The Immaterial of Materials, *by Jonathon Allen*

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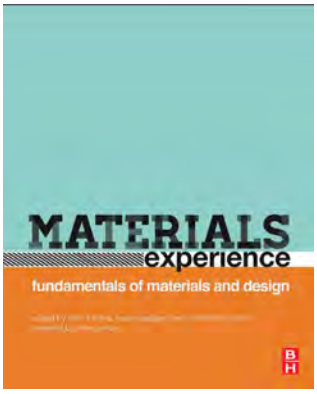

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Beyond physical and performance characteristics, there are several other, often tacit, criteria that guide or influence designers' selection of materials. These criteria, or choices, reveal more about the designer – his or her tastes, values and preferences. These are not merely abstract matters, however, but rather the very essence of a designer's knowledge and experience that shapes and influences our world when applied in designed artefacts. Through a series of illustrated examples, this chapter explores some of the immaterial dimensions of material selection – not *immaterial* in the English sense of being unimportant, but rather *immaterial* because it deals with the intangible and deeper philosophical, social, cultural, environmental and political dimensions of material selection.

Keywords: ethics, selection, sustainability

1. Introduction

I recall a lecture I once attended as a first year design student on the selection of metals for design projects. It was memorable in the way it was delivered, and the key tenet of the lecture remains still. "In all cases use steel", the lecturer said before gesturing to leave the room ... "oh, except if you need it to be lightweight, then you should use aluminium". He then left the room leaving my fellow students and I somewhat dumbfounded. Was that it – a supposedly hour-long lecture reduced to one sentence? The lecturer returned after just long enough for the idea to sink in. He continued the lecture, "oh, unless you need it to be really lightweight, and then you use magnesium", and then outlined more exceptions to this simple 'rule' of materials selection. The lecture had a profound effect on me. It was certainly an invaluable way of thinking about materials selection, but it left me insatiably curious about the choices we make when selecting materials – was that all there was to it? Don't get me wrong, I am in no way critical of the lecture or its message – far from it, for the simple elegance of this approach to selecting materials based upon their performance characteristics relative to their cost has helped construct the way I think about and select materials – but the thought that there must be more to material selection, and at what cost we select materials has remained with me ever since.

2. Aesthetics and ethics: reflections on personal tastes and material preferences

Perhaps the most obvious example of where the rationality of choosing materials based upon performance and cost is not so clear-cut (forgive the pun) would be the selection of timber. Timber's colour, figure, smell, texture, and so on, help inform our aesthetic preference – we may prefer lighter coloured woods than darker ones, or we may like the smell of cedar or sandalwood, or we may like the simplicity of straight grained timber or the more complex figure of a burl wood. Our 'tastes' are not solely based upon such sensorial stimuli, but also an emotional and cultural connectedness to the material.

Timber speaks of its geographic origins, be they native or exotic, we associate certain woods with their traditional location as embodied in vernacular architecture and furniture. Furniture and building traditions have utilized locally sourced materials, and hence there is cultural association of particular woods in particular parts of the world: Oak is to England as

Eucalypts are to Australia for instance, and Scandinavian furniture is exemplified in its use of light coloured straight grained timbers such as spruce and birch.

The popularity of Scandinavian design is of course global, but our choice of selecting one timber over another, when both exhibit similar physical properties can come down to not only our aesthetic preference but also to our cultural heritage and association of the material with our sense of history and place. This personal aspect of materials selection is important to acknowledge, but our aesthetic preferences are also being modified – or recoded – as we become increasingly aware of environmental concerns such as over-logging, destruction of native forests, and the depletion of bio-diversity caused by the globalized nature of timber plantations.

European colonization of the world brought about the export and import of native and exotic timbers, and wooden furniture manifestly expressed the extent of empire in the wide range of woods used in cabinet making. Indeed wooden marquetry work from the 16th to 18th Centuries unashamedly flaunted this, and thus began the incredible exploitation of timber resources across the globe. It was not just timber that was the spoil of colonial exploration and exploitation – many material resources were harvested and extracted from around the globe, and the exploitation continues today, but is somewhat less conspicuous.

3.0 At what cost?

I'm typing this chapter on my iPad on my kitchen table. Coffee in hand, I have the weekend paper before me. There are the usual news stories – a war criminal prosecuted, political ranting about carbon taxes, a story on global warming, someone's died of mesothelioma, commodity prices are up, a major company is recalling toys after lead was found in the paint, and a jewellery store is having a half price sale. But what's this all got to do with selection of materials? Unfortunately, a great deal.

Tucked away in the World section of the newspaper, there is an article about the Democratic Republic of Congo (DRC) and talks of the jailing of a warlord over the conscription of child soldiers, and of genocide and atrocities over the mineral riches of this region of Africa. As I read, I'm making the connections and links back to my own purchases and my own decisions to use certain materials in my designs and I am shocked by how much I didn't know.

The paper refers to an older Amnesty International Report that I duly download and read on my iPad.

> *Four years of conflict in the Democratic Republic of Congo (DRC) have proved among the most disastrous in the history of modern Africa. Some three million people are believed to have lost their lives and more than two-and-a-half million have been driven from their homes, 500,000 to neighbouring countries. ... Thousands of Congolese civilians have been tortured and killed during military operations to secure mineral-rich lands ... Children as young as 12 have been among those forced into hard labour in the mines. ... The ambition of all these combatant forces to exploit eastern DRC's mineral and economic wealth has been the biggest single factor in the continuing violence.*
>
> (Amnesty International, 2003, pp3-4)

The article lists the mineral wealth of the region: timber, oil, gold, diamonds, coltan, copper, zinc, wolfram and coffee to name a few. Some of these materials I was not aware of, nor what they are used for. I let my coffee go cold as I read on, "International commercial

interests in coltan, gold, diamonds, timber and other precious resources have, knowingly or unknowingly, contributed to human rights abuses." (Amnesty International, 2003, p5)

I begin to question where all these materials end up and what my role in all this might be. For some years now I've been aware of the Forest Stewardship Council and their role in certifying timber to ensure it comes from a well-managed forest or plantation, and will only purchase timber that has this international certification. I also buy Fairtrade coffee, but as for the other resources on that list I begin to realize I just don't know where the materials around me have come from.

Coltan, or colombo-tantalite, is an ore rich in niobium and tantalum. Niobium is typically used for high-performance alloys and superconducting magnets used in such things as Magnetic Resonance Imaging (MRI) Scanners. Tantalum is used to produce tantalum electrolytic capacitors used extensively in mobile phones, computers and consumer electronics. These capacitors are expensive but their value is in how lightweight they are compared to other capacitors and, with the drive to ever-smaller devices, the demand for tantalum is high. Indeed, the price of tantalum well over doubled in one month from $87/kg in May 2012 to $215/kg in June 2012 (InvestmentMine, 2012).

I look at the iPad and my mobile phone next to the newspaper. On the reverse of the iPad it says "Designed by Apple in California. Assembled in China". This is a powerful statement, and celebrates the importance of design to the Apple brand. Competitor products typically just state where they are made. As I question where the tantalum in my iPad, my mobile phone, my laptop, and countless other devices, came from, I wonder whether we perhaps need to see three levels of design and manufacturing information on the labeling of our products: where it was designed; where it was manufactured or assembled; and from where the materials were sourced. This third level would be problematic to implement on several counts – the shear number of materials in some products would render this unmanageable – but this is an important bit of information left out of the loop that could go some way to helping us make more responsible choices.

3.1 At what price love? The noble and ignoble story of the wedding ring

I retrieve the jewellery catalogue I had discarded in the recycling bin; a major jewellery store is having a half price sale. It describes the prices as "slashed", "cut", and "once in a lifetime", the jewellery as "hot" and "stunning", and it states that "you'll turn heads" wearing "this seasons' must haves", and "you'll be hooked on these new and exclusive collections" (exclamation marks removed). In the light of reading the report from Amnesty International, somehow all the adjectives in this punchy advertisement seem quite perverse – a truism perhaps. That precious gift is now much cheaper, but at what cost in human terms?

Consider the symbolic and monetary value of a wedding or engagement ring. Most commonly the wedding ring is a simple band of gold (or other expensive material). The monetary value associated with the ring, in times past, was very significant (an endowment), and the embodiment of value and inherent symbolic meaning of the material in being noble (resistant to corrosion and oxidation), its longevity and indeed its rarity established gold as the material to signify marriage. But let's consider modern gold and diamond mining practices, and the environmental, political and human costs associated with their extraction: far from being noble, there is an ignoble side – in parts of the world the story of gold and diamonds is one of human violation (childhood slavery, blood diamonds), environmental pollution (arsenic leaching into rivers killing fish stocks), and corruption (money laundering, weapons trading). Is this how we should symbolize love?

One of my Industrial Design students, Edward Sackett, took this question on as his final year Honours project, where he set out to design and make a series of alternative wedding rings to

the traditional band of gold. Two of Edward's designs for these rings are described here. The inherent value embodied in the design of the rings was achieved by two very different approaches to material selection; one material was rare and endangered, the other very common.

The first ring, "Hou Ola" (Hawaiian for 'new life') is made of bronze and wood from the endangered Hawaiian native Koa tree (Figure 1). As Edward describes, "The wood used in this ring comes from sustainable plantations where some of the profit from each ring is invested in planting a Koa tree. The planting of this tree is a physical metaphor for the beginning of the new life/journey for a newly wedded couple. The non-polished bronze becomes shinier over the years from being worn by the user, which represents the beauty of a growing relationship. Each set of wedding rings is made from the same piece of wood, which signifies a couple's unity." (Sackett, 2009). As the pair of rings is machined from the same piece of timber, the unique figure of the timber is congruous to both rings, with the grain of each ring aligning with its partner to symbolize the unique unity of the wedded couple.

Figure 1. *Hou Ola* wedding rings by Edward Sackett, 2009

The second pair of rings, *Semper Amemus* (Latin for 'forever in love') are simple bands of ferritic stainless steel with the couple's finger prints etched into the steel – each ring carrying the partner's 'touch' (Figure 2).

Figure 2. *Semper Amemus* wedding ring by Edward Sackett, 2009

The pair of rings is magnetic and, as Edward explains, "The magnetic properties of Stainless Steel F430 used in the bands symbolise the attraction and unity shared between two lovers." The *Semper Amemus* ring presents a lovely proposition – that the value of the ring is not so much in the *material* worth but in the *immaterial* worth – the symbolism and meaning inherent in the ring is its richness and treasure.

Interestingly there are also cases where the opposite is true – that is, the material itself is not valued. Let's consider the case of packaging.

3.2 On valuing materials

I used to present a lecture where I would hand out a few empty margarine containers that I'd rescued from the waste bin and a pair of sunglasses by a leading fashion brand, and asked the students which was the most valuable? Not surprisingly the sunglasses always won out, with a price tag of well over $50, the answer seemed obvious. However, weight-for-weight, the margarine containers are made from a more expensive and higher quality material – food-grade Acrylonitrile Butadiene Styrene (ABS) – than the sunglasses which were made of a standard grade ABS, and cheaper styrene blends. Yet the margarine containers were discarded without much thought, and were deemed to be of no value.

Packaging consumes more plastic than any other industry at 39% of the total use of plastic; by way of contrast this is seven times the volume of plastics used in electrical and electronic goods industries. Production of plastics has also grown on average nearly 5% per year over the past 20 years or so, with 265 million tonnes produced globally in 2010. Much of this plastic ends up in landfill; the exact percentage is hard to determine, and varies widely dependent upon who provides the information, but the European Association of Plastics Manufacturers reports recycling rates of between 15 to 30% (Plastics Europe, 2011), with other sources quoting much lower than this.

This is a significant problem – not just from an environmental perspective, but from the social and cultural perspective of not valuing these materials. Other materials used for packaging, such as glass, paper and aluminium and steel have far higher recycling or recovery rates (recycled at waste-recovery centres prior to going to landfill) than those of plastics. What is curious is that the use of plastics for packaging has, in part, devalued the perception of the material and the over-packaging of goods combined with our very systems of waste management (curbside collection of rubbish) has reinforced this thinking.

Since the first time I gave that lecture, I am now at least retrieving the margarine containers from the recycling bin rather than the waste bin, but the same issue remains; that we do not see the inherent value in the material.

For me, this example highlights the power of design to transform and embody value in artefacts, and reveals two compelling lessons:

1) the importance and value of the role of design in adding value and meaning to materials; and conversely,
2) that design can also contribute to the devaluing of materials – by excessive packaging and the encouragement of a throw-away society.

3.3 Changing perceptions: the curious story of cork and aluminium

Material perceptions are curious things indeed, and notions of social and cultural meaning, habitual behaviour, nostalgia, prestige, and so on, all come into the mix in forming our perceptions of materials. Increasingly, the environmental impacts of materials – their eco-

footprints as it were – are becoming part of the lexicon of consumers and designers. One curious example is the debate of the use of cork versus aluminium screw caps to seal wine bottles. Without going into the functional or emotional debate regarding which is better for the wine or the consumer, the environmental debate is interestingly contentious. The majority of Australian wines now use screw caps rather than the traditional cork. Cork is harvested form the *Quercus suber* oak tree, by peeling away the cork bark. Because the trees are not cut down in this process they continue to absorb CO_2, thereby helping to offset any carbon-emissions in the processing of the cork products. Conversely, in the production of aluminium screw caps the CO_2 emissions are much higher (in the order of four times as much). Aluminium, however, is produced locally whereas cork is imported from the other side of the world, hence the CO_2 emitted in transporting the corks should also be factored into the eco-footprint. Then considering that the bottle with the cork in is often wrapped in an aluminium foil anyway, the environmental argument can become a little academic. In short there is always more than one argument to support the selection of one material over another.

3.4 The immaterial of the material: the embodied energy in aluminium

The discussion of the ecological virtues of one material over another can be contentious, and aluminium presents another interesting case – where the aluminium is sourced from has a great impact on the material's eco-footprint. To produce aluminium an incredible amount of electricity is required – indeed, at the beginning of 2012 there were six aluminium smelters in Australia and combined they reportedly consumed 15% of all of Australia's electricity (Keane, 2012). Five of these smelters use electricity from coal-fired power stations, whilst the other sources its electricity from hydro-power; consequently the embodied CO_2 in the aluminium varies dependent upon its source of manufacture.

4. Material and manufacturing legacies

In the business section of the newspaper there's a headline reading, "Kurri Kurri smelter closure to trigger 450 job losses". The smelter in the Hunter Valley north of Sydney will have significant impact on the community, with many other businesses in the area growing up around, and relying upon, this industrial base. The last few months have seen many headlines discussing the fate of the aluminium industry in Australia, with two other smelting plants having discussed closure, only to be 'saved' by government bailouts. Without the government-funded rescue, hundreds of jobs would be lost, leaving communities devastated.

The de-commissioning of inefficient, power-hungry and highly polluting smelters in some ways is a good thing, but often whole communities and townships were built around these centres of work. When the smelter is no longer operating and the jobs are gone, communities can die, unless an alternative source of work is available. There are many stories of industries and communities dying, or else communities re-inventing themselves when major employers move away from the area. Industrialized cities in the west (North America and Europe in particular) have seen tremendous upheaval as manufacturing heads off-shore – be it the decline of the car plants in Detroit and Michigan, or the UK steel and ship building industries – the impact upon communities is majorly significant.

The dying legacy of certain industries – particularly manufacturing industries – forces change, and can re-orient a community. It also necessitates those whose livelihoods have either directly, or indirectly, depended upon those industries to change the way they do things. For designers this is very apparent where the globalized nature of material sourcing and manufacture has created greater complexity of the logistical management of the process of design and manufacture.

4.1 A painful legacy: from miracle material to mesothelioma

There are other legacies that some materials and manufacturing processes have left us with. There is a short article in the newspaper about another death from asbestosis, and a forewarning that many more people are likely to die from this dreadful and incurable lung disease in the coming decades. The length of the article is perhaps indicative that this has become an all too familiar story in Australia. Indeed, the UK and Australia have the world's highest rates of cancer deaths related to asbestos, and according to an article in the British Medical Journal, the peak of deaths is not expected until the end of this decade (Treasure *et al*, 2004). Asbestos is a naturally occurring mineral fibre that was used extensively after World War II, particularly in the construction industry, but also more widely as an electrical and heat insulator, for filters, and ship and car parts (brake pads, filters, gaskets).

From the 1950s many houses were constructed using asbestos fibre cement sheet, and the material was lauded as being a miracle material (see Bowley, 1960 for instance) – cheap, fire retardant, resistant to weather, fungal and pest attack, mouldable, light weight and easy to work with. The latter point about being easy to use subjected many builders and home renovators to unsafe practices of cutting through and breathing in the harmful fibres. These very fine fibres are now known to be toxic, and tend to lodge themselves in the lungs where they can cause asbestosis (chronic inflammation and pulmonary fibrosis) and lung cancers, including a once rare lung cancer, mesothelioma.

The asbestos miners and their families constitute some of the most severely affected by exposure to asbestos. The story of one mine, Wittenoom in Western Australia, is deemed Australia's worst industrial disaster. The Mesothelioma Center states that, "Of the 7,000 individuals who worked at the Wittenoom mine from the 1930s until 1966, an estimated 10 percent have died or will die of mesothelioma. Today, the town has literally been wiped off the map, with only a handful of people remaining." (The Mesothelioma Center, 2012).

Asbestos appeared to be the perfect material to help build housing stock and rebuild nations post war, but herein lies an important lesson of the potential dangers of economic and functional rationalism. With hindsight, now that we know of the dangers of asbestos we utilize other materials, but there was significant evidence linking asbestos and lung diseases well before the mines ceased operation. Indeed, asbestos was still being specified for constructing homes until the late 1980s in Australia when it was finally banned in 1989. Other countries have also taken action to ban asbestos completely – the latest being Turkey in 2011. Throughout this time though, and as argued in current legal proceedings, the Asbestos industry knew of the dangers of exposure to this mineral, yet maintained their operations.

I turn to the automotive section of the newspaper to see this headline, "Chinese cars use asbestos in parts: Vehicle recall". Perhaps we haven't yet learnt from history, with some manufacturers still using discredited practices.

4.2. Questioning colour: I see red

Unfortunately, asbestos is not the only material whose painful legacy we must live with. There are many materials and processes once thought to be safe that, as time and our knowledge advances, we see in a different light.

The decision to specify certain colours for products appears an innocuous one, yet there are several examples of materials that are now banned from use in pigments and paints. As designers and manufacturers, we often specify colours, but do we actually consider what is in the pigments and paints we chose?

From a materials perspective, paint can be made up of thousands of chemicals, but primarily consists of pigments (the colour), binders, solvents and some other specialist additives such as UV stabilisers, biocides, emulsifiers, flatteners and materials that create particular textures. The binder in the paint is typically a synthetic resin such as acrylic, polyester, epoxy, or an oil-based medium, and it is this material that adheres to the surface being painted and also constitutes the gloss level of the finish. The way in which these materials cure, or dry, is of note – many contain solvents that evaporate, and the solvents can pose a health risk. Solvents and other constituents of paint are often referred to as Volatile Organic Compounds, or VOCs, and thankfully environmental legislation now regulates their use. Even so, paint can still contain hundreds of toxins and harmful substances.

There are many highly toxic materials that have been used to colour our world. Take yellow for instance. Sweets that can be fatal if swallowed sounds like the basis for a macabre tale befitting of Edgar Allan Poe, yet the reality is that up until the late 19th Century, lead chromate was used to colour confectionary bright yellow. We now know of the extreme toxicity of both lead and hexavalent chromium that constitutes lead chromate, of its carcinogenic properties and that it can be fatal if swallowed or inhaled. Thankfully, Michael Vernon, the Australian consumer activist, campaigned for lead and cadmium to be banned from use in children's toys through the latter part of the 20th Century – we owe a lot to him, but still there are all too frequent violations.

When Mattel recalled millions of toys in 2007 because there was lead in the paint, it left them red-faced. It also coloured our judgment of the safety standards in place in some manufacturing plants and begged the question just how many other toys went unchecked by toy companies with less stringent safety standards. The recall was costly, not only in financial terms; reputations were damaged too. But what could have been the cost in human terms if this went unchecked?

Lead is toxic – a poison that affects many body organs and interferes with the nervous system – and can lead to permanent learning difficulties, seizures and even death. So what does lead do and why is it in paint in the first place? The answer is simply to add colour – which is rather perverse considering that as designers we specify these colours to appeal to children, luring them to want to play with them, and in the process expose them to a potential killer toxin.

So the key question is how these toxic chemicals still end up in our toys and paint? The answer is unfortunately a product of the way in which design and manufacture has become a global business. One key reason why the majority of manufacturing has moved from the West to China, South East Asia and parts of the developing World is the economic rationale that it is far cheaper to produce goods there. The reason for this, on the whole, is related to cheaper labour costs and scales of manufacture, but different labour and environmental laws between countries are also part of that equation. Environmental legislation is not necessarily binding or adhered to in all parts of the world, and certainly some countries have far more rigorous legislation than others and, conversely, some countries have none at all.

As designers we need to think very carefully about where our products are being made, and who is making key material and manufacturing decisions. We should question the underlying reason of why it might be cheaper to manufacture our products offshore.

5. Conclusion

This chapter has explored some of the lesser-considered aspects of materials selection, and has questioned at what cost we, as both consumers and designers, select materials. The

luxury of having choices comes with significant responsibility, yet we rarely consider or make explicit the connection between our material choices and the human and environmental costs our decisions may have. In many ways the information about those connections is difficult to find, or else hidden or obscured in some fashion, and the onus is upon us as designers to be due diligent and inform ourselves. Perhaps, also, this dimension to material selection should be covered in our curricula for design, materials and manufacturing courses to help contextualize the impact of our choices and at what cost we specify materials and manufacturing processes. This calls in to question how and where materials and manufacturing related units/courses have been taught in Industrial Design programs. Often the teaching of materials is outsourced to other disciplines or taught by engineers or material scientists (Pedgley, 2010), yet materials education needs to not only cover the technical aspects of materials and their associated manufacturing processes, but also the more human facets – the political, social and cultural dimensions – of materiality.

In one weekend newspaper I discovered many untold stories, simply by making the connections between the headlines, the story of materials and our complicit consumption of design. In the lifestyle section of the newspaper I see a nice tea pot – it appears inspired by the work of one of Christopher Dresser's 19th Century silverware pieces and I recall something Dresser, one of the founding fathers of Industrial Design, once wrote: "There can be morality or immorality in art, the utterance of truth or of falsehood; and by his art the ornamentalist may exalt or debase a nation" (Dresser, 1859, p17). Whilst Dresser referred to 'art' and the 'ornamentalist', today we can replace these terms with 'design' and 'designer', and the meaning behind his statement is just as poignant. The question for a designer is whose nation is being debased – perhaps given the globalized context of design and manufacture, it's every nation.

In the process of selecting materials there is more to design than form and function, economics, environment and emotion; there are deep-centred human and political dimensions that should also be considered. Labour and human rights along with environmental legislation (or lack thereof) should be factored not only into the selection of materials, but also from where materials are sourced. As consumers and designers we make material choices. The responsibility and significance of those decisions escalates however, when we are specifying materials that consumers will inadvertently use – in essence the designer makes the decision to use one material over another on behalf of the consumer.

The intent of the chapter has been to call for a greater awareness of the immaterial dimensions to materials selection, as the designer's decisions regarding materials can have a significant impact on the human, economic, environmental, political and cultural fabrics of our global society.

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