-based approaches to materials, which conceive of them as having inevitable intrinsic properties that will determine social and cultural implications or effects. We here celebrate socially empirical studies, and especially ethnographic studies, because they are the only way in which we can begin to observe what actually happens around materials, test whether our ideas apply and see just why materials matter. It is important to ask what is it that materials actually do?

Throughout this book, different authors present their own observations and studies of certain materials. What they also do is explore different ways of thinking about materials. There are a wide range of ways in which one can think about materials, and we need to find more such approaches. Through this book, hopefully every reader can begin to ask for themselves whether they are confident they know what materials are, and what their own approach is. And if they do not yet know, they can be helped to see some possible answers for themselves.

What disciplinary approaches are there to materials?

A number of disciplines have responded to the prospect of a materials revolution by outlining more focused approaches to what they are and what they do. Such approaches have particular characteristics, and show something of the variety of ways in which materials can be conceived and approached epistemologically.

We cannot attempt any kind of comprehensive bibliography here, just a few windows into different relevant areas of work.

Materials science and engineering is evidently a key field, where a scientific perception and analysis of materials is prevalent and well developed. There are a number of different approaches within this discipline. In Cambridge, one influential approach is provided by the team coalescing around Mike Ashby (Ashby and Johnson 2009), and popularized and promulgated with particular software tools known as CEU EduPack. Within engineering, there is a particular attention to the chemical composition of materials and structure at different levels (atomic, nano-, crystalline, etc.). Materials science often groups materials by category. The categories may in some sense overlap, or be sorted into macro- and micro- categories, but have a utility and commonsense nature about them. Hence 'stones', 'foams', 'metals', 'ceramics', 'plastics' could be deployed. One can also consider more abstract categories such as 'natural materials', when it is difficult to distinguish such materials as wood, resin, rubber, or shell, and such categories reveal the grey areas of engineering's approach where more flexibility is required. The field also has difficulty deciding how to incorporate many phenomena that other disciplines would consider very important as materials, such as textiles.

The capacity exists within engineering to define and measure materials' properties and to map and locate materials according to such properties as acoustic qualities, density, tensile strength and so forth. In this sense, practically anything that can be quantitatively measured can be seen as a property. Another implication is that practically anything physical in the world can fit into the schema. From an engineering point of view, you can take any observed situation and reduce it to its constituent materials and their properties. No particular aspect of a situation is more or less of a material, unlike within many cultural paradigms where certain things at certain times are seen as 'materials' more. There is also a strong degree of comparability, and in some cases even substitutability, of materials in engineering work. It is possible to begin to see materials as 'the answer' to a utilitarian problem. If you need a material for a task, which needs to have a certain density, strength, and thermodynamic properties, then through a quantitative analysis of these properties, one may produce a selection of possible alternatives.

While the greatest, significant contribution of products such as CEU EduPack has been to classify and categorize properties, it is very explicit that the people who have developed and use it do not consider this kind of 'intrinsic properties' approach to be sufficient in itself. Most engineers acknowledge the need to mitigate the more positivist tendencies of engineering. The quest for finding

the 'right' material or materials is not a journey, for them, which necessarily has a 'right' answer, but rather a journey in which one can avoid wrong answers and deploy measurements and modellings to get a much better-engineered result. Hence Ashby advocates taking several approaches in materials work, among them Synthesis, Similarity and Innovation. By this, he means that one should experiment with, compare and contrast, artistically experience and play with materials, as a part of their exploration. Mark A. Miodownik (this volume) is also one of a number of engineering voices who advocate much broader, and socially informed, approaches.

Mainstream engineering approaches to materials have provided especially powerful ways to model sustainability in materials. The definition of what is 'sustainability' here must be very specific (see Wilkes, this volume), often seen through an analysis of the measured energy implications if a particular thing or product is engineered in a particular way. An analysis of the energy implications of using a material must take account of, among other things, transport, lifespan, origins and production. This 'universalizing' approach to the energy implications of a material is exceptionally powerful and is an important weapon in making our world more environmentally attuned.

Within design (which is as diverse a field as is engineering, ranging from industrial design to service design, to arts, to graphic design), an entirely different set of paradigmatic approaches applies. The design literature is full of large, glossy books, which are not so much analyses as catalogues of materials to which a designer can turn for ideas or inspiration (Leiferi 2006; Howes and Laughlin 2012). Unlike in engineering, the physical image or presence of materials comes to be very important and an appreciation of the aesthetic properties of materials. It is impossible to produce anything remotely comprehensive, and so there is a balance between presenting materials that are in some sense typical of a category (e.g. a ceramic) and those that are somehow 'innovative' materials.

Many design materials would not from an engineering point of view be considered as materials but rather as composites. Hence materials such as textiles, various kinds of sculpted cardboard or layered wood are also materials from a design point of view. These types of thing-manifested materials expose the fallacy of the idea that a complete distinction can be made between form and substance. They are convergent. Likewise, design concerns itself equally with the 'experience' of people who use and work with designed products and services. Materials often 'speak for themselves', and there is a resistance to 'explaining' them in terms for example of abstract properties. Hence experience is ever more as an entry point into materials and categories of materials (Karana

et al. 2014). Where an engineer may distinguish the material as thing from the material properties, using the one to explain the other, in design this distinction may be less clear.

Both engineering and design are especially concerned with certain macro-categories of materials, which are not definitive but ways of considering significant issues in contested ways. Such categories may include sustainable materials, natural materials, bio materials, innovative materials, smart materials. The persistent tropes of naturalness, artificiality, and smartness, help to translate the implications of the incipient materials revolution into design-suggestive social or cultural terms.

Like engineering and design, philosophy has begun to address the implications of the putative materials revolution. The most common suggestion is that experience of materials is changing at an ontological level. In the past, in a world where materials were only rarely invented or discovered, where many materials were locally sourced and the possibilities for mixing and reinventing them was likewise relatively slow, you could be fairly sure of knowing the properties of any particular material you encountered. This predictability rendered materials as in some sense reactive. Their properties would be what Leibniz would call passive, appearing in pre-determined and pre-intended uses in reaction to human action. For a number of reasons, however, we can no longer depend on the predictability of materials. The conception of materials as active (Bennett 2010), as agentic, and as much more causal in social and epistemological situations, can be seen as a 'vitalist materialist' perspective:

Is it not possible to imagine matter quite differently: as perhaps a lively materiality that is self-transformative and already saturated with the agentic capacities and existential significance that are typically located in a separate, ideal and subjectivist realm? (Coole 2010: 92)

Coole and Frost (2010) explore the range of philosophical presentations of this phenomenon, which comprises one of the contemporary challenges to the notion of the Kantian subject (Poe 2011). If materials are something which can help constitute subjectivity, then this reverses some of the philosophical assumptions of the past two centuries. Materials come to be active ontologically, and in political participation.

All three of these disciplines – Engineering, Design and Philosophy – are lacking in empirical observations of materials in everyday human situations, because they depend upon experimentation, studio work and the academy. The immense literatures within archaeology, art, and craft (which, with apologies, we cannot broach here) each take a much more hands-on approach to specific materials.

Anthropological approaches meanwhile are the main concern of this volume's contributors.

What anthropological approaches to materials are there?

As well as setting out ethnographic studies of materials, the contributors to this volume present a range of new epistemological approaches to materials, largely from an anthropological perspective. Their work is however based on a longer-term tradition of studies of materials in social science. Historically, a number of approaches are particularly worth mentioning.

Leroi-Gourhan (1943, 1945) provides the starting point for a modern cultural appreciation of materials and matter, and reveals both positive aspects and difficulties with an anthropology of materials. Leroi-Gourhan is concerned with the question of the universality of technical tendencies in objects, being strongly concerned with archaeology and a material culture approach to society. Leroi-Gourhan's method involves the conundrums of how to approach social questions through things which are material, which exist in anthropology both as social artefact and as social data. Through an exploration of the 'technical' domain, he proposes one is able to conceive of the interrelation of human groups with environments and produce subjective modellings of operational sequences, which produce particular material and social forms.

Leroi-Gourhan's ideas are very contemporary in the ways in which they deal with the social problematics of materials. Leroi-Gourhan's notion of 'matter' (*la matière*) correctly clouds any clear distinction between conceptual and material. His approach is also admirably processual. However, in spite of his intentions there arises still a certain dualism, in which a need arises to deconstruct notions of nature and environment. In Leroi-Gourhan's terms, materials still 'fall somewhere between the category of the environmental or natural, and the category of the technical or resource. There remains the notion of materials as raw, unprocessed, awaiting the human hand as the magic ingredient that is to render them somehow cultural.

Through the mid-twentieth century, within the Anglo-American tradition of anthropology, the study of materials declined a little, as semiotic and linguistic approaches in anthropology, alongside an emphasis on production within economic anthropology, gained the ascendancy to the detriment of some other aspects of material culture. The revival of material culture interests from the 1980s at first occurred with an emphasis on objects and goods, more than

materials (Hahn and Soentgen 2011). Wagner describes the 1990s, for example, as a period of 'marginalization of materials' (2001; cited in Hahn and Soentgen 2011: 24). From the 1990s, however, a range of work brought concepts back on the radar which opened the door to a better appreciation of materials, especially work on properties and embodiment. One important earlier example in the Scandinavian tradition is Fredrik Barth's work (1990), which provided detailed localized ethnographies demonstrating the ways in which making with different materials can be generative of meaningfulness. Barth discusses materials as ways to significantly rework structures and categories of meaning in embodied acts.

The French praxeological tradition of examining the notion of technical action, begun by Leroi-Gourhan, also remained very active and unfolded through several generations of critics in journals such as *Techniques et Culture*. Pierre Lemonnier's work (2012) has in particular placed emphasis on the role of materials within the understanding of social action, techniques and skills. This school of anthropological approach has always advocated ways of approaching cultural and social contexts that take account of materials intrinsically as a part of modelling action. Hence materials are situated as one of the foci of anthropological and ethnographic activity, and one of the lenses through which one begins to perceive culture itself.

From the late 1990s, the work of Michael Taussig and Marilyn Strathern, in very different ways, proved beneficial to exploring materials. Through an emphasis on properties, both of these thinkers advance and problematize intersections between notions of knowledge and experience, between global and local. For Taussig (2008), an understanding of localized conceptions of what properties do, is one of the ways to resituate anthropological understandings of 'experience' as, rather, understandings of potentially oppressive socioeconomic forces of globalizing capitalism. This argument is most coherently advanced in his work on indigo, the substance and the colour. The glorious colour of indigo, he argues, has a literally magical subversive capacity, and in many ways the Western world works to suppress its dangers.

Marilyn Strathern has also helped to shift anthropological conceptions of materials. While we cannot in a short space summarize her ideas in themselves, we can consider some of their implications. One of the fundamental questions that Strathern's work addresses is 'What makes a person?' Rather than considering such entities as given, she points out how persons can be dependent upon the convergence of substances, properties and property relations in society (Strathern 1999). The science of new reproductive technologies (Strathern 1992) is one example of the prior anticipation of persons through perception of

materials. Like Taussig then, Strathern models one way in which material properties and property relations intersect and are evidenced in social effects. Second, she addresses the problematic inclination for material aspects of social life to be seen to represent universalizable qualities, while the quality of diversity is ascribed to human groups (Leroi-Gourhan's ideas, among others, imply this difficulty). By contrast, Strathern's work has enabled anthropology to scrutinize how notions of universality and of diversity are themselves culturally negotiated. Hence, she draws attention to questions about when cultures see themselves as pluralistic or monolithic, and how a diversifying world of properties may relate to reconceiving society.

A range of work through the 1990s and since 2000 moves attention from properties and more towards materials themselves. Tilley (1999) is one of these thinkers. He develops arguments to reconsider the cultural effectiveness of materials when they are categorized as types of matter and conceptually interconnected in metaphorical relationships. Rendered as metaphors, materials come to be not only ways of doing but ways of thinking and understanding, becoming a part of the architecture of ontologies and cosmologies. A second pillar of Tilley's work, also developed by other archaeologists and anthropologists (see Bradley 2000) challenges the notion of materials as separable from things that are artefactual or artificial. There is a long tradition in anthropology of deconstructing the notion of the natural, especially within rethinking of gender. Tilley brings this critique into material culture studies, by challenging distinctions made between, for example, different stones in an archaeological landscape – those which previously were seen as artefactual or monumental, and those which were seen as not worked upon by people and hence natural. By contrast, Tilley considers a landscape or environment which comprises in materials with which people engage in different ways. This leads towards a phenomenological position on culture (Tilley and Bennett 2004). Taking a more phenomenological approach challenges the idea that biographical approaches are adequate for a study of materials, and undermines some of Leroi-Gourhan's initial work in the field. Recent studies do not necessarily appreciate materials by asking where they come from, what their social journeys are, or what happens first and what happens next. If it can be deceptive to divide the natural from the artefactual, then of what relevance is the domain of the technical? Similarly, and perhaps counter-intuitively, this kind of work moves in a different direction from some work on properties by people such as Strathern and Taussig, because it begins to undermine the relevance of notions of exchange relationships around materials. In this sense, the anthropology of materials has fundamentally moved to critique the notion of 'the social life of things' (Appadurai 1986) being the key paradigm through which to

approach the material world. When one focuses on materials before objects, different concerns, tensions and problems emerge.

Tim Ingold (2012, 2007) has done perhaps more than anyone to put materials per se back on the map of social science, as subjects of inquiry in themselves. Materials are an integral aspect of what Gosden refers to as 'Ingold's ecological perspective', looking at 'the rhythms that exist in different areas of life which help create and grow things within a series of echoing forms' (2006: 430). In this work, notions of social life as experiential, and the idea of flow, are integral. Ingold retains a sense of environment as universalizable in description, such that similar materials in different places matter, coupled with a localist poetics. In a 2012 article, he argues that the study of materials in anthropology will rebalance a past emphasis in the discipline on discrete material object forms, which has among other things helped to undermine the appreciation of persons as material entities. Re-awakening our sensibilities to the fact that we experience the world as a knitted fabric of textures, colours, and properties which are embedded in a materials consciousness, Ingold's work has opened the space of debate about how social scientists can, and should, appreciate materials. The contributors to this volume, in different ways, respond to this call.

In brief, at the time of writing, an anthropologist, or other social scientist, has a choice of intellectual tools to engage with materials. One can look first at techniques, often with the implication of an emphasis on acts of making in the world; one can discuss material properties as social and cultural phenomena, in which substances and materials are often the means by which material properties, social property, and intellectual property, are conveyed, exchanged and demonstrated in politicized networks and frameworks; one can consider material metaphors and explore the experience of materials and convergent categories; and one can draw on notions of flow, experience and phenomenology in ethnographic work to aspire to a more cosmological approach to materials. The long and the short of it is, however, that one must first conduct some kind of empirical research, to observe materials, substances, properties and senses. The role of the anthropologist is often to 'ground' theory and knowledge through convergent acts of observation and interpretation.

What terms and terminologies can be used?

This history of ideas has resulted in a specific set of terminologies, which it is important to outline. Each discipline works with materials in an utterly different environment, and each anthropologist has wrestled with local and particular words and terms for materials; so the authority of particular materials 'languages' can depend on where you are standing. Nonetheless, it is important to propose the ways in which we can communicate because, in exploring the kinds of terms

that are professionally used, one also begins to perceive what the issues and points of difference may be.

When we talk of material stuff in general, the word *matter* is appropriate, and does not distinguish much between types of matter. *Materials*, meanwhile refers to slightly more specific categories of matter. They may be distinguished in a number of different ways: by chemical atomic composition, chemical or crystalline structure, origins, or the ways in which they are used in a particular place. The recognition of materials may be a question of etymology not chemistry, but nonetheless it is the notion of discreteness among types of matter which is often important. The term *substance* particularly tends to be used for material when a material is in a dialogue with the notion of *form*.

When we talk of *material properties*, this then means the ascription of the quality of having material effects. We have ascribed this ability to the substance of which a thing comprises. Recent debates have focussed on discussions as to whether properties primarily are a function of the relationships around things, or are intrinsic and essential to things. The notion of material properties, as a subset, then particularly focuses on the material substance.

Effects can of course take many different forms. Gell (1998) in particular placed an emphasis on effects, meaning the cognitive and social impacts arising from an encounter with a material thing. The idea of effects thus is useful partly because it is not very specifically defined but rather denotes a particular idea of how change happens between entities and in their engagement at discontinuous moments, rather than continuously. The notion of effects is handy for describing situations where change is seen to be connected to particular happenings or events.

The word *properties* tends to imply that there is a sense of inevitability about the effects or uses of materials, as if cotton must always be clothes, or plastic always kilsch, which is not correct. Alternatively therefore, we can choose to deploy the term *tendencies*, to describe and connote the sense of possibility or probability which surrounds properties. Leroi-Gourhan (1943) distinguishes tendencies (*tendances*) of materials from the facts (*faits*) of materials, to describe how materials are understood as doing things actively in the world, or may be considered as neutral and reactive in this respect. An active tendency of glass is to conduct light into a building and also to acquire dirt and become more murky unless cleaned. Those are active tendencies, and the glass causes the light to be a certain way. It also may shatter and create many sharp edges, but this latter tendency is a passive possibility, if you happen to want a sharp edge. Tendencies can themselves be described as intrinsic or extrinsic to a thing – for example, people with a scientific education see light as an intrinsic or reactive property. Light is in the atmosphere, and some things may reflect it, and have

the property of shininess. Others may ascribe the lightness to the object itself, representing this light property as intrinsic to a thing, such that a mirror might be described as a light or bright object.

Stratham's work on properties (1999) indicates how the term typically situates the specific qualities of a thing or material in a wider set of social relations. It is not enough in many cases to specify that a particular sensory quality exists; rather there is the need to explain where such properties come from. Material properties and property relations are here intermingled for the purposes of the examination of many social environments.

The terms *senses*, *sensorness*, or *sensoriality* are also frequently useful in this domain. This terminology comes to be useful within a paradigm which emphasizes perception and experience, either as social phenomena, or as the prime methodological tools by which a researcher comes to examine the material world. Phenomenological approaches are especially useful here.

In practice, then, one may encounter or use the terms materials, properties, and senses, within this field – and yet placing more emphasis on each of these three terms tends to carry with it a different set of paradigmatic assumptions.

The book

In the chapters that follow, we elaborate on these various themes. By examining particular interdisciplinary approaches, and a range of specific instances of materials, we aim to pull apart what this territory of the study of materials and society comprises. We set out social and cultural interpretations and understandings that arise from a focus on materials, and we criticize and problematize those that do not fit, with reference to grounded, observed examples. If a material's revolution is impending or occurring, we hope this book will point to some possible responses to the challenge and assist materials innovators, designers, engineers, artists, archaeologists, makers, anthropologists and others to rise to the choices that we face.

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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 sociocultural 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 Soenigen 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. Mirowsnik (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 have 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 Jakki 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.

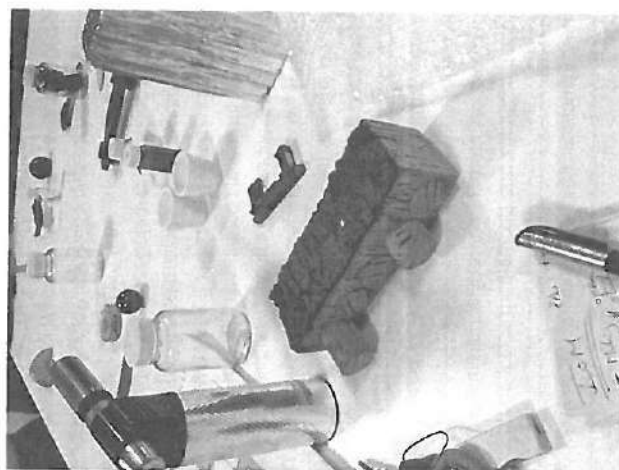


Figure 1.4 In the Institute of Making Materials Library. A sample that transforms between 'corks' and 'cork oak bark' demonstrates the material 'cork'. Photo by Adam Diazin.

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 craftsman. Heidegger is illustrating a perceptual shift by reference to tools, hence rendering the material world as tool-like. Hahn and Soenigen (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 Wene'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. Wene 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 Wene situates culturally and historically in Chapter 2). Barry's critique of invention (which is extended by Kuchler 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 A. 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 Werners 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 Werners 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 Doury'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. Doury 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 Doury 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. Umila 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 Warner'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 Calvão'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. Calvão 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 Calvão 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

ies have managed to sustain Procter & Gamble in their products. The topic of fragrance is an instance in which the product is to be detachable and new industry. The possibility of existence of materials in other worlds, Wain's work instantiates a substance used for fragrance to be intrinsic, semi-manufactured which are manufactured in trade in fragrance materials. Plutonic ideals of things, far beyond the localism of web of materials whereby properties are commandeered en masse across many different materials-based network is

Lastly, in Chapter 14, our concerns the mnemonics of providing a highly politicized encounters across the world with blankets made from wool blanket. Contemporary artist and then reappropriate, such experience of the material, a with it, that enables people paradigm here functions to harness. More importantly, she seeks and to challenge social relations she studies, within an art context this sense, their political role expands in more detail in the

These three studies of materials, build the points that

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 broached 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,

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

g and disruptive as they are, materials provoke responses. happen at moments when the material world manifests purposelessness us to rush in with intentions to fill the void. Materials happen – are at moments of the genesis and destruction of forms that are familiar et they have effects as if they act, and not only as 'smart' materials. g qualities manifest in every object and person the slow evidence gradual ruination, substances changing over time to subvert the of the social world. In a materials world, we are all incipient creations.

s comments, among many materials scientists, 'materials are no ight of as raw, physical matter' (Wilkes, this volume). It is tempting to tion that inherently uneasy materials are 'raw', acultural and unso f. All of the authors in this volume resist this temptation and attack rawness. First, we challenge the mistaken notion that materials are il' than objects. This comprises an ideology of 'nature' that has been d deconstructed for some decades with anthropology, most per thinking on gender (see Strathern and McCormack 1980; Bradley ose who think 'ideology' to be too strong a term, it may be more at nature exists as a social fact not scientific fact, and that materials y subject to being constructed as 'natural', and hence acultural until y processed into a particular form.

we challenge the misconception that materials are antithetical to Andrew Barry undermines this idea most strongly by pointing out s are 'informed'. Chow Wah's discussion of the globalized trade s closely evokes the same discussion. In other chapters, materials d as things that are, in Gell's (1998) sense of the term, 'cognitively als are carriers of a range of forms of information. They may, in ances or contexts, convey data, imagination, meaning, knowledge, uths.

of the mythology of rawness relates to skill. Skill is an increas- ant topic of academic study, and rightly so (Grasseni 2007; Ingold ver, the study of skill, crafts, and artisanal knowledge can detract edication of what materials can do. Skill is not distributed equally ity, and it often does not function to make materials evident. Good p often defies or conceals materials. A focus on skill, and crafts- exaggerate peoples' knowledges above objectified knowledges 90), including siliconized information (Horst and Miller 2012). Skill

therefore, while important, is not sufficient and e alternative is testified to by the ways that Chinese com- upersede the marketing-led behemoths of Unilever a Chinese bath products market, through the scents

The mistaken notion of the rawness of materials of specific presumptions. Traditionally, social st

and even of material culture, have each not quite typeries of a material (such as soap) are demonstratpae exercised. rials. Because of this, materials have often been otiable. Soap and scents are different materials in ttherefore arises from a number social life, once you have studied ways of knowing, a movement between form and substance, the exdies of knowledge, practices of artefacts and objects. In fact, to some degree, t words, is what makes properties detachable. Chnaken enough account of mate- fields of social life, and this is beginning to be recoints made both by Howes and by Barry. The kinteen as all the 'bits left over' in

agrance, which infuse soap products, are perceiv. ways of doing, and the forms

Beyond 'things': Reimagining st

Those people near the top have the power to make is also to a certain extent a trade in possibility an things transient, so they can ensure that their own s well as a trade in the senses themselves. Movin and that those of others are always transient . . . earlier chapters, Chow Wah is also exploring a globa

severe cultural and temporal confines can one he mass-manufactured chemical 'blanks' of materi things durable and to make belief that rubbish is defined by intrinsic physical red, shipped, reshaped and sold and appropriated objects are always durable these limits and one sees that the boundary betw rent places and social locales. The scale of such a Only if one remains within moves in response to social pressures. (Thompson

We can return to the problem of perceiving the scrf t the senses that happen around woollen blankets, an rubbish and non-rubbish development of material culture, the engagement t reading or mapping of historical processes. Colonial 12004: 295)

has traditionally been seen to be the form, or sha have through history been contextually associated Frequently it is making and doing that have been seol, and are evoked by the particular sensation of the ewdriver as materials. In the between minds and materials. Hence the study of 's deploy the properties of such blankets to manifest, between materials and minds understood as production, making, crafting, creati in political commentaries. She shows how it is the be, of objects and artefacts. accumulation, appropriation, of objects. We need ind especially the particular sensoriality associated en as the point of articulation

ings in the social study of materials, because they to locate themselves within history. The materials tuff' has come primarily to be to reimagine stuff in frameworks other than form istoricize and politicize the self and self-conscious- ng, designing, consumption, through examining transformations of stuff.

As several of us have observed, especially lons, especially historicized ones. The blankets that to add to these understand- are not sufficient. We need materials and minds engage. Looking back at, and is highly nuanced, a point which Susanne Küchler and praxis, and particularly ment moment, a great deal of social science effort he conclusion.

the notions of the Cartesian mind and of the materi,rials ecologies, or of networks of the social lives of tielcular fracture around how previous chapters have made into understandings as been directed to critiquing al world as simply the object moment in this respect was related approaches, critiquing rather highlighting processes has been widespread, but it and activities of making knowledges. Its influence r

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, Calvão), 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 (Calvão, 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.

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Part 2

On materials innovation