Materials, once thought of as covers, are now the functioning thing itself - crunchable, foldable and portable and feeling to the touch like denim. Known as 'smart materials', materials by design range from the practical to the hilarious and unsettling, but what they all have in common is that they draw our attention to a material world that does not just represent who we are, but which is capable of standing-in for us, substituting for some of our own capacities.

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## Materials and Design

Design has been a longstanding concern in anthropology with a formative tradition of thought reaching back to the 18th century historian and philosopher Johann Gottfried Herder (2002 [1778]). Herder's theory of sculpture pointed to the poetic nature of communication, shared by both language and repetitive actions of the body, and the relation between this poetic element of communication and the emotional pull of the resulting product. These ideas were famously developed by Franz Boas



(1927) into a concept of 'virtuosity' – understood as the pleasures of practice which are given substance in basket making, pottery making, or Northwest Coast wood carving – as well as by Marcel Mauss (1934), who drew attention to highly developed body actions that embody aspects of a given culture. More recently, this notion of the algorithmic and relational nature of technical action was taken forward by Gregory Bateson (1973) in his theory of 'style, grace, and information', by Fred Myers (1999) in his analysis of the prototypicality of Aboriginal painting, and by Alfred Gell (1998) in his theory of the indexical logic of manufactured artifacts. Design distinguishes itself from mere things, in the words of David Freedberg (1991), by the 'inherence' of intellectual expectations in the work itself, and anthropology's contribution has been in unraveling the intersubjective nature of thought made concrete in design.

Despite these formative ideas that open up the world of design to anthropological introspection, there has been one notable lapse of attention. As Margaret Conkey (2006) has shown in her discussion of style, design, and function in the *Handbook of Material Culture*, anthropology took with ease to the conceptual nature of the classical notion of 'disegno', in which an act of drawing was thought to be prefigured by a concept, embedding wherever possible the representation of mental schema into the context of social practice. It has coped very badly, however, with materials and their functional, sensorial, and technical capacities, which must enter into conference with the algorithmic and poetic qualities of making in order for a shared concept of design to arise (Reckwitz 2002; Miller 2005). In failing to include materials in their reckoning of what is social about design, anthropologists have missed a chance to question the assumption of the abstract and conceptual nature of the algorithmic calculations that issue forth in design. In order to open materials in design to anthropological introspection, this chapter will draw inspiration from Aletta Biersack's (1982) now classic essay on Paiela body counting, in which she argued for an alternative logic of concrete, calculative thought in Papua New Guinea parallel to Western science, where numbers are manipulated in the abstract. This parallel logic, captured in the concept of concrescence, was famously recovered for Western science by Alfred North Whitehead (1979 [1927]) in the age of the chemical revolution. Via this parallel logic of the concrete, anthropology can recover an approach to design that is not reduced to the context of practice and the divisive distinctions of style and function, giving instead substance to the difference design makes in society where ever it is made.

The recovery of the analytical potential of 'the material' in design has already happened in neighboring disciplines, notably in the history of science which, following in the Whitehead's footsteps, drew out the implication of the rise of an alchemic practice into the forefront of science during the 19th and 20th centuries (Bensaude-Vincent 2007; Schiebinger and Swan 2005). An increasing realization that a concern with form and individuation of style, practiced

in the history of art, is misplaced in approaches to modern art, art historians have begun to recover the theoretical potential of formless design (Bois and Krauss 1997), the material basis of formlessness (Rübel and Hackenschidt 2008), and the conceptual use made of materials in modern art (Wagner 2001). There is, however, an even more pressing reason than disciplinary competitiveness for anthropology to investigate the relation between the calculations at work in design and materials. For today, it is not just things that are designed, but materials, and it is this simple fact that shows up a convergence of interest, cutting across research and development laboratories to the islands of Melanesia, in ways that are both hugely exciting and subversive to our longstanding assumptions about the divide between 'stuff' and social practice.

## Materials by design

'We live,' as Mike Ashby and Kara Johnson (2002) have pointed out, 'in a world of materials'; we make things out of materials, and we see potential in materials before giving form to it. Yet, the materials we use for our design are no longer just found or grown, but are themselves subject to design in being 'made to measure' (Ball 1997). Bernadette Bensaude-Vincent (2007) has pointed to the growing polarity between the natural and the artificial in a world in which the majority of materials that surround us are engineered to assume functions that we used to associate with technical devices hidden in objects. What is distinctive about these materials is their composite nature and membrane-like quality, which allow them to stretch over any shape, merging formal and functional qualities in the very fabric of the material. Materials, once thought of as covers, such as the surface of a wireless keyboard, are the functioning thing itself – the keyboard is crunchable, foldable, and eminently portable. and feels to the touch like denim. Known as 'smart materials', materials by design range from the practical to the hilarious and unsettling, but in common they draw our attention to a material world that does not just represent who we are, butwhich is capable of standing -in for us, substituting for some of our own capacities. The goal of research into smart materials and structures is the animation of the inanimate world, by endowing it with more and more of the attributes of living things, and by creating networks of integrated artifacts that work interrelationally, forming huge complex systems of sensate things that (eventually) really learn (Küchler 2008). Alongside such chemically engineered materials, the rediscovery of 'old' materials today plays a prominent role in the fabrication of environmentally friendly materials for the future through new engineering techniques. Materials such as flax, bamboo, and hemp, typically found in archaeological and ethnographic collections, evoke ideas of heritage, identity, and place, but also open up debates about cultural rights and property.



The rediscovery of known materials shows that all materials are potentially new. What distinguishes the material we associate with the rise of modern imagination, however, involved making the technical function part of the material itself. This material was rubber, first processed by Charles Goodyear in 1839. It was soon followed by the innovation of synthetically produced, stretchable, and moldable materials with the invention of Bakelite, the first synthetic resin chemically formulated in 1909, and later, around 1938, of Polysterene for plastic materials and perlon fiber as well as coatings such as Teflon. Arguably, it was the capacity of natural rubber and its synthetic variants to cover any surface, irrespective of form, which created the capacity for new artifacts with new functions, such as the diver's suit, the rubber hose, and the raincoat. (Mossmann and Smith 2008). New ways of life in domains reaching from leisure to work were made possible by a 'stretchable' material that came to compare fittingly to the many new actions that took life beyond its known limits (Meikle 1995).

Social science's interest in the legacy of the chemical revolution and in the design and the take up of new materials has classically been low in the English-speaking world. Anthropology, ironically, has arguably borne witness to the chemical revolution's social effects perhaps more than other disciplines, as the rise of chemical engineering provoked shifts in political economy, which led to the local touchdown of the ethnographic method. An example of the distant effect of the chemical revolution that anthropology came to chart is New Guinea, where European incursion followed the chemical development of soap by Chevreul in 1823, who first separated natural dyes from the complex mixtures of oils, resins, and gums. This was made possible, in turn, by an earlier discovery by Nicholas Leblanc, who in 1801 extracted alkali from common salt and thereby created the basis for the development of the first chemical industry in Europe. From the 1830s onwards, the manufacture of soap and candles now used chemically manufactured vegetable oils instead of animal tallow, and by 1840 coconut oil extracted from copra was imported from Pacific Islands into Europe. Local histories of the global reach of an economy that began to function increasingly on the back of trade in raw materials for chemical engineering are, however, as yet largely unwritten, albeit from a purely historical, Eurocentric perspective (Schiebinger and Swan 2005; Smith and Findlen 2002).

Much without us noticing, in a move that was as swift as it was seemingly unremarkable, a rapidly advancing material technology has invaded into every aspect of daily life in the modern world, subtly altering the infrastructure of life in a manner far more effectively than paradigm shifts in scientific knowledge (Hansen 2000; Latour 1992). Nanotechnology, materials, and information technology are now combining with biology and the life sciences to enable

further integrations with pervasive effects from design (biomimetics) to end product (bionics). A world of materials, readily equipped with technical function, now cuts across all known classifications of nature and culture in quantities that now reach into their tens of thousands (Silberglitt 2001). Bruno Latour (1979; 1996) has captured the vanishing of the relevance of existing systems of classification in which 'things' were radically other to 'persons', inventing for us a vocabulary that makes manifest the agency of nonhumans and the recalcitrant materiality of humans. He speaks of a 'parliament of things' (2001) to draw attention to the ways in which material technologies form assemblages that interrupt, revise, or restructure political life.

As anthropology has come to appreciate artifactual agency (Gell 1998), following the history and philosophy of science where materials made by 'design' have become the new epistemic object par excellence (Bensaude-Vincent 2007; Daston 2004), it is dawning on us that distinctions – between the social and the material, the natural and the artificial – upon which our most trusted methods have rested for the past century have indeed become obsolete. As connections of molecules made tangible in materials take on a presence in our lives without us even being fully aware that they do so, materials by design have become far more than the mere technical substrata of a world lived in analog to a digitized presence. Ready made with a use and a user in mind, virtually un-reconstructable yet affecting the very infrastructure of life, new materials challenge anthropology to respond with a theory of design that enables us to understand how materials work and what they do from a social science perspective.

Libraries of materials are wrestling with an avalanche of designed materials, estimated at between 40 and 70,000, which no longer fit existing classificatory paradigms. Such libraries have sprung up since the mid-1990s, a commercial example of which is *material connexion*, with its outlets in New York, Milan, and Beijing. As the need for material consultants is increasing in all sectors of industry, design, and architecture, such libraries are rapidly becoming the main knowledge resource about what materials can do. As new materials are not just composites, which cannot be easily disentangled either conceptually or physically, impeding such actions as copying and recycling, but are also at least potentially aggregates in their systemic capacity for propagation and replication, those that need to select materials are facing a real problem. Knowing materials to the extent that one can select from a range of several thousand materials that more or less fulfill the same function has become a specialist domain for the material consultant. To assist designers in steering through this minefield, there is now burgeoning literature on the huge range of engineered materials from which designers and manufacturers can choose to use in the fabrication of any artifact (Benyus 1997; Hongu and Philips 1997; Askeland and



Pradeep 2002; Ashby and Johnson 2002; Gay et al. 2002; Mori 2002; Addington, Daniel and Schodek 2004; Wessel 2004). Publications on new materials also comprise handbooks directed at a specialist audience in design and industry (Beylerian and Dent 2005; Stattmann 2003; Satas and Tracton 2000).

Handbooks furnish the designer with an image of a material, its functional characteristics such as luminosity or tensile strength, but leave out any discussion of experience of use. Ashby and Johnson (2002) have recently began to fill this gap in writing a phenomenologically-oriented guide to designed materials, modeling the range of effects of materials so that designers can take these effects into consideration. Using grid systems, they map out acoustic, olfactory, tactile, and motion sensitive factors inherent in materials and arrange these on a spectrum at the center of which is the egocentric and relative sensorial space of a person.

Most new materials take the form of screens or fibrous membranes, a fact which cannot quite be explained by the perceptual paradigm implicit in this phenomenological account of new materials. Simulating cloth, such membranes much like skin form both a boundary and a point of contact between the human and the material world, binding people in social and economic relationships at the same time as it defines their difference. Individuation, which we used to associate with the consumption stage of commodity production, is now taking place at the moment of materials design and selection in a manner that is raising important issues about the difference such materials will make to our notion of and intellectual expectations directed to diversity.

The thriving economy in new materials revolves around highly mobile and complex materials, moving from institution to institution as they are adopted, transformed, and manufactured into products to suit a number of distinct functions. The inseparable link between materials and knowledge is now recognized to present a huge potential for growth but also to be highly vulnerable to factors affecting transmission and take-up. The materials industry in the UK – in which new materials are presenting a steady increase – has today an annual turnover of around £200 billion, contributing 15% of GDP to the economy, and employing 1.5 million people directly and supporting a further 4 million jobs. In 2006, a DTI report identified a number of challenges to the UK materials sector's place as a world leader in materials science. Recognizing the volatility of an economy run on the back of materials that need to be known in order to be taken up, the report emphasized that central to any future success would be the transfer of knowledge of materials across a network of stakeholders: an interconnected web of customers, universities, research and technology organizations, designers, and other intermediaries. As a result, the UK government created the Materials Knowledge Transfer Network in 2006 in order to improve the capacity of UK's innovation performance by increasing

the breadth and depth of knowledge transfer.

Designers and industry are facing the new relation between materials and knowledge with anxiety as untold numbers of designed materials fail to reach a market. Over and above the question of how to design with materials in mind, what material knowledge actually is when the distinction between nature and culture is meaningless, how this knowledge is transmitted, and what 'new' materials do when they come to replace existing materials in artifacts that are pivotal to identity are concerns that have not yet even begun to be addressed (McDonough and Braungart 2009). It is here that anthropology can contribute with a theoretical understanding of the nature of materials selection drawn from ethnographies, which testify to the absence of the distinction of the natural and the artificial in societies we tend to have disregarded in studies of design (Strathern 1999).

### Material, substance, and effect in the Pacific

The Pacific Islands are famous for the diversity and visual complexity of its art traditions, which are an inseparable part of trade and exchange, and flamboyant rituals. The rich and complex intellectual expectations that resonate with the world of the concrete have been the subject of numerous ethnographies that have provoked the theorizing of the analogical relation between concepts of the social and the material. The ethnography with the most lasting theoretical impact has been Marilyn Strathern's (1986) work on *The Gender of the Gift*, which explored the relational nature of actions and their intellectual understanding, which is thought to effect the making of persons and things alike. Social and biographical relations in Melanesia are internally defined and are likened to the aggregates of the gendered identities of bodily substances that need to be disaggregated (decomposed) for discrete persons to emerge, capable of physical and ideological reproduction. Such actions of taking apart invisible, composite substances involves the selection of material substances that are likened in terms of their transformative capacities, rather than merely their physical properties, to the relational capacity ascribed to bodily substances. When specific materials with concrete properties are chosen, such as, for example, softness and malleability as found in types of wood, associations with skin and bounded surface make the matriline materially manifest in ways, which paradoxically effect the momentary accentuation of the fiction of patrilineal descent. Gendered substance and material effect are complementary entities in a ritualized opposition scenario that makes visible and conceptually present what is at once the same and different (Bateson 1958).

Distinctions such as natural and artificial, person and thing, bodily substance and material, do not apply here, where effects are derived from fusions



of the alchemy of materials with the properties of persons. The unlikely 'likeness' of Pacific ethnography with the condition of contemporary design is underscored by the way materials are handled and transferred as knowledge, access to which is hotly contested (Barth 1990). For those interested in the intellectual expectations that meet a fully developed knowledge-based economy run on the back of materials, it is to Pacific ethnography that they should turn.

No better example has been given of how to excavate the inherent socialness of material knowledge, relating to the calculated selection of concrete materials, than Frederick Damon's (2004) analysis of the materials used for the construction of the Kula Canoe, famous in anthropological literature as the material expression of an image of the social body and of the cultural imaginary surrounding mobility in an island world. Damon shows how the many different types of wood chosen in the construction of the seafaring canoe are at once significant for the technical function of the canoe, as they are taken from trees that are grown in places associated with the biographical relations that make up a matriline. When making a canoe as a gift to secure an affinal relation, the knowledge that is required to create a socially acceptable and seaworthy canoe demands an understanding of the complex relation between material, substance, and effect.

The transformative effect that is unleashed when translating artifact production from one material to another, subtly altering daily life and relations of labor and loyalty, has been examined by ethnographers in relation to the introduction of cloth in the Pacific (Colchester 2003). Readily colored and often patterned, yet otherwise recalling the known and much desired material properties of partibility and portability, alongside the ability to be folded and to be wrapped around bodies and three dimensional forms, cotton cloth was readily seized in many areas of the Pacific when it became available through traders. As Nicholas Thomas (1999) has argued convincingly for Eastern Polynesia, it was Polynesians, rather than missionaries, who carried a wave of Christianization across the Pacific on the back of the new material, which was harnessed and transformed in ways redolent of established notions of status and deportment associated with prosperity and fortune.

Arguably, the impact of cotton cloth was marginal across areas in the Pacific where a cloth aesthetic prevailed already, maintained by and existing alongside indigenous fiber technologies utilizing the bark of the paper mulberry tree and the leaves of the pandanus plant. Others, like Lissant Bolton (2001) and Hauser Schaublin (1996), have argued that in areas of the Pacific where a non-cloth aesthetics prevails, articulated in the emphasis not on the planar surface of the wrap but on the line, the string, and the frond, cotton cloth was met with a very different response. Jarring with a fundamentally different con-

ception of status, based not on temporal but on spatial modalities of differentiation, imported cotton cloth was resisted and/or acted upon in a manner that led to the transformation of the material in ways that made it compliant with an established material aesthetic. Sweaters are still today unraveled, dresses shredded before being reworked into openwork forms. Where the donning of cotton clothing was enforced, relations of labor and loyalty changed dramatically, as women no longer could maintain their work in gardens unhindered by the new strictures of cleanliness and modes of bodily deportment.

The complex relation between the work demanded by the new material and the relations that became associated with the worked upon product is best illustrated with the case of the Polynesian quilt in the Cook Islands, a chain of tiny islands in the eastern part of Polynesia where cotton cloth was greeted enthusiastically (Küchler and Eimke 2009). Cook Islanders had for long been preoccupied with the coloration of its bark-cloth and the patterning of its pandanus sleeping mats, both difficult to achieve and requiring a lengthy process of soaking, burying, and drying. Ready colored cotton relieved of this time consuming work so convincingly that already 25 years after Chinese traders had arrived in the footsteps of missionaries, the main island of Rarotonga had its own cotton plantation.

Yet, cotton cloth was not merely used for the purpose destined by missionaries who encouraged the sewing of clothing and the domestication of the household, which followed in the wake of the new material with its demand for cleanliness and care. Women began to sew large and complex planar sheets from shredded pieces of cloth, known later as *tivaivai* or patchwork quilts. Competitive, potlatch-like presentations of quilts and the sewing of quilts for important life cycle events in which they figured as major item of exchange sustained the development of sewing bees, which began to run the political economy of the islands. Elevated with the support of the church, which regarded them as eager followers of its mission, women had – already by the mid-19th century – taken over the positions of *ariki*, the partially divine and partially human-ordained office of the chief, taking these positions from men who, since the condemnation of their ritual artifacts as idols and the acceptance of Christianity, could no longer pool divine power through the mechanism of sacrificial exchange. In a move that was a swift as it was seemingly unremarkable, women, who had previously moved in marriage in the opposite direction to divine power, access to which was granted to wife-giving groups among islands that became enchained in such exchanges, had assumed control over the relational nature of such actions.

Patchwork, in the Cook Islands, thus provoked a radical shifting of the axis of power relations, from a vertical topology of a chiefly polity centered in particular locations to the horizontal topology of a decentered polity that began



to grow its radius by means of reconnecting the lost and the forgotten touchdowns of power through the circulation of products of women's labor (Siikala 1991). Relations of labor that came to be associated with the actions upon shredding and restitching patches of cloth were able to effect the transformation of Cook Island society from nucleated island groupings to an expanding transnational community by means of what is known as skeuomorphism, or a translation of properties of form expressed in one material into another. In the same way as cotton cloth was not really new, but merely enabled the exploration of new properties in a material medium already central to actions at the heart of the configuration of the social body, patchwork was not new, as the missionaries had thought, but a material translation of the topology of a sculpture onto the planar surface of cloth. It was this move that enabled patchwork to partake in the concepts surrounding the actions that had been central to the strategic calculation of biographical relations right up to European incursion.

The formal relation between sculpture and patchwork is plain to the eye in an overtness that is not dissimilar to the quite unnecessary vertical seem at the back of the Wellington boot that allows us to recall its affinity with its counterpart made from leather. In the quilt, it is its scale that stands out, connecting the miniaturized with the magnified through a process of the multiplication of proportionally self-similar motifs in ways that are reminiscent of the sculpted wood of god staffs. Rendered invisible in the sculpture, which was tightly bound with tapa cloth, sennit cordage, and feathers, was the relational nature of acts of sacrificial exchange that accompanied the refashioning of the polity over time. The relational nature of acts of exchange through which women reconstitute their connectedness across the expanded Diaspora is also invisible in the patchwork. Hardly ever coming together in one place, Cook Island patchwork is made by three distinct modalities of technical acts, which can be described as partitioning, grouping, and mirroring. The resulting quilts have different names and are associated with distinct types of social relations. There is the patchwork proper (*taorei*) whose reduplicated motifs are made of tiny patches of cloth, which is gifted in an asymmetric, transitive, and relational manner between grandmother and granddaughter. Then there are the symmetrically appliquéd motifs of a quilt (*tat aura*) that are gifted between affines, and the mirrored motif of the snowflake or cut out quilt (*manu*), which is gifted between friends and casual acquaintances. What we are looking at is, in fact, an instantiation of a modular time-map hidden in the sculpture beneath its wrap and hidden in the quilt in the seeming divide of its distinct material techniques.

The work that Pacific Islanders put into the quasi-alchemic combination of materials would defy understanding were it not for the intuitive manner by which one can grasp the analog relations that are foundational to the social fabric. Methodologically speaking, inter-artifactual relations and the reconst-

ruction of the temporal and sequential nature of a logic of which they partake become important in the analysis in ways that remind of Bruno Latour's analysis of the complex web of relations between human and non-human actants in the laboratory setting, where seemingly very different materials are designed in a not too dissimilar manner.

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