

**Additive Technology and Material Cognition: A View from Anthropology**

Susanne KÜchler (UCL)

Additive technology has begun to make major inroads into manufacturing in the form of 3-D printing. Invented and not taken up in the late 19<sup>th</sup> century, present day rapid prototyping, and the additive modality of fabrication implicit within this technology, is set to have a decisive and yet still little understood impact on the way we cognitively inhabit and design for material worlds, shifting what the cognitive linguist Clark called the “canonical position” (Clark 1973: 34) with its ego-centred point of view, proceeding from a human body which stands upright and looks ahead, to a topological, 3<sup>rd</sup> person point of view of the world seen ‘in the round.’ Topology, the study of spatial properties of objects that remain invariant under deformation and that show up only in transformation. Discovered in mathematics only during the 1950’s as part of a branch of mathematics known as knot theory, topology is concerned with a complex of space, time, matter and process. Rather than directing attention to exact measurement, topology conceives of the nature of relation in terms of continuity, neighborhood, insideness and outsideness, disjunction and connection, rendering it open to material imagination at work in weaving and shaping foldable, stretchable materials (Serres 2008).

This paper will explore the difference the uptake of additive technology may make to the way we conceive of the relation between persons and persons and things via the new relations that its artifacts will evince. It is argued that additive technology forces us to rethink the nature of distributed cognition whose networked articulation we have not just begun to take for granted, but also accepted as the foundation of our most coveted theories of science and society. A model of the kind of distributed cognition to emerge from within the material and technical environment of 3D printing is constructed in this paper with the help of a case study set within Oceania where topological perception and an analogous modality of distributed cognition have long been at home.

The question of the take up of a new technology and the difference that it may make in culture and society has been given much attention across disciplines. I am thinking here particularly of the work of the art historian Yve-Alain Bois (1993) on the take-up of axonometric drawing and the reformation of painting, Wiebke Bijker’s (1997) science and technology study of bikes, bakelites and bulbs, Bruno Latour’s (1996) study of the failure of the Personal Rapid Transit System known as Aramis, and Emily Martin (1992) account of the dismantling of the centralized model of production in the 1970’s. While these and other comparable studies have born out the wider social, economic and political context surrounding the take-up or rejection of inventions in the material and technical domain, they

have arguable been less attentive to the cognitive ‘echo’ that the take up of new material technologies requires (Stafford 2007). Thanks to advances in neuro-science, in particular the discovery of mirror neurons in the late 1990’s, we know that the ‘motor functions’ of the nervous system not only provide the means to control and execute action but also to represent it, with action control and action representation being two sides of the same coin (Gallese 2000:10). This paper will consider the challenges thrown up by 3D printing and argue that they force us to reconsider the relation between cognition and material technology, still trapped in models of material engagement that situates things and the manner of their coming into being outside of and independent from thought (Malafouris 2013).

### **A Short History of Rapid Prototyping:**

The essential character of Rapid Prototyping technology is to be found in its additive mode of fabrication. Also known as 3D printing, the technology works by bonding materials layer by layer to form objects, quite in contrast to mechanical processes of fabrication such as milling or turning, in which objects are formed through repetitive action by removing material to create a shape which can then be further standardized into a form that is recognizable. We may imagine RP, as it is conventionally known, to be a new invention, though in fact it is not - it was present as the vanguard of fine art and laboratory practice at home in at least two technical areas of nineteenth-century technology, topography and photosculpture.

Topographical relief maps, invented by Blather in 1892, resulted from a layering method that served to impress topographical contour lines on a series of wax plates, by cutting the wax along the contour lines, and then stacking and smoothing the wax sections. This method layering produced a surface of positive and negative forms which when printed created a raised relief map. Photosculpture also arose in the nineteenth century from attempts to create exact three-dimensional replicas of objects, including human forms (Gall 1997). In 1860 Françoise Willème achieved the best realization of this technique (which was further developed by others in 1904 and 1924), using an additive process of a photography in the round, cardboard mounting and photosensitive gelatine, which expands when mixed with water to transpose the three-dimensional image onto object form.

Although these two techniques were short lived, additive fabrication technologies have been increasingly present in the twentieth century: in stereo-lithography, which works by changing liquids into solids through the application of light; in the extrusion of thermoplastics, also known as fused deposition modelling; and in the stacking of web material in laminated object manufacturing. While we may be unaware of what this technology does and how it affects our lives, more conceptual applications in art, famously articulated in Jackson Pollock’s drip paintings and theorized as the ‘formless’ undercurrents of modernist art by Yve-Alain Bois and Rosalind Krauss (1997), have found wide resonance.

It is not difficult to see why topographical relief maps and photosculpture did not take off at the end of the 19<sup>th</sup> century at a time when industrial production was in full swing. This is because RP ironically does not result in a prototype, one that can be serially reproduced in manufacture, nor does it produce a simulacrum by giving shape to an idea or a thing referentially (c.f. Ginsburg 2001: 63-65). What happens in RP is that the material translation of a code into 3D form becomes an intrinsic property of the materiality of the product, with its form recalling in a self-referential manner what has been rendered absent in the process of production. Thus while the application of RP can clearly result in the replication of a thing or idea that can be referenced independently, it has the potential to issue variations that are recognizable only in relation to the code and thus recursively back to the process of transformation that connects resulting forms with one another. The first 3D printers on the market have been advertised with downloadable codes that enable one to replicate anything from a screw or bathplug to a mug, almost to settle the user of the technology by not upsetting any conventional expectation of how it works and what it does.

The parts that can be refashioned using 3 D printers promise to become larger over time, enabling one to print seamless artefacts such as airplane wings or larger structures that previously had to be assembled, promising to eventually obfuscate the need for parts assembly in construction. As the distinction between parts and the whole vanishes, additive technology realised in 3D printing promises not merely to revolutionize production, but to create a new aesthetics embracing what Ton Otto and Niels Bubant (2013) have called, leaning on the work of the anthropologist Louis Dumont, 'holism' and its interiorized self-referential and self-organising logic set via 3D printing to become the main site of creativity and distinction. The capacity of 3D printing to create interior hierarchical structures previously inaccessible to tools by manipulating structures purely via the actions of the mind encrypted in code is already utilized in the biomedical field, where internally complex structures such as bones can now be replicated on demand.

The advent of 3 D printing arguably calls for a new theory of material cognition as the topology implicit in additive fabrication creates a vision of the world in which the environment is no longer outside, but inside material structures that envelop in a self referential manner and that work by aggregating and assembling, much like the layers of an onion. Interviews with entrepreneurs engaged in developing the next generation of 3D printers made it very clear that the problems that they encounter are not just technical and material in nature but chiefly concern the question of how the mind will inhabit this material technology that calls for and creates structures of internally held, manifold relations. The idea of an 'inhabited technology' resonates with the perspective brought by the anthropologist Marilyn Strathern (2001) to the effacing of distance between the world as made and the world as thought. The challenge posed by RP is thus arguably not the technology itself, which, as shown above, has covertly provided much of the texture of the world we live in for the past century and more. The challenge it poses to us is that our theories of the social world have remained stuck in a

first person perspective ushered forth by a 19<sup>th</sup> century theory of objectification in which objects could merely serve as substitutes for persons, mediating and laundering relations in the social world.

### **Inhabiting Topology:**

There are many examples one can cite to document the intervention of topology into material and technical cognition. An intervention we are most affected by, but are least aware of is modern satellite imagery, which situates persons within the environment in ways, which contradicts our egocentric assumptions about space-time (Rayner 2014: 128). The mistaken assumption that mobile phone data record the position of persons relative to spatial and temporal locations, rather than recording the position of persons via relations between satellites in space and time, algorithmically configured, has only recently been acknowledged as a major factor in miscarriages of justice over the last decade. Chemically engineered materials that are reactive and capable of interaction with other materials in an similarly conjure up a world in which relations between technically and materially informed artefacts provide the framework for understanding emergent relations between persons and between persons and the objects through which they seek to extend their influence in space and time. Reaching further back in time to the period prior to Enlightenment, we can recall Giovanni Camillo Maffei's *Scala Naturale* of 1564, in which the person is envisioned standing at the centre of the structure consisting of 14 concentric spheres envisaged to form a giant stairway, the ascent of which affords a comprehensive knowledge of the world seen from within. Tim Ingold (1993) made use of this image of hierarchically conceived, self referential enfolding structures in an essay on environmentalism, which was emergent as an ideology in the decade following the wide spread use of digitization in tracing and mapping relations in self-organising systems such as the weather.

There is perhaps, however, no better example that conjures up a vision of inhabiting the material and technological world in a topological mode than the works of the Tongan artist Filipe Tohi whose artworks translate the cord based lashing of roof beams in traditional Tongan houses into a variety of materials, revealing in the emergent scaled and 'opened', internally implied, shapes the logic of a topological, mathematically and geometrically informed system. Known as '*lavalava*', the technical process of lashing patterns envisioned in 4D, is introduced by Tohi as his 'computer', pointing to the combinatorial possibilities such internally self reflexive patterning affords and the associations of connectivity it provokes.

The lashed patterns of Tongan roofs echo the art of wrapping the body in tattooing whose profound cosmological significance in Polynesia has been the subject of one of the anthropologist Alfred Gell's

(1995) most ingenious yet perhaps least known papers on *Closure and Multiplication*. Gell points in this paper on ancient Polynesian cosmology and ritual to an ontology of immanence, with object and human properties alike recapitulating cosmogonic acts that are effacing distinctions of nature and culture and of mind and its object. Because connective and relational quality was considered immanent in the world in ancient Polynesia, its articulation was considered liable to dispersion, requiring acts of closure that allowed persons and objects for periods of time to localise and preserve *tapu*, so as to invest it with cosmogonic attributes and qualities. Contemporary Polynesian artworks like those of Filipe Tohi reflect provocatively on the parallels between this concept of immanence at the core of Polynesian conceptions of personhood and the management of knowledge at home in an Ocean world where manifold relations are cared for at a distance. As we are about to inhabit digital technology in ways that will similarly secure its immanence in a world that is known and managed not through experience, but conjecture, imagination and thought, we may want to take note.

In Oceania, the wrapping of objects and of physical bodies in composite, iterative shapes, internally held and additive in fabrication, is a chief way to secure the distinctiveness of the social body in the face of pervasive connectivity in a world in which perpetual movement and a conception of relation at a distance is not a matter of choice, but of necessity. Additive technology and modular construction, with parts internally and relationally conceived as commensurate with the whole and casting the reflection of a homunculus, is not just articulated in contemporary Polynesian artworks, but is found in the works that are at the very core of household economies that connect island homelands with the outer reaches of vibrant diaspora communities. Seemingly innocuous, patchwork, lace and crocheting are constitutive of a material technology par excellence, one that is at the vortex of social polities whose reach is extended to transnational communities by managing a plurality of worlds in ways that enfold the many into one. This paper will focus on exclusively on the production of patchwork, proposing its status as a model of distributed cognition in a world of immanent relation.

The Cook Islands, an archipelago of fifteen tiny islands in Eastern Polynesia, eight of them inhabited, are a prime example of the heightened state of mobility among a population that has always accepted inter-island migration as a way of life. Cook Island migrants have strong and lasting socio-economic ties to the homelands, and most want to return there after retirement to die and be buried on the islands. Knowledge of biographical relationships that are central to the political economy of the transnationally distributed community is codified and transmitted, drawn upon and activated at different times for different reasons via a combinatorial and fractal imagery that allow for the modular assemblage of motivic parts in such a manner that a single element permits the spontaneous recognition of encompassing wholes (Küchler and Eimke 2009).

Patchwork, unique in the form of piecework to the Cook Islands, invites an understanding that is distinctly non-anthropomorphic, non-ego centred and non-relative. It is perhaps because of the

decentred, third person perspective it invites, that we find its product difficult to figure out, as we tend to approach it with an expectation that it should represent the world from an ego-centric, relative and anthropomorphic point of view. In contrast to the canonical position, the patched and pieced work, however, demands to be seen ‘in the round’ as the eye searches for connections that allow the work to be both an aggregate of one among many and an assemblage of many into one.

The argument extended here is that image making practice in the Cook Islands, and arguable across much of Oceania, overtly exploits such a topological perception to construct rotational, movable and generative images that are capable of inviting a polyphony of possible, variant and yet connected perspectives on singular entities. While notably not foregrounded in the highlands of mainland New Guinea, where Marilyn Strathern (1991) has shown relations to be ‘intrinsic’ to persons and manifested in the partible constitution of social bodies, topological imagination invites the ‘extrinsic’ and imagistic propensity of relation as the multiple iteration, or the manifold, of one, conditioning instead a pervasive, modular logic of assemblage that is constitutive of notions of personhood and society alike.

In the same way as a core motif (known as *pu*) is assembled in an iterative, transitive and self-referential manner in the construction of patchwork, modular assemblage also invokes the capacity to aggregate distinct relational entities. There is thus not just one type of patchwork, but three distinct modes of modular construction, each directed to manifesting distinct spatio-temporal dimensions of social relations, distinct and multiple worlds that are gathered up and brought into relation with one another: a piecework named *ta-orei* that is stitched to be gifted between inter-generational relations, a patchwork known as *ta-taura* with applique rotationally arranged and gifted between extended sibling groups, and a cut-out known as *manu* made to be gifted between friends. This modular construction, simultaneously assembling and aggregating parts, recalls Lothar Ledderose (2000) study of the terracotta army discovered in Shaanxi Province in China. Ledderose demonstrates how different combinations of clay body parts are used to generate non-identical yet structurally similar models of the human form. Drawing on the most recent archaeological evidence to reveal how the makers of drainage pipes were organized in a standardized system of production to produce the uniform yet non-identical model soldiers, Ledderose suggests that this organization of production could be extrapolated to explain Chinese social organization as a whole.

In the Cook Islands, it is overtly the biography of the maker that is traced in the stitched patterns of the large and elaborate appliqué and piecework quilt patterns. Stored folded in treasure boxes or sent out those who have departed from the islands to take up work in distant lands, patchwork quilts are the tangible reminders of relationships that are thought integral to a person, yet which are to be distributed and externalised throughout life. It is symptomatic of the nature of patchwork as biographical object that most women start sewing around the birth of their first child, as they begin to

be active in the many exchanges that will van out quilts as parts of themselves, peeling off layer after layer of a composite social body, thereby connecting their own household to as many other households as possible.

An iconic manifestation of the plurality of worlds that are conjured up as resources for actual and potential biographical relations is a treasure chest known by the name of the ancient God A'a collected from the island of Rurutu and stored in the British Museum to this day. The treasure chest, carved in the shape of a figure, is covered in miniature outgrowths that are arranged in the round on the surface of the container. This treasure chest was collected ahead of the destruction of ritual artefacts by Polynesian islanders who had converted to Christianity at the start of the 19<sup>th</sup> century, leaving the work for the dead to the women who harnessed the capacities of new materials introduced by Chinese traders who had begun to frequent this part of the Pacific since the late 1800s. Coarsely woven and easy to rip into strips of equal width and length, absorbent and readily coloured, plain coloured cloth brought into the islands in large bales enabled women to translate the composition of so called God staffs that took the form of treasure chests and of several meter long pillars, carved from hard wood with descending rows of iterative and self-similar figures. Wrapped in layers of barkcloth, sennit cordage and feathers, such assemblages were central to secondary burial, a ceremony at which the unwrapping of the carving allowed the spirit of the dead to be sent to their final abode. Inverting the action of unwrapping and wrapping, the large assemblages of cut and re-stitched cloth known as *tivaivai* today are thus in a sense shrouds travelling in the reverse, gathering up the departed and reconstituting a genealogy founded on a concept of epochal time in which all pasts are rendered equally present.

Fanned out during life as quasi-second skins, quilts are brought back together again at death, when those who received patchwork from the household return gifts of patchwork to be lowered in the grave with the body. This grave is tiled internally and covered by a stepped cement foundation and a roof, a miniature version of the house next to which it stands. The grave and its invisible contents are the manifestation of the social body, analogous in its aggregate and modular assemblage to the new born child, calling to mind a fractal logic by which the many are but one.

As quilt-like sewing are in effect the burial shrouds of their maker, they anticipate a state of being where all possible past and present temporal worlds coalesce in a *modalised*, that is logically describable, enchainment of events that connect points in space and time that are visible with those that are not. Made as shrouds that travel in reverse, gifts of patchwork connect the living with the dead in ways underscored by a practice of naming known as *ingoa mate*, or the giving of death names, the official registration of which was banned by the Cook Island Christian Church in 1958, but which is still privately observed in families. Names recalling the assumed cause of death, such as '*Mate Anu*' ('Cold Death' – a reminder of death in the cold sea) or '*Totiko*' (the name of a passage in

the reef in which a young man drowned), are given to family members in remembrance of the deceased, collapsing all possible past and futures into one.

The young person who is given the name, and is called in this way with affection by his family, is made to stand in a definite relation of succession to the dead, as he or she is associated with the act of offering water, paying back services received during life. In addition to explicit death names, which refer to services performed by the recipient for the deceased and which are acquired later in life, all birth names also refer to a deceased relative or friend of the person giving the name to the child – specifying either the cause of death, some personal attribute of the deceased, or some circumstance associated with the last illness of the deceased.

Graves are everywhere on the tiny uplifted volcanic islands – new ones with their roofed superstructure standing next to houses, and rectangular stepped gravestones where houses once will have stood, marking the places to which future generations can return. When we imagine each grave to be filled with layers of patchwork, we notice that its distribution is replicated on a smaller scale, within its own interior cavity. As such, both grave and patchwork, at different scales and levels of complexity recall a modular notion of personhood as the aggregate of external relations (the outcome of genealogy, fanning out in time and space) while giving at the same time concrete expression to a notion of personhood as the possession of an interior person, a homunculus, or an assemblage of homunculi. Like a Russian doll, we cannot individuate grave or the patchwork, for the grave and the patchwork have no boundaries, merely layers of encompassment.

Returning to the patchwork itself, we notice that patches and their arrangement reflect a modular logic in their iterative, reflexive and transitive composition. A single motivic element is replicated to create a whole that is the same as each of its parts, permitting one to create the part as the whole – zooming in or zooming out – creating views that project one and the same subject matter – usually flowers – in seemingly brilliant detail or so abstract that we may well fail to recognize what is depicted.

Where we see distinct patchwork, covert relations in fact exist between patchwork, showing up their composition to be simultaneously invariant and yet capable of transformation. To see how this is possible we need to look at how patchwork is made: Plain coloured cloth is shredded into stripes and cut into shapes of equal size, and strung up. The order of the coloured pieces and the number of patches of the same colour that succeed one another is key to the overall pattern, each squared motivic element being broken down into two rectangular sections, each of which has the same succession of coloured patches running up and down two of its sides. The arrangement of patches inside each triangular piece is surprisingly deductive and non-random, replicated within each triangle bringing about the completely symmetrical and iterative composition of the motivic part and the patchwork as a whole.

Given the fact that mathematical calculation is a must when approaching the task of patchwork, lest one wants to waste a lot of money on cloth that would remain unused, it should come to no surprise that the construction of the motivic part is utilizing a mode calculation that is both complex and yet tangible and easy to calibrate. The sections out of which each motivic element is composed are in fact made up out of non-commutative number sets known as quaternions. Quaternions allow for the calculation of a surface area and its invariant extension, enabling one conceptually to create an assemblage, capable to serve as modular aggregate, out of a single set of numbers.

The virtuosity of Cook Island quilts is quite clearly capturing ways of making persons and of projecting a map of biographical relations that enables navigation in a fractured world. None of this is too difficult for us to comprehend and use our conventional ethnographic method to document. The logic of material imagination at work in patching, however, is easily overlooked and difficult to reconcile and yet it is here that the explanation of the capacity of patchwork to distribute cognition beyond the confines of the person really lies.

### **Additive Fabrication and Relational Thought**

It has, so far, in this paper been argued that additive fabrication is constitutive of a homunculus conception of immanent interiority that, in so far as it pertains to both person and thing, shatters our received assumption that the environment surrounds rather than inheres in things. Entranced we gaze at the bewildering iterative, self reflexive and transitive shapes that make up a bone printed as a prosthesis or lampshade designed to enthrall those who are known to the world to be crafted by hand. The pleasure we derive from looking at these things does not seem to be satisfied by their iconic status, but propels us to ask – what does it do? Does it work? And how? Our theoretical apparatus that has equipped us with methods of interpretation of artefactual constancy and variation, yet has not enabled us to interrogate internally held relational structures that defy the mind accustomed to look for simple continuous resemblance between what is represented and what is referred to as existing externally, verifiable independently from the artefact.

To sketch out how additive fabrication will transform the way we think with and through the things that make this thinking manifest, Oceanic cultures offer up a vast resource of ethnographic case studies of models of personhood and of the social body expressed as the sum total of the distributed effects of persons actions and thoughts, - a composite, fractal, future directed social body that is uncontrolled by institutions and yet firmly asserting itself via material infrastructures that are as mobile as they are easily localised. Oceania is famous for the way this relational thought is made tangible in artefacts and yet it is hardly unique.

Across disciplines scholars have exposed the relation between non-randomness of relations immanent in artefactual form and its capacity to evoke lasting and distributed associative thought. Perhaps the most famous example is the work of Michael Baxandall (1975) on the geometric and algebraic configurations encrypted in 16<sup>th</sup> century Italian painting, knowledge of which was essential to social and economic transactions of any kind. A classic ethnographic example of encrypted metrics is found in the work of the anthropologist A.B. Deacon (1934). It was possibly Deacon's original training in physics that enabled him to see that the forms which were drawn, plaited, lashed and danced by the islanders of Ambrym in island Melanesia were not random, but a performative articulation of complex geometric calculation, enabling Deacon to establish the existence of the most complex marriage system known to us consisting of six classes. It was the abstract and yet concretized logic manifest in these artifacts that inspired the anthropologist Claude Levi-Strauss to seek the aid of computing to model structures of kinship, creating the means to investigate marriage rules comparatively (c.f. Levi-Strauss 1966: 125-126). The relation between the performative geometry informing the fabrication of artifacts, quaternion number sets capable of manipulating relations between points in 4D and the conceptual modelling of kinship relations was made explicit, however, for the first time in Alfred Gell's (1998) *Art and Agency* – a proof that Gell was thinking off something a little less straight forward when writing about the agency that things can have

By describing, leaning on Sartre, such modelling of relations in image making actions as 'thirdness', the analytical vantage point that allows for the conception of social 'wholes', Knut Rio (2007) has successfully brought a simple, but remarkably important point to the attention of anthropology, namely that it is not just anthropologists but also their subjects who deploy images to capture, translate and transmit their understanding of ways of relating in the social world. I have gone a step further here by arguing that these images, while productive of a distributed and lasting social imaginary, are not a product of imagination, but of geometric calculation capable of translating between and thus relating to one another dimensions of life, of thought and action, we hold to be distinct.

### **Conclusion:**

This paper has set out to argue that additive technology as presently developed in the form of 3 D printing or rapid prototyping is challenging not just how we conceive of the relation between thought and thing, but requires us to create a theory of material cognition. Starting from a discussion of topology and the decentered apprehension of relations seen in the round the paper questioned the difference additive fabrication will make to the conceptualisation of connectivity by directing us away from a network oriented approach informed by communication systems to a localised and immanent system which replicates internally relational elements in a simultaneously enfolding and expansive manner. The mathematical, geometric and transformational logic of such homunculi permits for a

generative mapping of spatial and temporal relations and their extension, in theory encompassing vast extended communities. Working under the veil of obsolete ritual technologies, such additive fabrication serves to connect transnational communities in the Pacific and beyond. As we struggle to realise the potentials and implications of additive technology in the making of Futures, we should take note.

Baxandall, M. 1972. *Painting and Experience in Fifteenth-Century Italy*. Oxford: Oxford University Press.

Bijker, W. 1997. *Of Bikes, Bakelites and Bulbs: Toward a Theory of Socio-technical Change*. Cambridge, Mass.: MIT Press

Bois, Y.A. and Krauss, R. 1997. *Formless: A User Guide*. Zone Books.

Clark, H.H. 1973. "Space, Time, Semantics and the Child." In T.E. Moore ed. *Cognitive Development and the Acquisition of Language*. New York: Academic Press: 27-63.

Deacon, A.B. (1934). *Malekula: A Vanishing People in the New Hebrides*.

Gall, J.-L. (1997) 'Photo/sculpture: L'invention de Francois Willeme', *Etudes Photographiques* 3: 1–10.

Gallese, Vittorio (2001). The 'shared manifold' hypothesis. From mirror neurons to empathy. *Journal of Consciousness Studies* 8 No 5-7: 33-50.

Gell, A. (1998) *Art and Agency*. Oxford: Oxford University Press.

Ginsburg, C. 2001. "Representation: The Word, the Idea, The Thing." In his: *Wooden Eyes: Nine Reflections on Distance*. New York: Columbia University Press.

Ingold, T 1993. "Globes and Sheres: The Topology of Environmentalism." In K. Milton ed. *Environmentalism: The View From Anthropology*. London: Routledge, 31-42.

Küchler, S. and G. Were 2005, *Pacific Pattern*. London: Thames & Hudson.

Küchler, S. and A. Eimke. 2009. *Tivaivai: The Social Fabric of the Cook Islands*. London and Wellington: British Museum and TePapa Press.

Latour, B. 1996. *Aramis , or the Love of Technology*. translated from French by Catherine Porter. Boston: Harvard University Press.

Ledderose, L. 2000. *Ten Thousand Things*. Princeton: Princeton University Press.

- Levi-Strauss, C. 1966. *The Elementary Structures of Kinship*. London: Beacon Press.
- Maffei, G.C. 1564. *Scala Naturale*. Digitized 2008 by the Bavarian State Library.
- Malafouris, L. 2013. *How Things shape the Mind*. Cambridge, Mass.: MIT Press.
- Martin, E. 1992. "The End of the Body." *American Ethnologist* No 1: 121-140.
- Otto, T. and N. Bubant 2013. *Experiments in Holism: Theory and Practice in Contemporary Anthropology*. London: Wiley-Blackwell.
- Rayner, S.F. and C. Heyward 2014. "The Inevitability of Nature as a Rhetorical Resource." In *Anthropology and Nature*, edited by Kirsten Hastrup. London: Routledge: 125-147.
- Serres, M. 2008. *The Five Senses: A Philosophy of Mingled Bodies*. Continuum International Publishing Group. Third Edition.
- Stafford, B.M. 2007. *Echo Objects: The Cognitive Work of Images*. Cambridge, Mass.: MIT Press.
- Strathern, M. 1991. *Partial Connections*. Savage, MD: Rowman & Littlefield