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Article

Temporal Objects—Design, Change and Sustainability

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Abstract: In this paper, *design for change* is explored as a means of contributing to socio-economic equity while minimising environmental damage. To create a material culture capable of accommodating technological progress and aesthetic development while also adhering to the principles of sustainability, it becomes important to recognise the potential role of *design for change*. This theme is explored here by considering design within an integrated strategy that includes mass- and local-scale manufacturing, service provision and re-manufacture. General design objectives are developed that provide a basis for generating 'critical design' concepts. Engagement in the process of designing requires a transmutation from generalisations to specific design decisions. This process enriches our understandings of *design for change* and the concepts presented here articulate the ideas *via* form, function, materials and aesthetics. In doing so, they provide tangible expressions of the strategic implications. These 'temporal objects', which in this case rely on a relatively stable technology, highlight the importance of localisation and more distributed forms of innovation. In addition, they clarify the designer's role in developing useful things that are capable of being continually transformed through time, with continuous use of technological components and changing aesthetic components that, through creative employment of materials, have virtually no detrimental environmental impacts.

Keywords: design for change; sustainability; temporal objects; localisation; emerging enterprise models

1. Introduction

When we create things we draw on the materials of the earth. In the process, we unavoidably alter and in some way diminish the natural world. To build a road, we dig up vegetation and soil that may have been centuries in the making. We blast and crush rock and exploit hydrocarbons, which were formed over millions of years. And we pave over land that once provided habitats, absorbed rainfall and was part of the ever-changing cycles of nature. Such industrious human activities have long been so commonplace that they are done without compunction. Indeed, our language reveals how we tend to view the natural environment when we refer to its constituents as 'resources', sources of 'supply' that are there to 'exploit'.

Today, we are beginning to realise that nature is fragile, precious and not inexhaustible. Yet, the attitudes that brought us to this place remain prevalent, and modifying our behaviours can seem onerously slow. Even though we have an overabundance of information about the global implications of our collective activities, vested interests and disagreements between nations have time and again resulted in procrastination and inaction e.g., [1,2]. In addition, measures and programmes that aim to offset the effects of our activities, while they might assuage guilt, are often ineffective or even counterproductive [3]. One prominent climate scientist has even likened carbon trading to selling indulgences [4]. Meanwhile, emissions in the industrialised countries continue to rise [5].

Change towards more sustainable ways of living, if it is to be effective, has to occur at the level of our ordinary individual acts. Sustainability cannot be externally imposed through a one-size-fits-all approach. In conjunction with international agreements and regulation, progress depends on growing a culture of sustainability that is sensitive to the specificities of locale [6]. Effecting meaningful and significant change at this everyday level requires a new sensitivity and the development of fresh perspectives. In whatever roles we have in society, there is a need to reflect upon our activities and, where necessary, develop new practices. Such changes can yield many benefits for individuals and communities, quite apart from any potential long term contributions to the wellbeing of the natural environment.

In exploring these ideas in the field of product design, this discussion focuses on the development of a series of simple functional objects. The first is a floor lamp. The second is a table light that articulates the same themes at a different scale. The third is a wall sconce created from selected components of the floor lamp, the unused elements of which are returned to the natural environment with no deleterious effects. Informed by contemporary thinking in sustainability, the considerations that led to these designs are indicative of the nature and magnitude of change needed to transform product design and, with it, our approaches to manufacturing and consumerism.

Traditionally, the product designer's area of concern was restricted to the object itself. However, as we are increasingly acknowledging, the design of a product exists within a wider system of production, consumption and disposal. To make this system less damaging, we have to change each interrelated element in ways that represent new understandings and new priorities. This is difficult to do because the 'system' is large, multi-faceted and complex and has its own inertia, making it cumbersome and unresponsive to change. The system may be problematic, but at least it is known and, to this point in our history, at least, it has 'worked', particularly in terms of creating economic wealth and material benefits for many. Change, on the other hand, is uncertain, risky and uncomfortable. We can try to change the system from the top down by responding to the problems it creates, but without a clear idea of what we are trying to achieve, top down systemic changes will tend to remain incremental, reflexive, disparate and reluctant. However, this kind of reactive approach to problem solving is quite different from creating new visions of how we might live and developing more positive ways forward [7].

An alternative is to address the issues from the bottom up—to look at how products can emerge from, and be aligned with, new sensibilities—and then to develop a system that supports their effective production. Potentially, through many such bottom-up approaches, and their cumulative effects, our larger, globalised production systems, which are proving so damaging and so intractable, can be transformed.

In this approach, 'designing', understood as a creative, integrated and iterative process of *thinking-and-doing*, becomes a key element of broader strategic change. The conceptual object, or prototype, becomes a tangible expression not just of functionality and aesthetics but also of strategic ideas that can inform and help steer systemic change. This more expansive notion of designing, which some refer to as *design thinking*, is becoming an important aspect of contemporary design and a valuable driver of change [8]; '*design thinking*', however, is a somewhat problematic term because it fails to convey the essential 'thinking-and-doing' nature of the creative design process.

In this study, an explanation of the factors that led to the development of design objectives is followed by a discussion of the design process and an illustrated description of the artefacts themselves. The study concludes by considering how the manufacturing of such products can be implemented, and what this might mean for a new kind of production system; one that integrates top down, mass-production with bottom-up initiatives that are sensitive to and shaped by the particularities of place. Combining different forms of production, spanning mass-production of individual components to local batch-production of products, would enable functional goods to benefit not only from sophisticated technologies and economies of scale but also from local environmental knowledge and cultural relevance.

2. Design and Technology

To design a functional object, two major types of components have to be considered. Firstly, there are the technological components that the object will incorporate, which deliver the primary functional requirement. Secondly, there are those elements that enable the technology to be presented in a manner that is usable and desirable. For the moment, let us consider these two sets of elements separately so that we might more clearly identify the distinct contribution of the product designer.

In the case of a domestic lamp, the technology that delivers the primary function will be some kind of electric light source. This could be an incandescent bulb, a halogen, a compact fluorescent or an array of light emitting diodes. As scientific research progresses the particular and preferred technologies will continually change. Be that as it may, it is important to recognise that these technologies are not developed by product designers, but by scientists and technologists. The product designer makes use of them and, in some cases, might even be able to influence their development, but they are based on scientific research that generally falls outside the product designer's range of expertise.

In addition to the technological components, a product includes elements that enable the functionality to be presented in a manner suited to its purpose and its anticipated context. A floor lamp generally requires some kind of stem to raise the light to an appropriate height, a base to stabilise the stem, and a shade around the light source to prevent glare. These elements have both a functional and an aesthetic role and they transform a technology into a useful and attractive object. Ensuring that the whole can be manufactured and delivered in an economically viable manner transforms a functional object into a marketable product. The form and arrangement of these additional functional-aesthetic elements, which will be referred to here as the *design components*, together with the effective incorporation of the *technological components*, is the responsibility of the product designer.

This distinction between the contributions of the technologist and those of the designer is intimately linked to the useful life of a product. Both the technological components and the design components will eventually become outmoded, but these changes will occur at different rates. For example, the incandescent light bulb, first marketed in 1879 by Thomas Edison, lasted for about 130 years, until it started to be phased out in the first decade of the twenty first century in favour of the more energy efficient compact fluorescent bulb [9]. During these 130 years, aesthetics in home decor changed many, many times—ranging from the decorative styles of later nineteenth century Arts and Crafts and Art Nouveau, through the abstract, rationalistic aesthetics of early twentieth century Modernist movements of De Stijl and the Bauhaus to the decorative surfaces of 1980s Memphis and the whimsical styles of Droog at the beginning of the twenty first century. Hence, for products such as lighting, the rate of aesthetic change is often far higher than the rate of technological change. In other cases, such as computer products and mobile communication and music products, the reverse may be true, at least until technological development reaches a point where it becomes relatively stable.

It becomes clear that, when the technology on which the product depends is in a rapid state of advancement, a primary driver for product replacement will be scientific progress and improved technological capability. In such cases, the designer's contribution in ameliorating the impacts of product change will be limited, unless that contribution is able to incorporate more systemic mass-production/service changes, such as design for modularity and incremental upgrading [10]. However, when the technology is relatively stable and replacement is likely to be for aesthetic reasons, the designer can play a much more significant role in ensuring that the product is designed in a manner that can be considered 'sustainable' through bottom-up change.

3. Design and Change

For a product to be 'sustainable', those factors that can directly or indirectly affect socio-economic equity and the natural environment must be carefully considered. One way to do this might be to create products that are long lasting [11], while utilising materials and manufacturing methods that reduce environmental burdens, and by ensuring their production offers good quality employment. However, designing technology-based products to last can create conflicts with the priorities of sustainability. For instance, our financial system demands brisk product turnover and continual product replacement to ensure a buoyant economy and to create and maintain jobs. In addition, even when the technology is relatively stable, designing products to last fails to acknowledge the relatively rapid changes that occur in aesthetics and taste. Moreover, products designed to last may eventually become less energy efficient compared with more recent versions and, if robust, built-to-last products are discarded anyway, in preference for ones with more up to date technologies or styles, then this approach to *design for sustainability* can be counterproductive. Hence, attempting to design long lasting technology-based products can generate a variety of negative environmental, social and economic consequences.

Another approach is to accept that technologies and product preferences continually change and to design accordingly. Designing for change requires an entirely different strategy, one that more fully recognises that products are temporary accumulations of materials that will eventually be discarded and replaced. This is not only a much more realistic way of looking at products but it also brings into focus the environmental and socio-economic factors related to our activities. Firstly, there are a range of environmental considerations associated with the design and specification of components, their manufacture, and their post-use implications. Creating products from a perspective that accepts the inevitability of change can help ensure that responsible, informed design specifications are developed. Secondly, a design process that acknowledges change can contribute to a system in which socio-economic development is characterised by the creation and continuation of rewarding employment opportunities; it implies an interdependent and continuous process of production, servicing and re-manufacture. Hence, the emphasis of such a product-service system is on product maintenance and upgrading at the local level, to contribute to environmental and social issues. This differs in emphasis from conventional definitions of product-service systems which focus on fulfilling user needs *via* marketable product-service combinations [12]. However, it is consistent with approaches in which product-service combinations are part of a larger ecodesign strategy involving infrastructure change and system innovation [13].

When designing products for change, the decisions made by the designer become especially critical. Every element added to the product, over and above those essential technological components that deliver the functionality, will have a range of environmental repercussions related to materials acquisition, energy use, shipping, and eventual disposal. Each additional manufacturing stage represents more energy use, waste and pollution, and each time materials are processed and combined to form product components they become increasingly complex and further removed from their natural state, making their recycling or disposal more problematic.

To contribute to sustainability, the designer has to consider how products can be developed so as to be environmentally and socio-economically responsible even though they are in a continuous process of change. Moreover, an essential ingredient of such a scenario is localisation and 'site-here to-sell-here' approaches [14]. Within such a scenario, the designer would be obliged to use local materials wherever possible, while recognising that sophisticated technological components may have to be mass-produced elsewhere. Emphasis on local markets and use of local materials reduces the need for shipping and packaging, and an integrated batch-production/servicing/re-manufacture approach would offer a diverse range of local enterprise opportunities. Hence, this *design for change* direction recognises the importance of localization along with mass-production. It is also in accord with developments in design for modularity and product upgrading, and contributes to product-service scenarios that allow functional goods to be maintained and adapted over time.

The implications of this kind of approach to product design are many and significant. They suggest a quite different way forward from the globalized mass-production methods that are currently dominant and which, on the whole, create a one way and highly damaging system of cradle-to-grave resource acquisition, production, consumption and disposal. The concepts presented here combine locally appropriate design with cradle-to-cradle approaches [15], product-service systems and creative communities [16], emerging enterprise models that recognize the diversity and heterogeneity of people's material needs, and the tremendous potential of distributed forms of creativity and innovation [17].

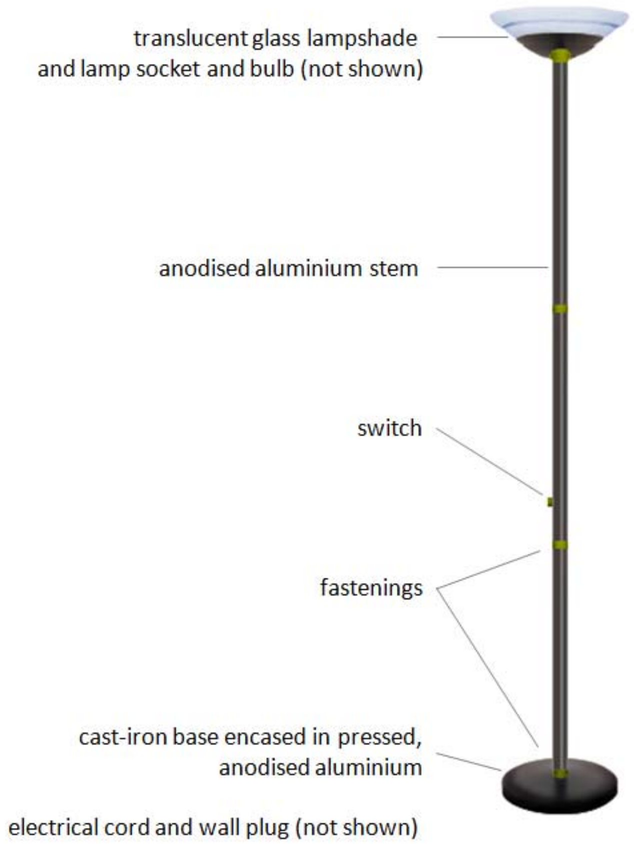
4. Design for Change

The progression from design intentions to designed object involves a process of transmutation that converts generalizations into specifics, and abstract or theoretical ideas into concrete manifestations. This creative process entails decisions about materials, processes, forms, connections and composition, all of which require particular deliberation when designing objects for change. It is best examined through an example because design decisions are always specific to an individual product outcome; these decisions can never be generalised. Moreover, when localisation becomes an important aspect of a product's creation, as is the case when considering issues of sustainability, the designer's decisions become related to locale and the regional context; this is an aspect of design that has become far less prominent within contemporary, globalised production systems. Therefore, a design approach that embraces localization for sustainability must enable products: to continuously evolve over time to accommodate changing needs and aesthetic preferences; to change and be upgraded as technologies advance; to be produced (in part), maintained and repaired at the local level; to benefit from a diversity of initiatives and design innovations that are sensitive to and pertinent to place [18] within a notion of 'multi local distributed economies [19].

The process of particularizing and defining is an inherent part of the activity of designing. This means that designing itself becomes an indispensable element of research that seeks to explore, reflect upon, manifest and advance our understandings of product design for sustainability. The priority in this type of design work is not about creating novel products that can fill a market need. Rather, it is concerned with imagining alternative paths forward, creating visions of what could be, and articulating tangible concepts that strive to comply, in all their aspects, with sustainable principles. In this present discussion, the vehicle for engaging in this kind of design process is a simple floor lamp for domestic use. Such a product requires *technological components* to provide the light and *design components* to enable the light to be presented in a suitable form. If we briefly consider how such a product might be typically designed within current mass-production systems, this will allow us to better understand how the examples developed here for sustainability and change differ from these more conventional approaches.

When a floor lamp, such as that shown in Figure 1, is designed so that it can be mass-produced for international markets, the designer will make assumptions about materials and processes that are pertinent to that context and these will guide how the design is developed. For example, the lamp may comprise a translucent glass lampshade, a cast-iron base encased in pressed, anodised aluminium, a stem of anodised aluminium, and a variety of fixtures and fittings. These, together with the electrical components might be flat-packed in a disassembled state for shipping to the market destination. Producing such a product entails a series of energy-intensive processes that include materials extraction, transportation and refinement followed by a variety of manufacturing stages that mould and shape the materials into components and sub-assemblies. Typically, the various parts of the lamp will be encased in sturdy packaging so that it arrives to the customer in pristine form.

Figure 1. Rendering of a 'Typical' mass-produced floor lamp.



In developing such a product, the designer can be located virtually anywhere in the world. The design, and each of its component parts, can be specified *via* a series of visualizations using a design and styling software package. And these specifications can be readily delivered to a manufacturer that might be located on another continent. In manufacturing such a product, materials will often have their origins in many different countries, all over the world [20]. Such practices have become the common currency of design for mass-production.

Let us now consider a process of design that adheres to the factors discussed earlier, including localisation and design-for-change. Such a process requires an understanding of context and place, a knowledge of local materials and skills, and an awareness of the potential impacts of production on both the environment and socio-economic development [21]. To explore the potential of such an approach, in the following concepts, the design criteria were tightly constrained. For those additional functional-aesthetic elements that are the particular concern of the product designer, these constraints were taken to something of an extreme:

- **The aim** was to develop a concept for a floor lamp that would be functionally effective, aesthetically attractive and appropriate for domestic use. The concept also had to be adaptable to change while remaining in continual use.
- **The technological components** were minimised and restricted to off-the-shelf parts obtainable from any local hardware store.
- **The design components,** *i.e.*, the functional-aesthetic elements defined by the designer, were also minimised and restricted to materials that were completely natural and local, or if not currently available locally, could be made so if such a design were to be batch manufactured. While the term 'local' has no strict geographical boundary, for the purposes of this exercise, it was assumed to be the area that lay within a few miles of the design studio. In converting the raw materials into product components, processing had to be either non-existent or kept to an absolute minimum. Fasteners were also restricted to natural materials, and constrained to temporary or semi-permanent connections, which would facilitate disassembly. These tight constraints would help ensure that detrimental environmental impacts associated with those aesthetic elements specified by the designer were virtually non-existent.

Bamboo & Stone I: In this floor lamp concept, Figure 2, the technological components comprise a compact fluorescent light bulb, a lamp socket, an in-line switch, a wall plug, and electrical cable. All these are off-the-shelf, mass-produced electrical parts that are suited to a wide range of applications.

In defining the additional, non-technological elements, an effort was made to choose materials that could be found as locally as possible to the design studio. This condition did not refer to materials that were simply *available* locally. Rather, the intention was to use materials that:

- either occurred naturally within the local environment
- or were currently, or could readily be, made locally.

Critically, and in contrast to the design for mass-production process referred to above, the process here was *not* one of designing the lamp with pre-conceived notions of materials and manufacturing stages in mind. Instead, observations were made of the immediate vicinity while contemplating the kinds of elements that might be used in the lamp. In addition, an effort was made to keep all processing to a minimum, thereby reducing energy use while simultaneously ensuring that the materials remained in, or close to, their raw, unadulterated state; this would allow them to be eventually returned to the natural environment without causing harm. Hence, through observing and becoming aware of locale and its naturally occurring elements, creative decisions become sensitive to context and to what a place can yield without injury.

Figure 2. 'Bamboo & Stone I', a floor lamp, 2009. Raw stone, unprocessed bamboo, rawhide, handmade paper, compact florescent lamp and off-the-shelf electrical parts.

The Lamp Stem: A variety of bamboo plants were found to be growing in the vicinity of the studio. Bamboo is a prolific, fast growing plant that would provide an appropriate and attractive means of creating the lamp's stem and it is a completely natural and renewable material. A length of black bamboo was selected, which was simply pruned from the living plant and trimmed, leaving a few branch stubs in place on which to hang the electrical cable.

The Lamp Base: Turning next to the heavy base needed to stabilise the stem, the simplest solution would be a raw stone of suitable size and form. Large natural stones in the immediate locale were inspected and one was chosen that suited the purpose. A small piece of felt made from recycled fabric was attached to the underside of the rock to protect wooden flooring. The inclusion of a specially selected stone in a mass-produced design would be entirely impractical. However, creating a local design for batch production and local use allows the incorporation of such materials. The natural differences between such unrefined elements mean that each product possesses its own particular characteristics. This creates aesthetic diversity even within the same design concept, fostering heterogeneity in material artefacts that is related to place; this contrasts markedly with the sweeping homogeneity that characterises so many contemporary 'global' products. In addition, if the designs are for local markets, then delivery of such products to their place of use is unproblematic and requires little or no packaging.

The Connection of Stem to Base: A fastening was sought that would not damage the stone or require significant amounts of energy to administer. Drilling a hole in the stone to accept the bamboo stem was therefore ruled out. A rigid tie would be a suitable solution, and it was decided to use un-tanned hide thongs (rawhide) for this purpose. This natural material is soaked in water before use until it is soft and pliable. It is tied in place and as it dries it shrinks and hardens to form a tight, rigid connection. Locally produced rawhide was unavailable. However, if the product were to be batch manufactured, this material could be readily produced from a variety of local stock raising activities. When applying this solution to the floor lamp design, a small length of green bamboo was inserted between the rock and the stem to ensure the latter stood at the desired angle. This was a simple way of overcoming the uneven surface qualities and erratic angles presented by the raw stone.

The Lampshade: This was fashioned from a piece of crumpled, rough-torn handmade paper. A pristine, smooth shade would be delicate and easily marred, so this deliberate wrinkling and tearing of the paper enhances its aesthetic durability. It was simply rolled into a cylinder and held in place with two slivers of bamboo.

In keeping with the earlier discussion, because the rates of change of the technological components will differ from those of the other elements, the lamp has been designed so that these two sets of components have only a loose connection, allowing them to be easily separated for purposes of repair, upgrading and change. The technological components are simply draped over the stem, with no permanent fixings and, because they are standard, off-the-shelf parts, they can be easily replaced when the need arises. All the other elements are completely natural, and processing has been kept to a minimum.

Bamboo & Stone II: The second example is a table light, Figure 3. Here, the light source is a small light emitting diode (LED), which has a relatively long useful life and consumes very little energy. However, light output from a single LED is considerably less than a typical compact fluorescent or incandescent bulb. While this constrains its practical application, the concept still serves to demonstrate the design principles at a different scale and using an alternative lighting technology. The non-electrical components are again bamboo, raw stone, and handmade paper, but instead of rawhide, a natural rubber band was used to connect the stem to the stone.

Figure 3. 'Bamboo & Stone II', a table light, 2009. Raw stone, unprocessed bamboo, rawhide, handmade paper, LED lamp and off-the-shelf electrical parts.

In both examples, the use and processing of materials to create the non-electrical parts are kept to an absolute minimum, Figure 4. As a consequence, these elements can eventually be returned to the natural environment or recycled with no detrimental effects. In both cases, the aim was to create an elegant and minimal lamp design by employing the least means possible. Almost all the materials were sourced locally; the exceptions being the rawhide thongs in the first example, which potentially could be produced locally, and the natural rubber band used in the second example. If such concepts were to be batch produced at the local level, the most suitable fastening materials from the immediate vicinity could be sourced.

Figure 4. Natural, minimally processed materials for 'Design Components'.

Figure 5. 'Box Sconce', 2009. Re-used cardboard, compact florescent lamp and off-the-shelf electrical parts.

Figure 6. 'Box Sconce' with old straw hat.

Figure 7. 'Box Sconce' with paper scroll.

Box Sconce: When the above lamps are no longer required, and the un-processed, natural components have been returned to the environment or recycled, we are still left with the technological elements. As these are electrical parts created for general use, rather than for a specific product, they can be very easily re-used in a completely different lighting design that, again, can be created for local production. An example of such a concept is the 'Box Sconce', the essential component for which is a simple cut-out of re-used, corrugated cardboard; this is folded along score lines and fitted with the electrical parts formerly used in the floor lamp design, Figure 5. It is then hung on a nail and covered, as in 'Box Sconce with Hat', Figure 6, or enveloped in paper, as in 'Box Sconce with Paper Scroll', Figure 7.

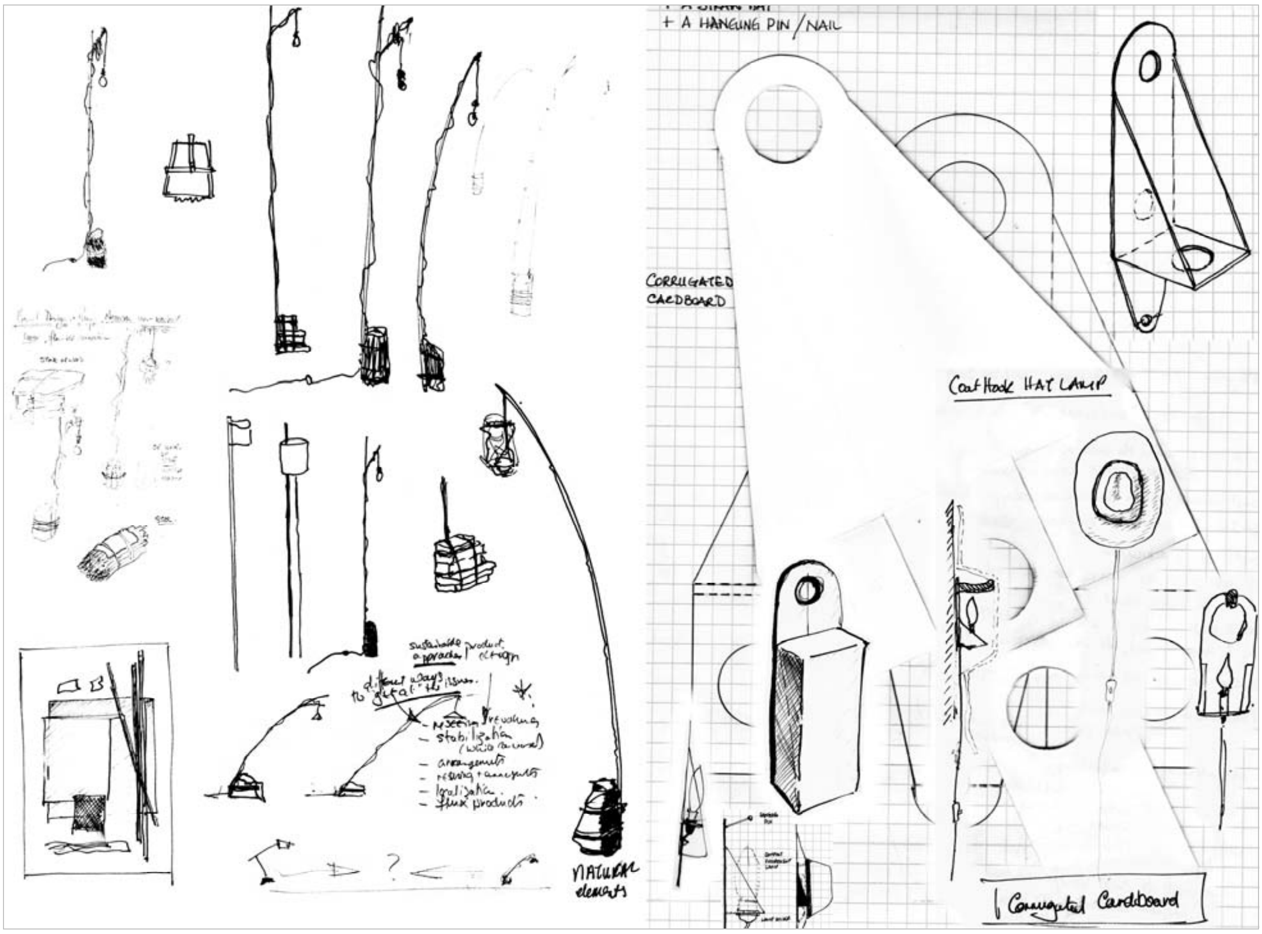
5. Reflections

In developing these concepts, an attempt has been made to combine the technological with the natural, the mass-produced with the local, and the simple with the sophisticated. This can be a difficult marriage of conflicting priorities and contrasting materials. However, the value of 'critical design objects' lies not so much in what they do or how they look, but in what they represent. Critical design employs the process of creating speculative propositions to question assumptions about the nature of functional goods [22]. Such objects represent attempts to transform issues of concern into tangible things, and in the process their implications are explored and encapsulated. Hence, the primary purpose of critical design is to examine issues, challenge conventions and contribute to new ways of thinking about and developing material culture. In this sense, critical design is concerned with strategic directions and systemic change. While it yields specific artefacts, conventional design priorities, such as functionality, ergonomics or market segment, are not necessarily significant factors. Instead, the object of design, which could be a lamp, a chair, a telephone, or any other kind of product, is principally a vehicle for exploring and expressing ideas about other issues. The object itself might remain notional and unrefined, yet it can still add to our understandings, and serve as a focus for reflection and a catalyst for change.

In the concepts presented here, the issues of concern include ideas about sustainability and design for change, and the interdependent worlds of local context and distant, globalised mass-production. The 'local' suggests familiarity, small-scale, adaptability and sensitivity to place. The 'global', in terms of production capability, offers precision, standardisation, and sophisticated, complex processes and materials; it is also 'removed', unfamiliar and, too often, its effects are highly damaging. We tend to pay a high price, environmentally and socially, as we move from the local to the global, but there can also be considerable gains for many in terms of material benefits and economic standards. While industrialization and international trade have transformed and improved lifestyles in all kinds of ways, as we increasingly comprehend their detrimental effects, it becomes important to develop new, rather different ways forward. These must not only acknowledge the advantages of technological progress and globalised production, but also afford greater prominence to the potential environmental and social gains that can evolve from localisation and context specific solutions [23]. The design concepts presented here represent a bringing together of local and global modes of manufacture to develop new more sustainable ways forward; they attempt to show a direction that can benefit and flourish from drawing on and integrating both. Of course, the precise nature of such an integration will be a continuous negotiation spanning local, regional, national and international scales of activity that encompass materials sourcing, production methods, supply chains, and product distribution, use and maintenance. However, the propositions developed here explore an approach for incorporating 'the local' in everyday consumer products and indicate the potential implications for design and product aesthetics.

It is also important to point out that the process of designing is not used to simply illustrate previously developed ideas. If the 'thinking and doing' design process is to contribute to our understandings, it has to be creative, not merely illustrative. In the explorations carried out here, the design process began with an idea to design a floor lamp, and to use this as a way of probing issues about design, change and sustainability. At the start of the exercise, no assumptions were made about materials-use or form, these emerged from making observations in the local environment. Through an iterative process of selection, trial and error, and sketching, the design took shape, Figure 8. In the process, forms emerged that depended on and were characterised by locally available materials. Completion of the floor lamp, 'Bamboo & Stone I', naturally led to the idea of trying the same principles at a different scale. In the second object, 'Bamboo & Stone II', lightness of touch was further accentuated. Slightly different materials (natural rubber) and a different lighting technology (LED) were used that were more suited to the smaller scale, and the low voltage technology allowed the use of bare wires rather than plastic coated wires, which helps reduce materials, eases recycling and maintains aesthetic lightness. Reflecting on these two objects in the context of the main thesis, *i.e.*, aesthetic change with technological constancy, led to the idea of using the same electrical components in a completely different—but equally 'light' and 'sustainable' design, which yielded the cardboard bracket that forms the basis of the 'Box Sconce' design, with lampshades made from a re-used straw hat or a paper scroll.

Figure 8. Development sketches and study model.



Hence, the process was one of discovery, which took unpredictable turns and directions. Each step is sparked by what went before, which is how the creative process develops and evolves. However, while such a process involves chance, it is based on more than serendipity. Chance connections and relationships occur to the designer within an immersive process in which the 'doing' of design takes place in conjunction with thinking about and researching issues of concern. This symbiotic process of thinking-and-doing enables the *thinking about issues of concern* to inform the 'doing', and the *doing and reflecting on the processes and outcomes of doing* to inform one's understanding of the issues and their design implications. Lastly, these explorations are less concerned with design as a process of problem solving and much more about design as a positive, creative process of exploring opportunities and developing desirable and conscionable ways forward.

6. Evolving an Integrated Production System

Such a direction, which includes locally appropriate design, cradle-to-cradle and product-service approaches, and more distributed forms of creativity and innovation, as discussed earlier, are capable of minimizing resource use and waste while also recognising the important benefits of technological advance. This is shown in Table 1, which indicates the potential providence of each of the temporal objects' components. Waste from consumer products can be drastically reduced by adopting a design approach that facilitates: re-use of components in subsequent designs; the benign return of components to the environment through use of completely natural, no- or low-processed materials; and/or ease of recycling by ensuring the components are made from minimally processed, single type materials.

Table 1. 'Sustainable' characteristics of temporal object concepts.

TEMPORAL OBJECT	**Technological Components**	**Future Potential of Technological Components**	**Design Components**	**Future Potential of Aesthetic Components**
FLOOR LAMP **Bamboo & Stone 1**	Off-the-shelf electrical parts	Readily re-usable in another design	Unprocessed natural materials: stone, bamboo, hide Handmade paper	Return to natural environment with no detrimental effect Recycle
TABLE LAMP **Bamboo & Stone 2**	Off-the-shelf electrical parts	Readily re-usable in another design	Unprocessed natural materials: stone, bamboo. Natural rubber band Handmade paper	Return to natural environment with no detrimental effect Re-use in another application or recycle Recycle
WALL LAMP **'Box Sconce'**	Off-the-shelf electrical parts	Readily re-usable in another design	Re-used cardboard Handmade paper Re-used straw hat	Recycle Recycle Re-use in original application

Table 2 demonstrates product transitions over time for the concepts developed here. Starting with the 'Bamboo & Stone I' floor lamp (Column 1), this object undergoes a *maintenance* transition (Column 2) in which the paper shade is replaced. The next transition is a *design* update to a Box Sconce (Column 3) in which the *design components* are replaced, but all the technological parts are re-used. The final transition is a *technology* update based on a change to LED components (Column 4). At each transition, the added and discarded components are indicated. These transitions result in a total of nine components being discarded. Three of these—stone, bamboo and rawhide, are natural, unprocessed materials that can be returned to the environment with no ill effect, three are paper-based that can be easily recycled, and three are general-use electrical components that can be easily re-used. By comparison, discarding three complete lighting products over the same period, such as the example in Figure 1 which contains 10 major parts, would result in approximately 30 assembled parts being sent to landfill. Hence, the concepts presented here, which are intentionally designed to accommodate change over time, result in a ca. 70% reduction in discarded components and, potentially, close to 100% reduction in parts that would normally be sent to landfill.

Table 2. Temporal objects—product transitions over time.

1	2	3	4
			
Floor Lamp Bamboo & Stone I	**Update: Maintenance replace Shade**	**Update: Design to Box Sconce with Scroll**	**Update: Technology to LED Light Array**
Design Components Paper Shade Bamboo Stem Small Bamboo parts Rawhide Natural Stone	*Added Components* Paper Shade 2	*Added Components* Paper Scroll Shade Cardboard Bracket 1	*Added Components* Cardboard Bracket 2
Technological Components Compact Fluorescent Bulb Lamp Socket In-line Switch Wall Plug Electrical Cord			Transformer LED Lamp Socket LED Lamp Array
	Discarded Components Paper Shade	*Discarded Components* Paper Shade 2 Bamboo Stem Small Bamboo parts Rawhide Natural Stone	*Discarded Components* Cardboard Bracket 1 Lamp Socket Compact Fluorescent Bulb

A system that integrates mass-production with complementary local production and services, for design, repair and upgrading, would mean significant change in our notions of business enterprise. It suggests a shift away from the mass-production and global distribution of complete products, and greater emphasis on mass-produced parts and modular formats that allow components to be used and re-used in a variety of locally or regionally defined applications. It also suggests a production-service relationship in which effective supply chains are developed between large scale component producers and local scale enterprises. A local manufacture-plus-service model would allow products to be continually adapted to changing needs and could create constructive, long term relationships between customers, local enterprises and large scale producers. Such significant, systemic changes are consistent with research in ecological economics [24] as well emergent research in design that addresses the environmental and social concerns of sustainability, including post-materialism, [25], significant social and technical change, with an expanding role for design [26], and major, systemic, structural change [27].

Perhaps more importantly, such a system would more explicitly recognise the transitory nature of material culture. This recognition, within an integrated production-service system that embraces localisation, suggests a way forward in which:

- care for the autochthonous environment becomes innate. As a matter of course, natural materials extracted from the vicinity would be used and re-used prudently and intelligently because to do otherwise would be to degrade one's own local surroundings;
- creative, productive work becomes more strongly connected to local community, culture and identity while simultaneously recognising the value of larger-scale, 'global' contributions. This would help foster practices that not only benefit from distributed, context-appropriate innovation and enterprise, but would also be *significant* to those involved. And, of course, a sense of significance can give meaning and joy to our endeavours [28,29].

In these ways, social equity and justice, cultural significance, personal identity, environmental responsibility and economic viability all become embedded, mutually dependent facets within a diverse, democratised approach to the production and continual re-articulation of material culture. Such a system would support an ethos of responsible use, in which the discarding of materials would be seen as inefficient, harmful and wasteful. Moreover, local manufacturing and services would allow people to better understand the nature of their material products, where they come from, how they are made, their repercussions, and how they can be adapted and re-adapted to meet changing needs.

This direction combines bottom-up initiatives with corporate, top-down supply chains capable of providing sophisticated technologies that would be beyond the capacity of small, local businesses. It is also consistent with democratised forms of design and innovation. The availability of suitable off-the-shelf parts is equivalent to what von Hippel calls 'toolkits'—produced by manufacturers to enable non-specialists to create custom products that meet their needs [30]. A responsible integration of global and local means that the benefits of both scales can be drawn upon for delivering context-appropriate, sustainable solutions. In doing so, they would help overcome the homogeneity and cultural erosion that occurs from globalised, one-size-fits all solutions [31,32]. While such a direction might conflict with prevailing business forces and conventional practices, it is in accord with initiatives that foster socially and environmentally responsible developments—from service systems and community initiatives to microfinance banking. Hamel refers to such organisations and social systems as 'positive deviants' and sees them as key elements of the future of business management and of strategic change [33]. In contributing to the development of such a direction, international corporations would benefit from the plethora of creativity and cultural diversity that occurs at the grass-roots level, which could inform context-specific solutions in other locales. Moreover, greater acknowledgement of localisation can actually strengthen the economy [34] while ensuring that production practices comply with endemic employment and environmental legislation. Hence, such practices begin to *internalise* many of the socio-economic and environmental ramifications of product production, use and after-use processing. Finally, an economy based on multifarious, locally appropriate production and service enterprises linked to a supply of technologically sophisticated components would be intrinsically diverse and therefore more robust than the rather homogenous, globalised, product manufacturing approaches that are so prevalent today; mono-cultures tend to be inherently vulnerable and unstable.

Therefore, in all respects, it seems that ‘temporal objects’ capable of continual adaptation *via* an integrated, responsible local-global system—exemplified here through a variety of simple lighting concepts—can be judged ‘sustainable’. However, the question remains as to whether it is possible to apply such approaches to the huge variety of short-lived products that are dependent on rapidly advancing technologies and which have become so essential to modern lifestyles and modern economies.

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