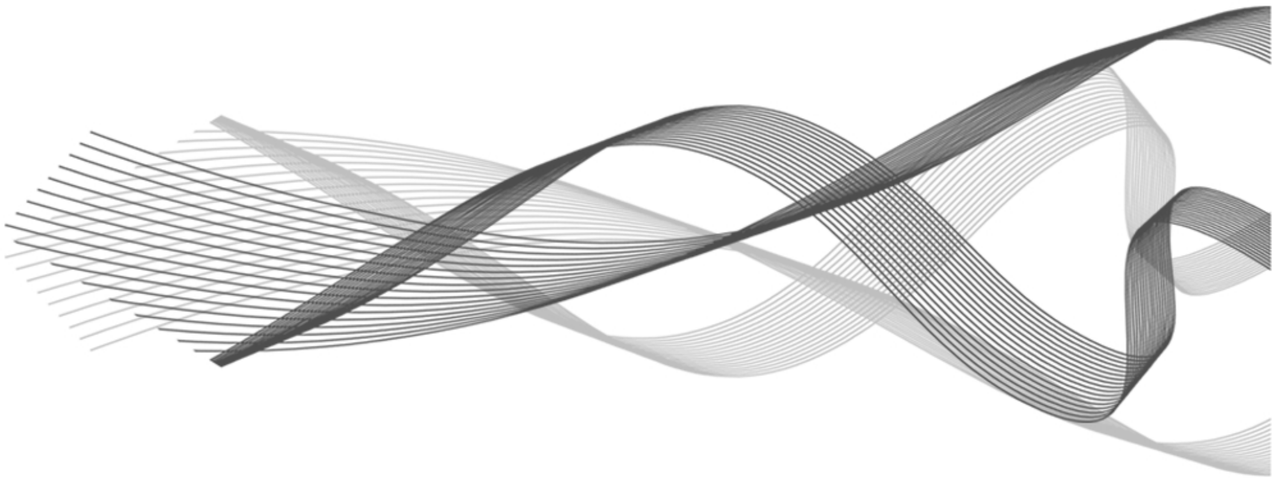
Flow

a case study in integrating sustainability values with affective design



Master of Design Essay | 197.800 | Massey University Wellington
A written component in partial fulfillment of the requirements for the degree of Master of Design at Massey Uiversity, College of Creative Arts.

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Abstract

This research integrates affective design strategies with sustainability values in the context of a soft seating furniture design solution. Rejecting polyurethane foam cushioning, the research proposes a conceptual and material alternative to the conventions of soft seating. A full-scale prototype demonstrates the fusion of ethical integrity and dynamic form, explored through an innovative and iterative design process.

Keywords:
affective design, desirable, product experience, soft seating furniture, sustainability, bamboo

Acknowledgements

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My gratitude to my fellow cohort of Masters candidates, for your camaraderie and good humour; thank you. I also wish to acknowledge the Massey University's IDIE 3D workshop staff for your assistance in prototype construction along with assistance from the Fashion department's pattern making technicians. I also wish to acknowledge the staff at Hunza Productions for being part of this journey.

My sincere appreciation goes out to my family for the financial, moral and spiritual support. Your prayers and concern have been empowering.

A special thank you to my beautiful wife Dana and our precious son Caleb, who joined us during the course of this study. You have both been incredibly generous in accompanying me along this adventure. I am humbled to have you at my side and love you both dearly.

This document is dedicated in loving memory of my Poppa, Dave Benge and Grannie, Cathy Paton who both went home to be with the Lord in 2010.

Document overview

Instructions to the Reader

Hello and welcome to my Master of Design essay. This document provides background and context to my research, situating it within a body of work by scholars and practitioners who hold a concern in my field of inquiry. Discussion includes the approach taken to the research, contemporary theoretical discourse and models for sustainability and affective design, acknowledgement of sources of design inspiration, my creative response to those stimuli and reflection on the processes undertaken. This project is firmly couched in the belief that design is a valid and rewarding mode of research inquiry.

The document is written in first person voice, as the research has been a personal search for an approach to design that brings a sense of fulfilment and integrity. A Case Study methodology has been employed, with the goal that this project may provide a personally relevant process template for engaging with future design projects.

A List of Figures appears after the main body of text and before the Bibliography. Image credits are listed subsequently.

Referencing within this document has been laid out using footnotes in accordance with the 16th edition of the Chicago style. The intention behind using this style is to provide citation where needed, without disrupting the flow of the text. The footnotes progress in ascending numeric order, with a corresponding reference placed at the bottom of the page on which the footnote appears within the text. The footnote includes a condensed form of citation, featuring the author's surname, publication title and page reference (if appropriate). A full bibliography is included at the end of the main body of text, containing full references plus sources that have influenced the direction of this study without necessarily being directly referred to.

To assist in defining terms distinctive to this research, a glossary has been included ahead of the main body of text. Terms that feature in the glossary are indicated by an asterisk after the word the first time they appear within the main body of text. For example: The off-gassing* of these compounds from furniture…

Glossary of terms

Affective design: a relatively new field of design research concerned with how a person relates emotionally with a product throughout a user experience. This is typically a result of cognitive processing of sensory stimulation, and addresses questions such as: ‘What feelings does the product elicit?’ and ‘What associations are made to the product?’

Bio-accumulate: the absorption of a substance, such as pesticide chemicals, at a rate greater than an organism or ecosystem is capable of breaking down and removing it. This can be problematic if the substance poses health risks.

Biological Nutrient: A material derived from organic sources that can be broken down and absorbed into a biospheric food chain without detrimental effect. For example; wool.

Carcinogen: a substance or agent that can cause cancer.

Ecosystem services: provisions that nature supplies for free to society, including holding our soil, regulating water flow, cleaning our air and our water, and recycling nutrients so that ecosystems can remain productive. These are the result of complex interactions between living organisms and cycles from the atmosphere, biosphere, lithosphere and hydrosphere.

Off-gassing: the release of compounds or fine air- borne particles into the atmosphere by chemical degradation. Can lead to a reduction in air quality, particularly indoors and in enclosed environments leading to respiratory related illness and general physical discomfort.

Product architecture: the configuration and interaction of components within an assembled three- dimensional product.

Technical Nutrient: A material from the lithosphere that can be used and recycled in a perpetual closed cycle. For example; aluminium.

Ecology and the environmental equilibrium are the basic underpinnings of all human life on Earth; there can be neither life nor human culture without it. Design is concerned with the development of products, tools, machines, artefacts and other devices, and this activity has a profound and direct influence on ecology. The design response must be positive and *unifying*. Design must be the bridge between human needs, culture and ecology.

Victor Papanek [1]

[1] Papanek, *The Green Imperative*, p. 29. Italics included in original text.

Getting into the flow

My research is fascinated with the way in which design can be used as a tool to elicit desire for three- dimensional products that seek to form the bridge of integrated sustainability values hailed by Papanek in the above quote. This research is born of an aspiration to gain a sense of significance from the work I do, along with a personal awakening to the importance of engaging with the sustainability discourse as a design practitioner. While compelled to create objects that make people's lives better, the nagging question of 'by what measure?' remained. What values do I wish to support and embody in the objects I create? What assumptions are embedded in the choices of product architectures* and materials (if required) I develop? What sort of impact will these decisions have on the environmental equilibrium I am part of, along with the enduring physical, cultural and economic health of my global community?

When embarking upon this course of study I wanted to explore the sustainability discourse as it relates to my field of Industrial Design. At the same time I suspected that promoting an object on moral grounds alone would not ensure its wide adoption. This is particularly so if it fails to align with the user's pre-defined aesthetic sensibilities or performance expectations. So, an aim of this study is to create an object that ticks the ethical, the aesthetic and the performance boxes.

This process of personal discovery is set within the rhythmic flow of creative design intervention and critical reflection. Reduction of an object to its essence, coupled with simultaneous investigation of dynamic and engaging ways to re-present those core traits give rise to the design outcomes discussed within this essay.

By identifying and collecting threads from the multiple facets of sustainability discourse, I seek to comprehend the design implications of what is discovered. Concurrent to this, a process of reviewing design theory with regard to user experience and the way a product is encountered and understood provides a theoretical construct for weaving together a design response.

Figure 1: Sprout Couch by Readymade Magazine: the ultimate in green furniture?

Research Proposition

The premise to this research is that the emergent field of affective design, also referred to as 'design for desirability',[2 3] can be a successful means of fostering engagement with sustainability principles. Indeed, it is proposed that Affective Design and Design for Sustainability are inherently complimentary design objectives, which, when combined in a design process, can enhance aesthetic differentiation and affirm ethical integrity throughout a product experience. To test this theory a case study has been embarked upon, based on the design of a prototype 'soft' seat.

The soft seating furniture industry has been chosen as the focus of this study because their products are widely recognised furnishing our daily lives. As will be discussed, this is an example of an established, relatively low-tech industry with entrenched conventions for how a product should function and be made. It is generally not an industry that has engaged with design innovation or sustainability, although there are exceptions that will also be discussed.

Figure 2: The LC2 Grand Confort chair by Le Corbusier, 1928; a modernist design classic and archetypal soft seat with exposed rigid frame, foam padding and an upholstered leather cushion.

Figure 3: Naked Confort by John Angelo Benson, 2003, presents a parody on the LC2 chair by questioning whether the modernist's ideal of truth to materials was fully adhered to in the original.

[2] Warell, *Visual Experience*, p. 1
[3] Demirbilek & Sener, *Product Design*, p. 1347

Research approach

The Case Study has been selected as an appropriate research methodology for this project due to a twofold strength it offers, as proposed in Yin's seminal work: *Case Study Research: Design and Methods* (2009). Firstly, considering the scope- "the case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within it's real-life context, especially when the boundaries between phenomenon and context are not clearly evident".[4] Primarily the focus is on the questions "How" and "Why?" Secondly, "this methodology copes well with multiple points of interest, relies on multiple sources of evidence, with data needing to converge in a triangulating fashion".[5] There is opportunity for amalgamation of data and evaluation of the outcome against the research question.

This methodology ties in well with the open funnel type of analogy presented by Rhea,[6] which describes the flow of information gathering and 'sense making' throughout a design project. (See figure 4) Applying such an analogy to this project, stimuli and design inspiration are collected in an ever broadening sweep of the factors and contexts that influence the design of a piece of furniture. This divergence can be considered research for design, and the result of this includes a set of design criteria to help guide and screen subsequent activities. A subsequent convergent process, using design as a research tool, draws together the ideas into a design response to the research question.

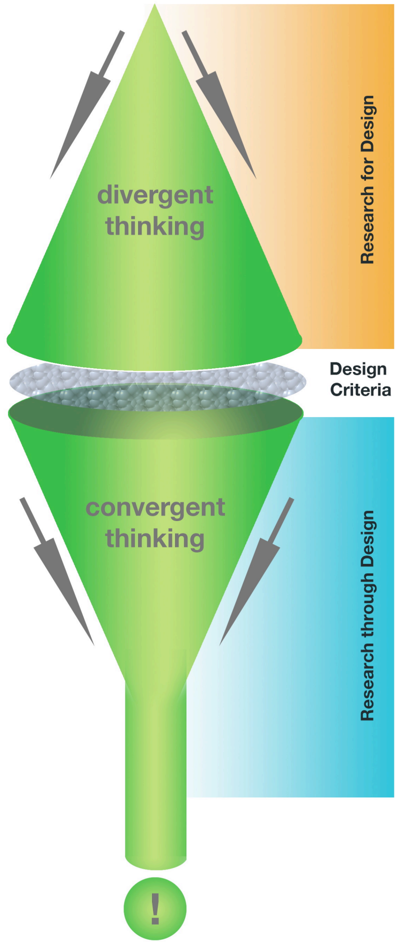


Figure 4: The design process as a dual funnel analogy, allowing contexts and criteria to be established for product idea generation and development screening

[4] Yin, *Case Study Research*, p. 18
[5] Yin, *Case Study Research*, p. 18
[6] Laurel, *Design Research*, p. 143

Without any previous design experience with this type of product, I undertook an immersive research process of observation, informal discussions with stakeholders, literature review and material exploration, with the intention of gaining insight and familiarity with the materials, assembly processes, use and lifecycle of a soft seat. As will be discussed, rich opportunities for innovation emerged from this process of research for design.

Insights gathered through this immersive approach were combined with reviewed theory on sustainability and affective design to establish criteria through which ideas could be filtered and concepts critiqued. These criteria fall under two categories: Performance and Experience.

In subsequent design activity I sought to work within these newly established guidelines, while allowing materials to express their natural characteristics, forms to evolve through iterative experimentation and product architectures to assemble from fusions of ideas birthed during the research for design phase.

As depicted in figure 5, it is hoped that the output of this study is a desirable, sustainable object that can stand on it's own. As such, it can be referenced for future design projects.

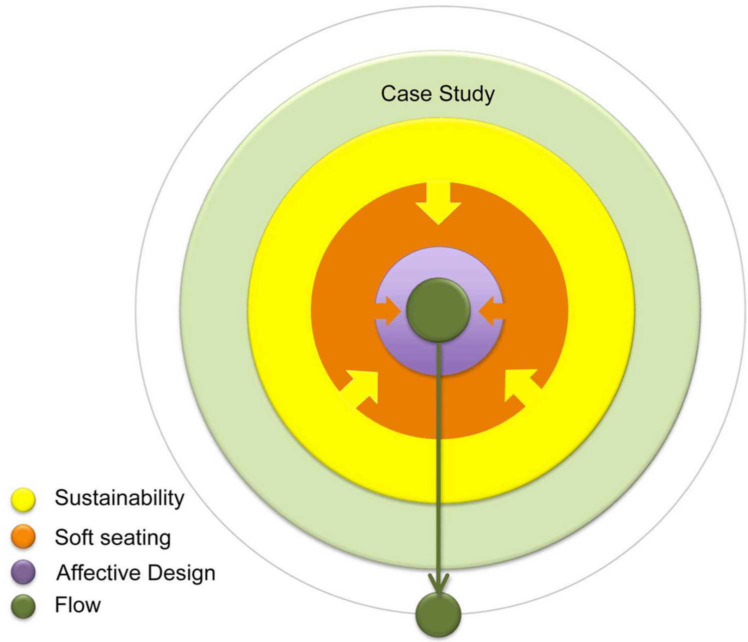


Figure 5: Hierarchy of content within this Case Study

Sustaining flow

This case study is titled *Flow* for multiple reasons. It recognises that design interventions have flow on effects on culture, on economies and on natural systems in which we live. A state of fluidity has been required to facilitate the intersection of these multiple currents of design impact. Acknowledging and accommodating one another's requirements and limits forms the rhythm for this dialogue.

Sustenance, the essential support of life, is one of these currents of inquiry. What are the parameters for sustaining the ecological health of our planet while processing materials for human use? How do these shape sustaining values for a career in design and what ethical guidance do they provide? These are considered through the design of a seat, an object created to sustain or support a person's body in a moment of rest. The object that is the outcome of this study is therefore an embodiment of this theme in more ways that one.

To define the parameters of something that can be sustained is to question behaviours and their effects. 'Sustainability' is defined for this research with reference to the United Nation's 1987 Brundtland Report. This landmark document calls for human economic endeavour to be "*meeting the needs of the present without compromising the ability of future generations to meet their own needs*."[7]

It is within this spirit of stewardship that a working definition for sustainability within this project has been established as: *A symbiotic process in which the ingredients necessary for an action and the effects of that action are mutually beneficial.*

[7] United Nations, *World Commission on Environment and Development*, p. 1 (Italics added)

The ethical awakening of society to the finitude and fragility of ecosystem services* available to support present human activity and growth, and how we as a society are going to respond lies at the crux of the sustainability discourse.[8] *The Natural Step* funnel, shown in Figure 6, presents a basic scenario of two simultaneous yet opposing linear trends; one of decreasing natural capital through wasteful resource use, and the other; increasing human demand for resources through population growth and consumption habits.[9]

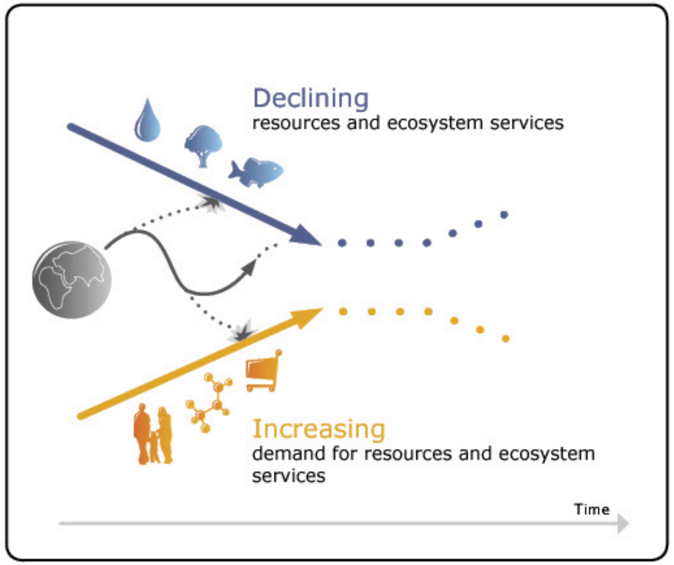


Figure 6: The Natural Step illustration of the dangers of maintaining current trends in consumption of natural capital

[8] Washington, *Embedding 'Sustainability'*
[9] The Natural Step, *The Natural Step Framework Guidebook*, p. 2

It is argued that without the provision of our planet's ecosystem services including fresh air, clean water in regulated volumes, secure and regularly enriched soils then human society, including our cultural and economic systems, become destabilised and can not be sustained.[10] As creators of 'things' that shape our material culture and fuel our economic systems, the design community is fundamentally implicated in this discourse. The fact that designers rely upon physical materials sourced from our planet's finite stores makes it a discussion that we must engage in with an ecological, social and economic perspective. The challenge is a complex balancing act of values and priorities.

Critics of western consumption models cite the prevalent anthropocentric[11][12] and increasingly urbanised worldview[13] as a major contributing factor to the disproportionate and dysfunctional relationship man has with our natural world.[14] Drawing attention to this dichotomy presents a design opportunity within this study in ways that seek to reacquaint users with the origins and destiny of the seat they rest upon: our planet Earth.

[10] Papanek, *Green Imperative*, p. 20
[11] Leiserowitz & Fernandez, *Towards a New Consciousness*, p. 18
[12] Stegall, *Designing for Sustainability*, p. 60
[13] Thorpe, *The Designer's Atlas to Sustainability*, p. 170
[14] Washington, *Embedding 'Sustainability'*

As questions arise around what the impact of Western culture's insatiable consumption habits may be, a systems overview that recognises people and our products as part of a bigger whole becomes critical to understand.[15] Accounting for the flow of energy and material resource throughout a product's life cycle and what their impact is on ecosystem services is therefore a central sustainability consideration in this Case Study.

Figure 7 illustrates this flow, which may be linear (with items disregarded at the retirement stage) or looped (with items captured in a cycle of recovery and value retention). This illustration will be revisited as I discuss the state of the art with soft seating.

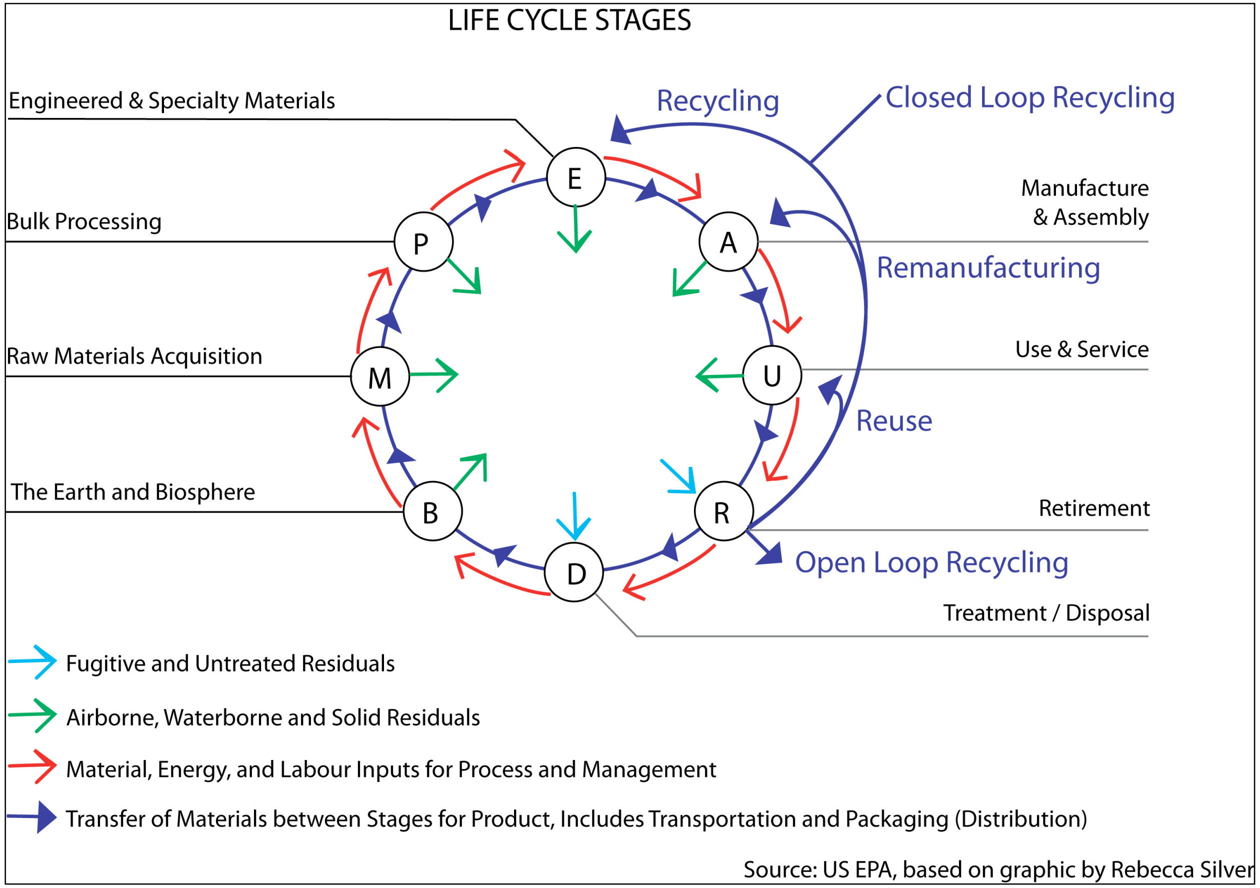


Figure 7: The life cycle overview for manufactured goods.

[15] Allen, *Life Cycle Thinking*, p. 69

To expand on the cyclical illustration presented in Figure 7, McDonough & Braungart[16] propose that the materials and processes utilsed to create, use and retire products should be considered as a form of 'bio-mimicry', operating within perpetual 'closed loops' as seen in the ecosphere. Biodegradable (or otherwise degradable) materials that are derived from the biosphere present no immediate or enduring harm to natural systems, so are deemed appropriate for consumable products as they return to the biosphere as nutrients for life after use. In the soft seating industry this could include consumables like natural fibre upholstery coverings, provided they have not been compromised with toxic chemical treatments during manufacture.

The second mode of materials within the Cradle to Cradle paradigm are referred to as '*Technical nutrients*', which include valuable minerals and petroleum based synthetics that can be processed within a closed loop of continual manufacture, recovery and reuse. Ideologically, these materials can be converted into the same thing again. In reality, the materials are frequently down-cycled to a lesser-quality second life material due to contaminants.[17] Design for disassembly is a critical consideration to help facilitate the efficient recovery of materials. This cycle demands a rethinking of goods as being a means of service, where the user benefits from the function of the object but does not own the physical materials. Conversely, the emphasis placed upon reuse of materials without a true account of the energy resources and infrastructure required to facilitate such ideals is problematic.[18] This is particularly evident in light of the complex global nature of existing supply and distribution chains that dilute material concentrations. [19]

Figure 8: An example of a Biological nutrient: Terra! lawn furniture by Nucleo (2005) utilizes biodegradable cardboard and soil to form an outdoor chair.

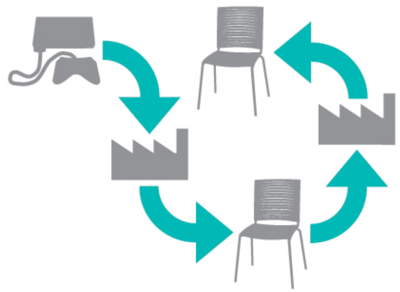


Figure 9: An example of a Technical nutrient: The Reee Chair by British company Pli, (2008) which utilizes plastic salvaged from old Play Station consoles to create flexible slats. A product stewardship program ensures the manufacturer retrieves used chairs at the end of their useful life and reconverts them into new chairs.

16 McDonough and Braungart, *Cradle to Cradle*
17 Thorpe, *The Designer's Atlas to Sustainability*, 42

18 van der Lugt, *Design Interventions for Stimulating Bamboo Commercialization*, p. 5
19 Thorpe, *The Designer's Atlas to Sustainability*,, pp. 44- 45

Materials or compounds that fit neither of the two nutrient cycles presented need to be avoided or phased out.

Figure 10: A monument to Western lifestyle receiving another offering: an unwanted couch being thrown into an open landfill.

While 'sustainability' awareness has grown within the design community in recent years,[20] commentators observe that a confused variety of definitions, strategies and jargon associated with the term exist.[21] [22] While attempting to establish a baseline understanding for this project, I experienced confusion first-hand with each new perspective I encountered! This sense of being overwhelmed by the seemingly disparate foci and approaches of different commentators[23] also lead to the inevitable dose of what Dr. Michael Braungart refers to as 'guilt management' around being less bad.[24] Braungart's colleague William McDonough also observes the negative overtones of much of the sustainability discourse 'as our culture tortures itself now with tyrannies and concerns over limits and fear'.[25] The widely publicised mantra of 'reduce, reuse and recycle' places emphasis upon increasing efficiency and endurance of a design without necessarily questioning the effectiveness of the design in the first place.[26] [27] This realisation shaped my determination to approach the research- through- design phase of this study with a positive new mantra: re-think!

In this Case Study sustainability is deliberately considered an aspirational goal. It encompasses pursuit of enduring prosperity in a triumvirate of environmental, social and economic measures known as the 'triple bottom line'.[28] Considered design choices about materials and the context of how they are obtained, assembled, used and retired during the furniture's life fuel this pursuit. Systemic integrity, featuring accountability for the impact of design decisions throughout the furniture's lifecycle, is gauged across the triple bottom line.

[20] Stegall, *Designing for Sustainability*, p. 56
[21] Robèrt *et al*, *Strategic Sustainable Development*, p. 197
[22] Salmon & Jones, *Who cares about Greenwashing?*, p. 9
[23] Waage, *Re-considering Product Design*, p. 640

[24] Braungart, *The Wisdom of Designing Cradle to Cradle*
[25] McDonough, *William McDonough on Cradle to Cradle*
[26] Braungart, *The Wisdom of Designing Cradle to Cradle*
[27] van Hinte, *Eternally Yours*
[28] Sustainable Business Network, *Your Business and the Triple Bottom Line*

Tradition and the innovative flow

As I will discuss, the industry covered in this case study is ripe for design innovation, with a typical soft seating solution incorporating a multitude of materials and chemicals that are inherently unsustainable. Designing out of the problem appeals as the approach richest in opportunity, particularly when the design phase has influence over 60-80% of the environmental and social impact of the object during its life cycle.[29 30] Well-intentioned yet reactionary attempts to reduce negative side effects from a specified process or component, (for example, replacing a known neurotoxic flame retardant used on upholstery with a non-toxic version) contrasts sharply with a pre-emptive questioning 'is this original action even necessary? Is it the best option we have?' (What if there was no need for flame-retardants at all? Could alternative materials be specified and configured so that the seat did not provide an opportunity for combustion?) The graph in figure 11 to the right illustrates the performance benefit of this second approach in terms of environmental improvement factor.

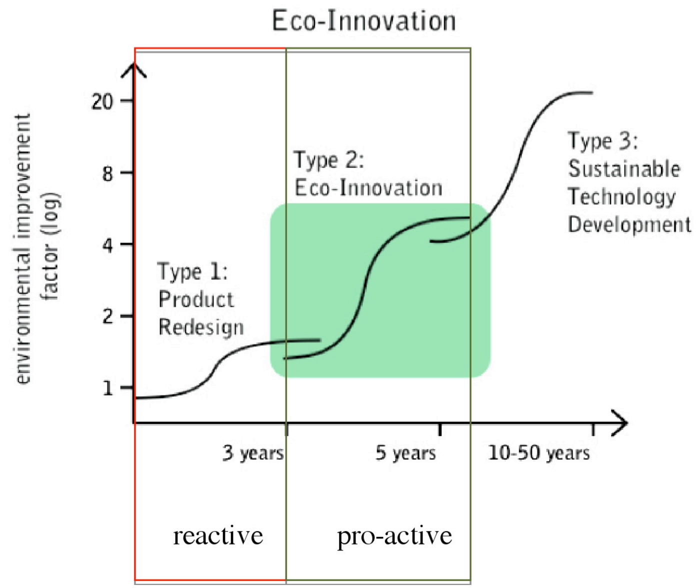


Figure 11: The opportunity for significant improvements in sustainability goals held by proactive design innovation (Type 2) over reactive product redesign (Type 1) approaches.

[29] Ottman, *Design: Green*, p. 8
[30] Waage, *Reconsidering Product Design*, p. 639

To gain perspective on the implications of the sustainability parameters thus distilled and identify opportunities for innovation, it is valuable to discuss the state of the soft seating industry, as it exists at the time of this Case Study. Analysis reveals that the majority of seats on the market conform to conventions of soft seating, i.e. seeking maximum body support 'comfort' (see item 4 in the chart below) within familiar material and product architectures. This contrasts with the low volume artisan interpretations of seating that experiment with form and material, making statements about possible alternatives.

Figure 12: Bipolar representational cross section of soft seating products displaying a divergence of emphasis between functionalism and ideology. The seats featuring on this chart are introduced in detail in Appendix 1

While artisanal 'designer' seats offer alternative views on the possibilities for how a seat could be considered and is the direction this project is destined, it is valuable to discuss the state of the art in commercial soft seating as this is the baseline against which this case study can be measured.

The basic product architecture* of a contemporary padded seat and the methods/ processes used in it's construction in New Zealand are discussed in this case study, as information was gathered from first hand observation and interviews with those in the industry. Based on reviewed literature, it is believed that the materials and processes are not dissimilar from those used in other countries and should have universal relevance.[31]

[31] van Hinte, *Eternally Yours*, p. 54

To start with, the typical components used to build a soft seat include:

1. A structural frame in either timber (glued and screwed) or metal (welded or bolted together), or an amalgam of the two.
2. Fabric Webbing: provides structure to mount springs over.
3. Burlap: acts as a protective barrier for spring assembly.
4. Padded layer: can be various soft compressible materials. The left hand chair below features cotton wadding, the right hand chair; open- cell polyurethane foam.
5. Steel coil springs, secured in place by clip and hand tied cord. These exist to provide resilient elastic response to compression forces.
6. Upholstery fabric or leather: secured in place with glue and/ or staple

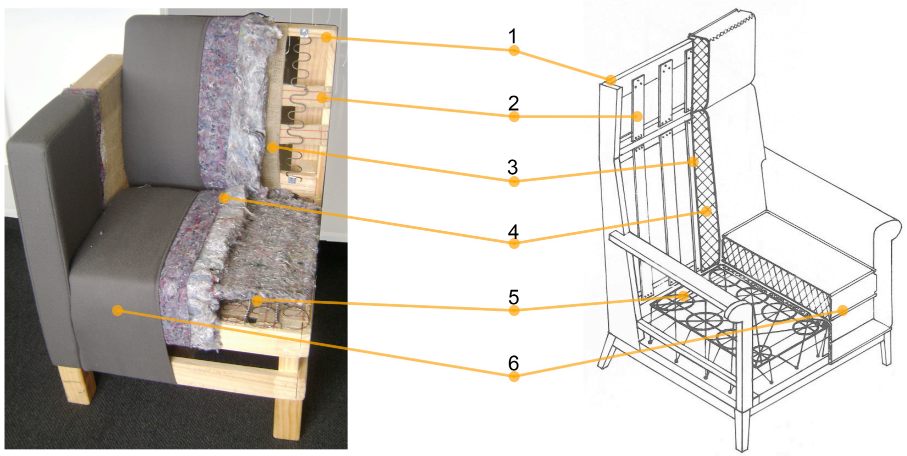


Figure 13: Cross section of a typical soft seat, revealing component parts.

Figure 14: Typical soft seating configurations from commercial suppliers do not deviate far from rectilinear and geometric forms.

A browse of various New Zealand- based commercial soft seating supplier's product ranges reveals that the product architecture described above does not alter very much between suppliers. The predominant form is that of a rectilinear geometric volume.

It has been concluded that three fundamental elements of 1: structure, 2: cushioning and 3: covering surface are present in the archetypes of a single seater, ottoman, bench seat and multiple seater.

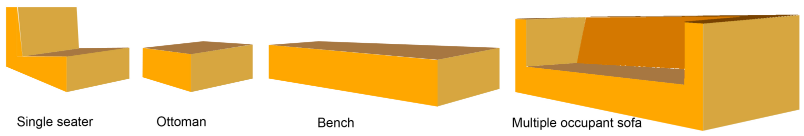


Figure 15: Archetypal configurations of a mass-produced soft seat.

Upholstery fabric typically encloses the cushioning and structural elements, providing a visually unified whole. The monolithic structure becomes a single volume, an object. At the same time this fabric skin creates a sense of mystery around what is contained within. This basic architecture is firmly entrenched in the market.[32] As will be discussed, there has been iterative development of the materials utilised, particularly in the cushioning element, but no significant innovations in recent times.

[32] van Hinte, *Undercover*, p. 54

In order to gain insight into how these materials are physically put together and identify possibilities for innovation a site visit to a small-scale (5- 49 employees) manufacturer based in Lower Hutt, New Zealand was conducted, along with informal interviews with staff. This family owned business has been serving its local community since 1982 and specializes in custom making upholstered chairs and sofa to order. It is a typical scale business for the industry in New Zealand.[33] The mass-customised business model is responsive to user needs, helping ensure that the product they receive will be not only fit for purpose, but in accordance with aesthetic preference. The artisan skills of upholstery are supported through trade apprenticeships within the company. Unfortunately the industry in general is experiencing a death of these skills through cheap competitor product imports taking market share and starving jobs.[34]

Figure 16: A typical soft seating product from the company featured in the site visit. Key features include rigid framing structure, firm and durable upholstery and a minimalist aesthetic.

[33] According to Statistics New Zealand Industry Profiler. http://businesstoolbox.stats.govt.nz/IndustryProfilerViewProfile.aspx?ProfileID=CC911

[34] The Press, *Furniture feels the squeeze*, 2010.

Observing the low-tech and largely manual process of assembly (illustrated below in figure 17) revealed the emphasis upon quality workmanship and durability of construction. A useful life span of decades is intended.

These elements are recognised as valuable traits to celebrate and retain in developing a design for this case study, as they align well with sustainable principles of product endurance, retention of culturally valuable knowledge/ artisan skill and local production.[35]

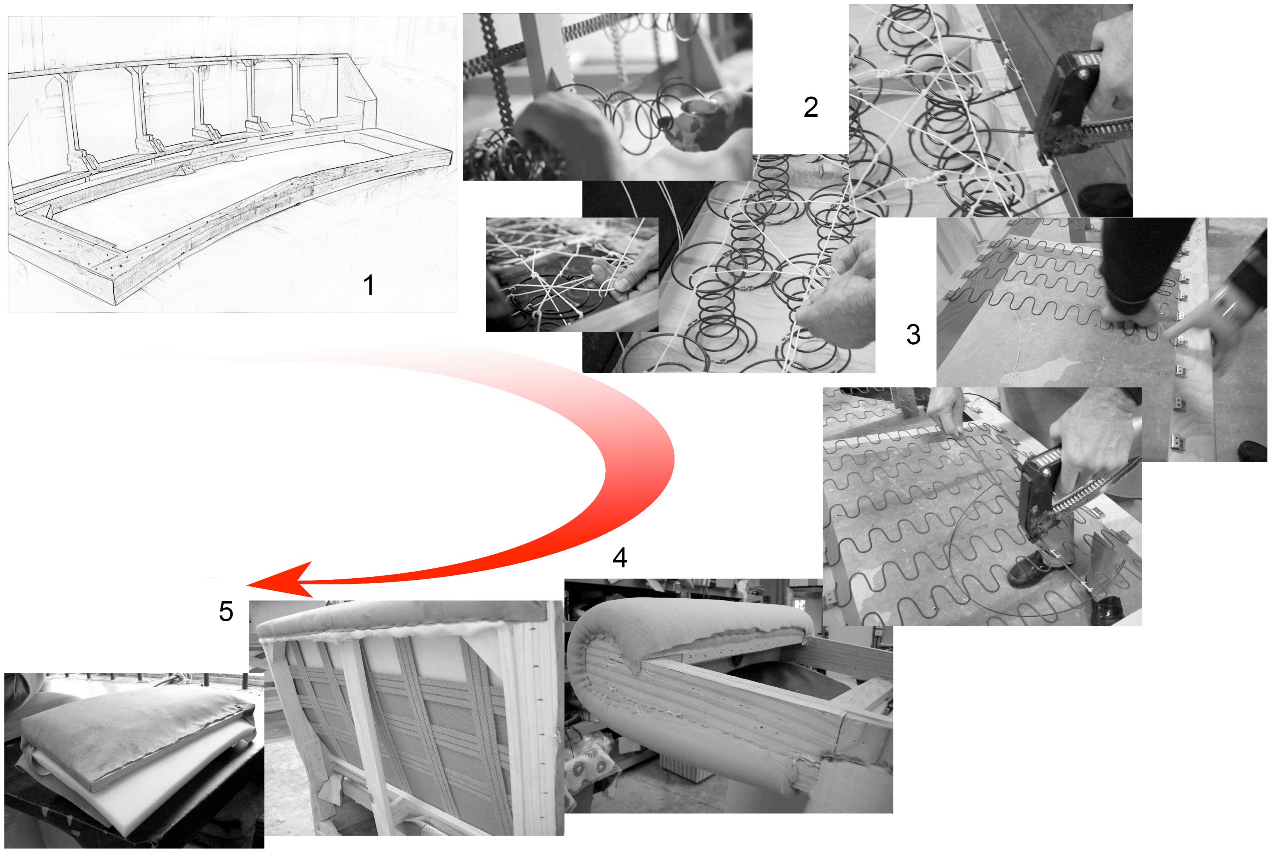


Figure 17: Commercial construction process of a soft seat.

[35] Van Hinte, *Eternally Yours.*

Observations from the assembly process as depicted in figure 17 include:

1. A timber frame is assembled to size using nails, screws and glue. Attention is paid to bracing joints and corners to ensure no movement is possible.
2. Burlap, webbing and spring mount clips are fixed in place on the wooden frame with metal tacks, Coil springs are hand tied in the void with cord, on either two, four or eight sides (the best)
3. Helical (anti-sag) springs are mounted and crimped in place by hand
4. Open cell polyurethane foam is placed over spring assemblies and is stapled and glued directly to the frame
5. A barrier fabric and pre- sewn finishing fabrics are laid over the foam and held in place by staple and glue

The effort and time spent assembling the surprisingly complex composite of mechanisms and materials that form the 'soft' cushioning element was identified as an area that could possibly be simplified. Visually revealing the internal elements so users have a greater level of sensory exposure to exactly what they are sitting on was also identified as an area of design potential. This initiative is in response to what Thorpe identifies as a lack of transparent communication of material origins and processes to consumers in a majority of consumer products.[36] Hiding away the constituent parts of an object maintains a state of user ignorance and exempts suppliers of any accountability as to negative impacts from the ingredients. While microscopic chemical ingredients remain invisible, visually displaying parts could help to stimulate curiosity- as per the Naked Confort shown in Figure 3- and increase the sense of integrity the object maintains.

The lack of regard for how a seat may be disassembled at the end of life was identified as an area to address, with extensive use of glues and metal fixtures that cannot be easily removed from the substrate they are attached to. Separation of technical nutrients, such as metal spring components, from biological ones, such as the timber framing, is not currently valued.

Figure 18: The Mirra chair by Herman Millar is an example of an award winning chair designed for disassembly. Transferrable ideas from this chair include the use of slip on/ off covers that replaced former use of adhesives and staples. The chair is 96% recyclable by weight and has a disassembly score of 93% by weight.[37]

[36] Thorpe, *The Designer's Atlas to Sustainability*, pp. 36- 37

[37] Greiner et al, *Healthy Business Strategies*, p. 34

Typical soft seating products are assembled and shipped as finished goods, creating inefficiencies in packaging and transportation due to the volumes they occupy. Flat pack upholstered furniture is a fledgling initiative, built on ideas of self assembly popularised by international producers like IKEA as a way to lower production and transportation costs, but has yet to catch on in the New Zealand soft seating market.

The practical challenge of navigating narrow passageways with a traditionally assembled product is overcome with this approach, as the prefabricated modules are assembled in the space the seat will be used. Over-coming user perception that the product is of inferior stability and durability due to its ability to disassemble is an interesting quirk for this genre of furniture. This trait is observed in the Frequently Asked Questions section of websites from manufacturers of flat pack upholstered furniture such as British company Nabru.[38]

Flat-pack and self-assembly ideas are highly relevant to the sustainability discourse due to the efficiency gains in transportation energy required, and should feature in the final design. Its important to note that if modules are used these also need to be easily disassembled to facilitate material reclamation.

Figure 19: The EKTORP sofa by IKEA is an example of rethinking the notion that a soft seat must be preassembled to be sturdy and attractive. This approach creates efficiencies in transportation and consequently lowers the financial cost of the product.

[38] www.nabru.co.uk/assembly_faq

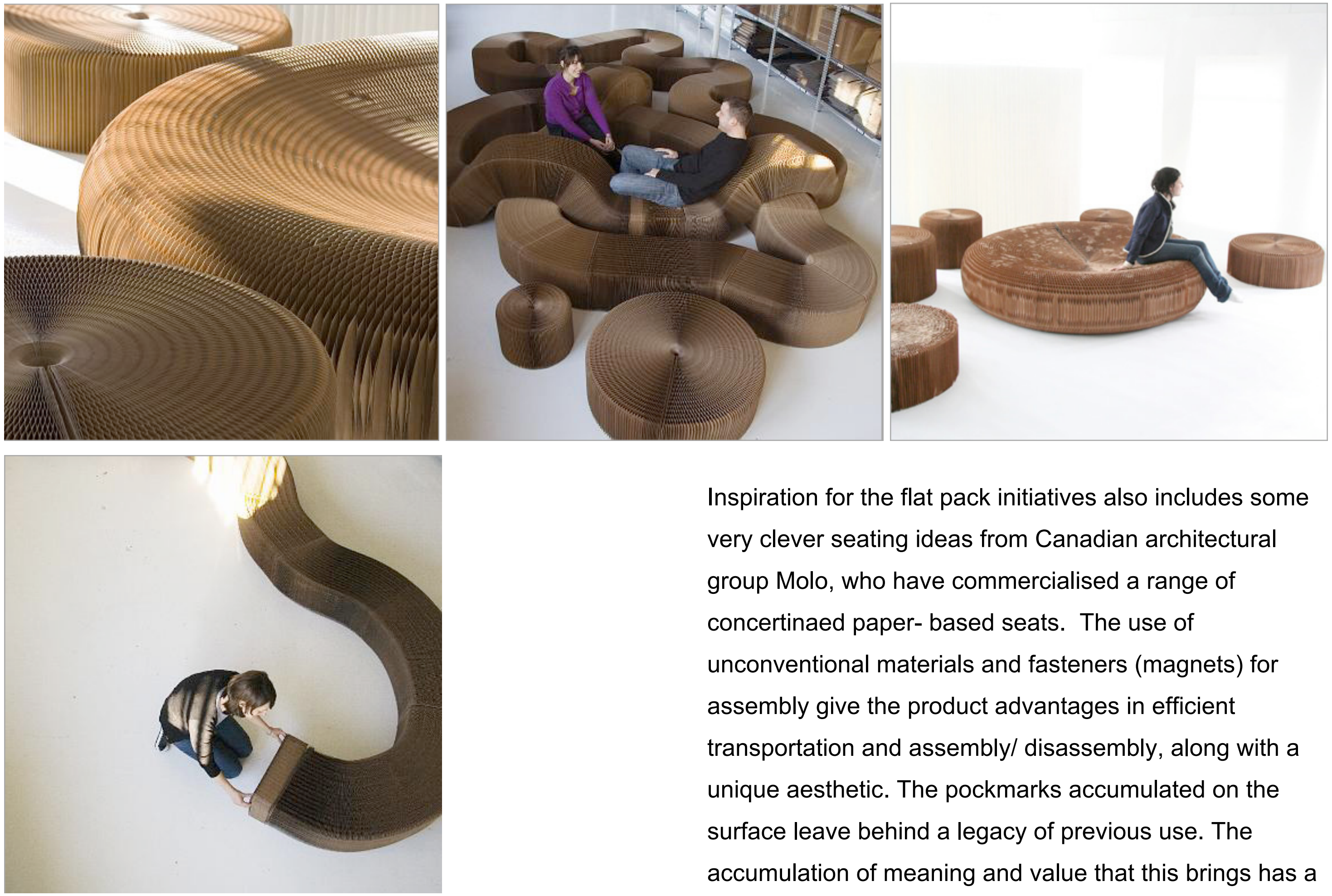


Figure 20: Inspirational ideas for flat-pack furniture from Molo Soft.

Inspiration for the flat pack initiatives also includes some very clever seating ideas from Canadian architectural group Molo, who have commercialised a range of concertinaed paper- based seats. The use of unconventional materials and fasteners (magnets) for assembly give the product advantages in efficient transportation and assembly/ disassembly, along with a unique aesthetic. The pockmarks accumulated on the surface leave behind a legacy of previous use. The accumulation of meaning and value that this brings has a lovely poetic element to it, which would be nice to incorporate in someway in my work.

Re-thinking the prototypical and innovating in ways that redefine the product function, material specification and ultimately, product life cycle are rich design opportunities for this industry. Establishing an enduring relationship between manufacturer and user is important to ensure that old stock with technical nutrients is returned to its maker, if disposal is intended. The example of a product stewardship policy in action illustrated below is from a Wellington-based chair manufacturer seeking to form a take-back relationship within a product-sales paradigm. With no financial incentive for the user and the voluntary nature of the return policy effectiveness is challenged.

Product-leasing arrangements (as opposed to consumer ownership models) align well with the soft seating product category and emphasize the need for simple disassembly, modularity and aesthetic customisability. These initiatives help ensure that a design appeals to a broad range of customer preference and applications, while changing trends in interior décor can be accommodated with updated furniture surface treatments or configuration. Leasing arrangements also assume the existence of a product stewardship programme within individual manufacturer's business systems to retrieve and process used product.

Figure 21: An example of product stewardship within a model of product ownership

When considering the environmental performance of the materials and processes used in a typical upholstered, padded seat there are a number of issues that became apparent through literature review and stakeholder discussion. These need addressing to enhance sustainability credentials.

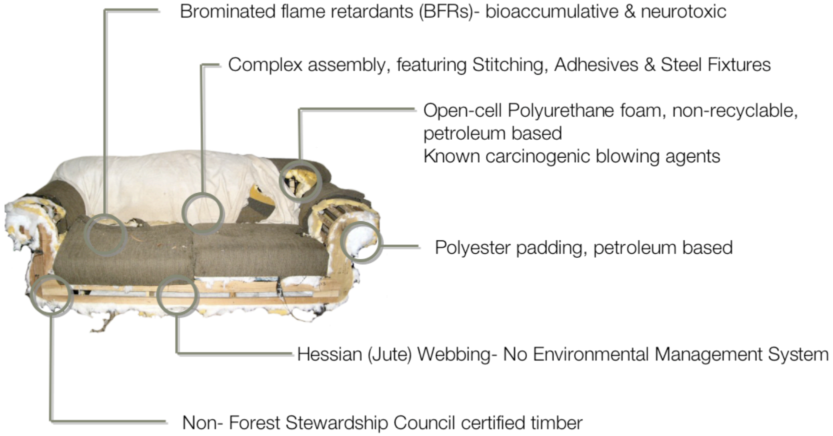


Figure 22: Materials within a soft seat with sustainability flaws.

One particularly pertinent issue I have focussed upon is finding an alternative to the industry standard use of open cell (low density) polyurethane foam cushioning. While this foam has many impressive performance characteristics, such as customisable density, durability, affordability, low weight and being moldable for profiled cushions, it also has some nasty ingredients. These include methylene chloride, fluorocarbons and carcinogenic blowing agents like toluene.[39] The open cell structure of the foam is a perfect trap for oxygen, creating an environment that is highly combustible, and the multiple human deaths each year from fires started by smouldering cigarette butts or other heat sources is testimony to this danger.[40 41] British and American fire safety regulations have prescribed the need of additives to retard combustion and prevent such tragedies, with other countries following their lead, including New Zealand. A retardant widely used to suppress combustion has been the halogen-based family of chemicals, such as pentabromodiphenyl ether (pBDE)- a known endocrine inhibitor and neurotoxin.[42 43 44] The off-gassing* of these compounds from furniture has direct negative health effects for both humans and the wider ecological context, particularly due to its bio-accumulative* properties. Volatile organic compounds (VOC's) and leachates released from the foam during manufacturing, secondary processing into furniture applications, releases during use and final disposal into landfill or incineration represent significant opportunity for occupational, consumer and general population exposure.[45]

Figure 23: Open- cell polyurethane foam- the ubiquitous cushioning material of choice in soft seating may not have us sitting as comfortable as we would like…

[39] Cik, *Five Problems With Crib Mattresses*

[40] Stone, *Basics of Polyurethane Foam*
[41] Wong, *Contribution of Upholstered Furniture to Residential Fire Fatalities in New Zealand*, p. 20
[42] Blake, *IPEN Factsheet on PBDE's and BFR's*, p. 2
[43] Environmental Protection Agency, *Furniture Flame Retardancy*, p. 1-2
[44] Ottman, *Design: Green*, p. 6.
[45] Environmental Protection Agency, *Furniture Flame Retardancy*, p. 3-2

Other widely used materials that present sustainability concerns include timber and natural fibre- based materials that are sourced from unmanaged stocks. Without environmental management systems or stewardship plans in place, such as replanting programmes and soil stabilisation measures, these resources, along with the arable land and water resources they depend on for growth can be can be depleted.

While not unique to soft seating, and therefore not the main focus of this study, it is important to note that the textiles used in upholstery have suffered a chequered environmental history. The industry is awakening to the issues of toxicity associated with leather tanning, wool scouring, cotton production, fabric dyes and synthetic fabric manufacture among others.[46] While significant damage is done during manufacturing processes, ongoing problems occur in the use and disposal stages.[47]

Third party auditing and certification of manufacturers' claims around resource management and processing have become a growth industry associated with sustainability. This is true of the soft seating industry, with upholstery textile and timber suppliers developing labelling codes that trace the environmental impact of a material throughout its chain of custody. Life cycle analysis forms the basis of awards given by, among others, the Forestry Stewardship Council and the New Zealand Ecolabelling Trust's *Environmental Choice* programme.

[46] Hoffman, *FutureFashion White Pages*.
[47] The New Zealand Ecolabelling Trust, *Criteria for Textiles, Skins and Leather*, p.5

Fabrics and timber products that feature a mark from such a labelling party provides peace of mind for the designer wanting to specify materials that align with sustainable values, and for the end customer who want to know that what they are sitting on is responsibly produced. A small but growing range of options is now available within the New Zealand market, and shall be sourced from in the development of a design solution in this Case Study.

In light of the discoveries around the sustainable performance of the materials used in standard soft seating it is understandable why some manufacturers have engaged in product redesign, substituting nasty components with certified non-toxic options. Cisco Brothers is one American manufacturer who heavily promote their environmentally sound product based on this approach.

Figure 24: Cisco Brothers' Betula Chair with certified components

While admirable, it seems unfortunate that there is no aesthetic differentiation between Cisco Brothers product and competitor options. Alternative cushioning approaches appeals as an opportunity for both differentiation and innovation.

A literature review was conducted to gain an appreciation of historical approaches used to create cushioned elements within upholstered seats and what some of their strengths and weaknesses are in light of this study. The results of this analysis are summarised in Tables 15 and 16 in Appendix 2. Materials discussed include organic fibres like animal hair, down, coconut fibre, cotton batting, latex foam, polyurethane foam and two versions of spring steel options. While this list is not exhaustive, it provides a useful overview. Key findings include:

- Emphasis upon durability is important- all forms of organic material are susceptible to degradation through use. While man-made foams are more resilient they too will degrade. This degradation needs to be allowed for in designing a cushion architecture that facilitates refurbishment or replacement.
- Life cycle thinking needs to be applied to any cushioning material to acknowledge the processing it goes through to be created, then what it becomes once it is no longer wanted. Certified environmental management plans are needed for organic materials. Closed loops of use and recycle for non- degradable components need to be facilitated.
- The subjectivity of what forms ‘comfort’ has changed over time, with increasing volume and complexity of materials used to create a better performing cushion.
- Historical cushioning materials have typically been locally sourced from organic based resources. Utilising readily available materials reduces embodied energy burden while lending a local vernacular to furniture pieces. This principle retains merit in this case study.

Alternative materials- biological nutrients

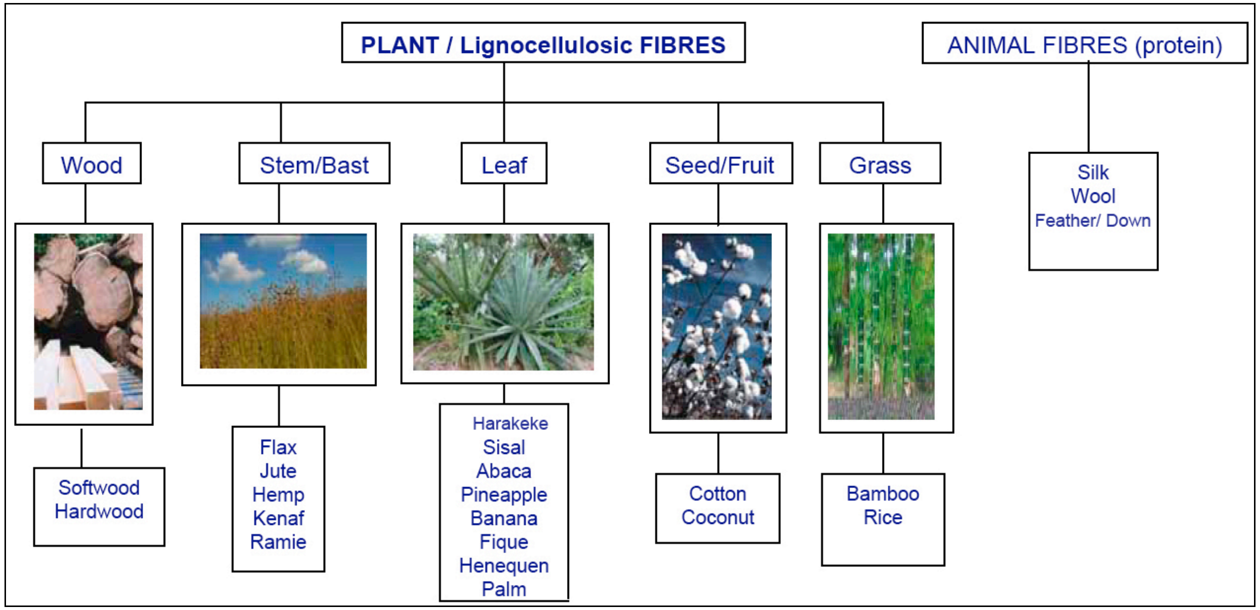


Figure 25: An overview of organic fibrous materials with potential applications in furniture thanks to developments in material science.

There is extensive research being performed in the field of bio-based materials science, with new production and processing techniques leading to potential new design possibilities that I wanted to survey and evaluate for relevance to this study. A literature review was conducted to help establish an understanding of the state of the art developments.

Utilising bio-based materials that fit into Biological nutrient cycles appeal as a way for social and economic development, as the production of the feedstock sources is commonly in areas of low income.[48] Bamboo, for example, is a plant grown throughout the developing world and is recognised by the United Nations as a resource with tremendous latent potential due to its rapid growth, ease of processing, carbon sequestering and soil stabilising abilities. The unique flexibility and tensile strength of the fibres lends it to all manner of applications when processed into laminated boards and veneers.[49] As information on this remarkable material was gathered I became more intrigued and determined to explore it's suitability for use in this Case Study.

[48] van der Lugt *et al*, *Design Interventions For Stimulating Bamboo*, p. 7
[49] van der Lugt & Otten, *Bamboo Product Commercialization*, p. 29

Another of the emerging trends identified is that of Bio plastics, an example being Poly Lactic Acid (PLA) polymers derived from starch. An assessment of maturity of the science and suitability for this project can be summarised as:

Pros- stock is sourced from a renewable resource, in contrast to petroleum- based plastics (PBP). Can utilise organic matter that would otherwise be considered waste. Can be used in existing manufacturing processes as a direct substitute for PBP.

Cons- Supply stock is commonly using arable land otherwise used for food production. Adverse effects include soaring food prices as production of food is squeezed out.[50]

Figure 26: The Ecopin is an example of a 100% biodegradable injection molded plastic from New Zealand based Ecocover.

Work is being carried out in this area to develop bio-based alternatives to polyurethane foams. Soybean oil- based polyols have been successfully introduced in up to 20% composition of urethane mixtures. These foams have been used in seating within Ford Motor Company vehicles since 2008.[51] It is a compromised state though, as the foam material remains toxic and non- biodegradable.

Bio- composites are another developing area with design potential for this case study. Research by McGruddy[52] into the design potential and requirements for reviving the New Zealand Flax (Harakeke) processing industry in New Zealand aligns strongly with research into glass replacement composites by the likes of Vuure[53] and the Biopolymer Network.[54] If the challenge of extracting the fibres intact and in commercial volumes can be overcome then there is high potential for use of harakeke fibre within a resin matrix. This could lead to exciting design applications. Pre-pregnated fibres can be extruded or formed through pultrusion dies to create consistent profiles useful in modular assemblies. This could be used to mould structural elements in a furniture context. Unfortunately existing two-pot resins used in the composite industry are not biodegradable and can be toxic. Organic epoxy resins are being developed from natural plant oils, such as those found in soy, linseed and canola seeds and cashew nut husks, but is considered a fledgling science, not in commercial production at the moment.[55] Other bio-plastic materials have successfully been combined with fibrous plant matter to create automotive acoustic panelling, among other applications.

[50] van der Lugt et al, *Bamboo Product Commercialization*, p. 7
[51] Urethane Soy Systems, *SoyComfort*

[52] McGruddy, *Integrating New Zealand Flax into Land Management Systems*
[53] Vuure, *Natural Fibre Composites: Recent Developments*.
[54] Biopolymer Network Ltd. *2006 Industry Workshop Summary*
[55] Mohanty et al, *Sustainable Bio-Composites from Renewable Resources*, p. 19

Alternative materials- technical nutrients

The other field of material resources I explored was the potential for recycling of existing technical nutrient waste streams generated by New Zealand society, in a move inspired by the Reee chair cited in Figure 9. One waste stream identified as highly visible and familiar to most New Zealanders is that of the High Density Polyethlyene blow film shopping bag. The same material is used in the agricultural industry for wrapping winter livestock feed called baleage. The material has become an ecological and aesthetic pollutant in both rural and urban environments throughout the country. Pilot recycling initiatives are being launched in the Hawke's Bay and Southland districts to recover and recycle the agricultural plastics, so it appears timely to find applications for the reclaimed material.

Figure 27: Used baleage wrap plastics have become a rural pollutant and disposal problem. What if they could be captured in a value adding closed loop by being recycled into furniture components?

Experimentation with fusing layers of film together to create a sheet suitable for vacuum forming or molding into structural elements for a seat pan lead to an unexpected tangent in the form of a range of children's bibs, but issues with material inconsistency and trapped air pockets prevented vacuum forming trials from being successful.

Figure 28: Fused waste HDPE film transformed into a baby bib. The intention of this materials exploration was to see if common waste could be converted into structural elements via up-cycling.

Another waste stream with potential relevance to soft seating is vulcanised rubber, as found in inner tubes. The elastic nature of this material appealed as a potential replacement for metal springs. Experimentation with weaving and sewing used inner tubes to generate a matrix of flexible membranes yielded some promising results worth pursuing further with prototyping.

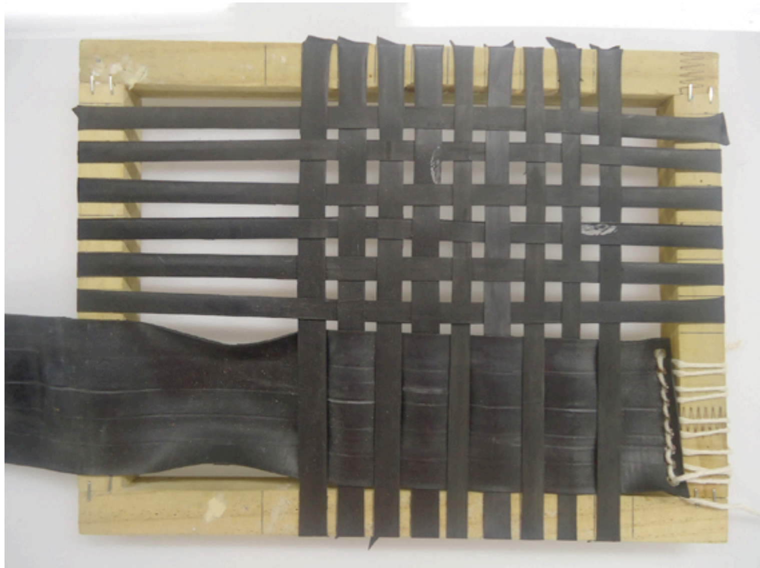


Figure 29: Material experimentation with repurposed bicycle inner tubes used to create a flexible matrix.

The challenge with using repurposed materials is obtaining a reliable supply of material. I attempted to see whether those generating the waste might form a reliable supply. I posted online adverts on New Zealand bike user forums such as VORB, seeking to gauge feedback on having old inner tube collecting stations at local mountain bike parks.[56] Respondents were enthusiastic about the idea, but concerns over cost of recovery and material redundancy (due to tubeless tyres) indicated that regular supply in New Zealand might be an issue. While establishing infrastructure to ensure a reliable material supply chain is not the focus of this study, it is an important parameter to acknowledge for any design to be commercially successful.

The outcome of this analysis is that there are alternatives to those commonly used material choices in the soft seating industry. Some of these were explored using design as a research tool, and are discussed in the subsequent research through design section. The limitations of time and scope for this study determined that materials with established infrastructures and verified environmental stewardship structures in place took preference. Commercially available material options, including bamboo laminates and bio-based plastics meet these requisites while exhibiting potential for innovative cushioning solutions.

[56] www.vorb.org.nz/recylcling-old-inner-tubes-t95197.html

Desirable flow

This brings me now to the third strand of this research; the theoretical field of Affective design, which deals in the sensuous and the subjective aspects of product experience[57]. As mentioned with the Cisco Brothers example, making a sustainable seat is not enough in itself, for if it does not differentiate itself to the market then it will struggle for perception as a sustainable product, and it is this premise that necessitates an amalgam of sustainability values with affective design strategies.

This field of design research seeks to understand and potentially craft the emotive relationship a person has with a product during three distinct phases of product experience:

1. Enticement (anticipation and desire for product interaction),
2. Engagement (product interaction) and
3. Appreciation (reflection and appraisal of product interaction against prior expectation)

Affective design in this case study is therefore about presenting coherent and consistent communication of the purpose and ideals represented in the furniture. Stimulation and nourishment of desire for the furniture is realized through considered choices of material, colour, form and function based on their conative and associative merits.

[57] Demirbekel and Sener define this as a 'consumer's psychological response to the semiotic content of the product.' *Product Semantics…* P. 1347

Figure 30: Mae West Lips Sofa by Salvador Dali relies heavily upon connotation and association for it's appeal.

Recent design research has been focused upon how it is possible to design a product that excels across three dimensions of its phenomenological profile, namely: how it is perceived, how it is experienced and the extent of reflective appreciation it generates. These elements contribute to what is termed *Design for Desirability* by Goellner, et al.[58] Such inquiry is interested in how a design can go beyond fulfilling functional requirements to establish a positive emotional connection with a user. The notion of designing a desirable product taps into the subjective and emotive qualities of a design, as interpreted through the values of its user.

The design of a successful sustainable seating concept requires crafting of the user's experience into a congruent

[58] Goellner et al, *Design for Desirability*

sequence of assessments of the object. According to Heufler[59] this sequence involves 3 levels. The first is described as the '*observer'* and is concerned with the aesthetic qualities of a design and how it provokes critical association through sensory stimulation. The second level is that of the '*user*', which is concerned with the functional performance of the object and whether it fulfils expectations. The third level is referred to as that of the '*owner*', and corresponds to the symbolic value of being associated with the object in a social context.

Heufler's framework is closely echoed by Norman,[60] who posits that a design is considered through visceral, behavioural and reflective dimensions of experience. In Norman's construct the 'visceral' element is concerned with the aesthetic of a design, 'behavioural' is related to the pleasure (or distress) using a product generates, while the 'reflective' aspect considers the intellectual significance of the design.

The Perceptual Product Experience (PPE) framework proposed by Warell expands upon the writings of Norman and Heufler. It is a multi- modal construct that seeks to enfold and consciously map out the holistic product experience and ties in well with ergonomic, usability and functional design development tools.

The PPE framework breaks down the way in which a user's sensory stimulation, cognitive processing of the stimuli and consequent affective reaction contribute to a product experience. The Presentation mode covers the elements that contribute to a 'pleasurable' experience and aids in understanding what a product 'is', while the Representation mode covers the elements that contribute to a 'meaningful' experience and reveals what an object stands for or symbolizes.

Within the presentation mode three dimensions are considered.
Impression poses the questions "What do people notice?" and "How does the product stand out?"
Appreciation poses the questions "What do people 'like'?" and "In what way does the product appeal?"
Emotion poses the questions "What do people feel?" and "What emotions does the product elicit?"

Within the representation mode three further dimensions are considered.
Recognition poses the questions "What are people reminded of?" and "What does the product look like or resemble?"
Comprehension poses the questions "What do people 'understand'?" and "How is the product used?"
Association poses the questions "What are people reminded of?" and "What does the product stand for?"

These elements are visually depicted in Figure 31 on the following page.

[59] Heufler, *Design Basics*
[60] Norman, *Emotional Design*

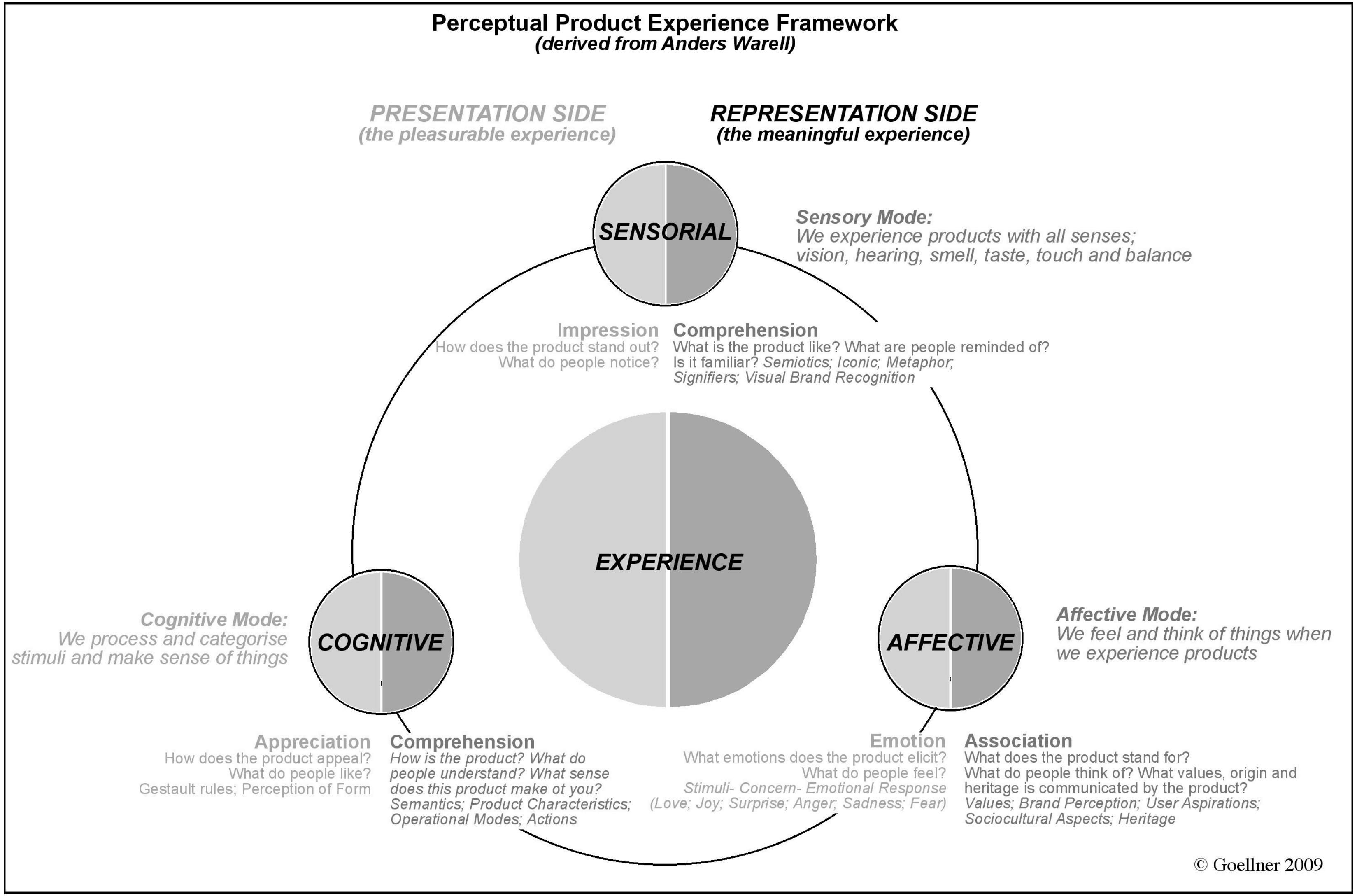


Figure 31: Warell's perceptual product experience model provides a means of breaking down the complexity of a product experience into discernable facets that can be mapped out.

The PPE tool was used to quickly assess a variety of contemporary soft seating products (presented in the bi-polar chart in figure 12, page 12) to gauge their perceived sustainability value. This analysis is included in Appendix One. Table 1 below features an example of this analysis, focussed on a chair called Tio, by New Zealand based Conscious Design.

The Tio Chair was a recipient of a sustainability award at the New Zealand Designers Institute Best Design Awards in 2006. It has been designed to have easily removable/ upgradeable cushion covers with textile designs from some of New Zealand's top fashion designers. Timbers are from sustainably managed sources.

Presentation	**Representation**	
Impression Appears low and wide- no arms Thick cushioning looks comfortable Timber sweeps up from seat pan to form backrest	**Recognition** A stable and solid chair Proportions reminiscent of the Barcelona chair by Mies van der Rohe	
Appreciation Clean lines and visual simplicity. Upholstery is in season	**Comprehension** fabric areas are for resting body, timber areas are structural	
Emotion Appeals as contemporary- affirming values of owner Concern from elderly about ease of egress	**Association** Relaxing, reclining Scandinavian?	Tio Chair by Conscious Design

Table 1. PPE analysis of the Tio chair by Conscious Design

The above example demonstrates the challenge in making connections between an abstract notion of sustainability and an object. Although the object has been the recipient of publicity as a 'sustainable design' this is not immediately apparent, as suggested by the results of the PPE analysis. This indicates that the designers could have done more to draw attention to the sustainable aspects of the design. It also raises the question; is it realistic to expect that a product can be perceived as sustainable? Are there examples of products that can instantly be perceived as sustainable? Brazilian design researcher Gabriela Varanda de Castro suggests that an aesthetic appearance making connections with nature, while incorporating natural materials that have been processed beyond a 'just left the forest' state is a vehicle for non- didactic promotion of sustainability virtues.[61]

With this consideration in mind, a search for a more organic shaped seat lead to the discovery of work by American designer Matthias Pliessnig. PPE analysis of a seating

[61] Varanda de Castro, *A New Design Language*, p. 9

prototype titled *Providence* was conducted and is summarised in Table 2. This chair is part of a series of steam bent white oak creations that Pliessnig developed during his University of Wisconsin Master of Fine Arts studies. The materials are harvested sustainably and assembled using boat building craft techniques.

Providence by Matthias Pliessnig, 2008

Presentation	**Representation**
Impression Dynamic, organic form Hollow Structure	**Recognition** A curved seating surface, like a wave suspended in mid flow, like a timber boat frame or woven basket
Appreciation Different aesthetic Warm material Craftsmanship is evident- looks strong but light	**Comprehension** Sculpted dips are for sinking into, raised areas are for reclining against
Emotion Excited curiosity Seduction/ lust	**Association** Nature Fluidity, lightness Sculpture

Table 2: PPE analysis of Providence by Matthias Pliessnig.

The PPE analysis of the Providence seat generated an entirely different set of language from that of the Tio Chair, indicating that the product architecture and distinctive aesthetic has a large role to play in the perception of the natural, sustainable qualities it holds. It is interesting to note that the seat still appears inviting, despite the lack of padding or upholstery textile. The nakedness of the design, in which elements of its construction are clearly visible, brings a sense of integrity that is compromised in the Tio Chair.

It is the associative connections that users make between sustainability values and the design object that is of particular significance to this study. Warell asserts that association is "solely based upon interpretation through symbolic signs, which are largely connected to brand interpretations established through marketing channels."[62] The example above suggests that organic forms can stimulate desired associations too. Thorpe suggests that the role of nature in our psychological frameworks has not been fully appreciated, citing new theories in 'ecopsychology' that suggest human development is linked to the natural world in which we live and we are subconsciously affected by forms that evoke memory of nature.[63]

While this does not mean a seat should be made as a direct copy of nature; abstraction and reference to organic shapes seen in our natural environment offer scope for new aesthetic languages. This notion of a possible sustainability aesthetic disputes what British design researcher Stuart Walker suggests when proposing:

> Design for sustainability does not necessarily imply any particular type of aesthetic or outer appearance for a product. On the contrary, the relationship of sustainability to localization, cultural expression and use of regionally available human and natural resources suggests a diversity of expressions that are concomitant with local preferences and, where appropriate, local capacity. And in further contrast to the current uniformity in product appearance that relies so heavily on 'newness', design for sustainability must also embrace the aging of products, the accumulation of meaning over time, and more profound notions of attachment and empathy.[64]

The challenge with Walker's assertion is reflected in the Tio chair. While locally sourced materials that facilitate cultural expression and local manufacturing capacity are utilised, the seat has not engaged the observer at an impulsive level in the same manner as the Providence seat. It is interesting to note the suggestion by Helander[65] that aesthetics can also have a stronger role in a user's perception of a seat's comfort than the existence of carefully engineered ergonomic features. Warell suggests that an aesthetic balance between novelty and

[62] Warell, *Product Experience Workshop*, p. 54
[63] Thorpe, *The Designer's Atlas to Sustainability*, p. 170.
[64] Walker, *After Taste*, p. 30
[65] Helander, *Forget about Ergonomics in Chair Design?*, p. 1306

familiarity is necessary for product success. Signifiers that carry meaning and help make sense of an object and differentiators that set the product apart as original must be simultaneously active.[66]

Using the PPE tool helped identify the signifiers for soft seating and sustainable design from the ‘observer’ stage of user experience. These qualities, combined with some of the more pragmatic aspects previously discussed help form design criteria summarised on the following page.

[66] Warell, *Product Experience Workshop*, p. 63

Design criteria for an affective sustainable soft seating product include:

Performance
Strong and durable construction
Customizable modular assembly expandable for various client requirements
Ease of assembly/ disassembly for unskilled labour
Constructed from easily separable 'technical nutrient' materials for perpetual re-use and refurbishment OR Specification of entirely bio-degradable materials for safe retirement to landfill
Easily removable/ replaceable upholstered surface for updating/ customizing using fabrics
Flat- pack construction for efficient transportation
Provides adequate ergonomic support for temporary sitting
Surfaces are easily cleaned
Specified materials are stain, rot and fire resistant
Low or Non- VOC adhesives (if required)
All materials have a verified full chain of custody and product stewardship programme in place, as certified by a 3rd party sustainability auditor

Experience
The design is recognised as a cushioned seat
Aesthetic portrays a sense of invitation, trustworthiness & integrity with clear signifiers for where to sit
The design invites inquiry with an aesthetic that portrays a sense of innovation, breaking down rectilinear volumes and challenging established conventions for soft seating
Biological nutrient material choices are processed beyond raw state, while retaining natural grains and characteristics
Method of construction, cushioning and furnishing is clearly visible
A firm but responsive cushioning in areas in contact with a user's body
It appears comfortable, with seat pan areas featuring contained volumes that could be upholstered

Research through design:

Getting into the creative flow

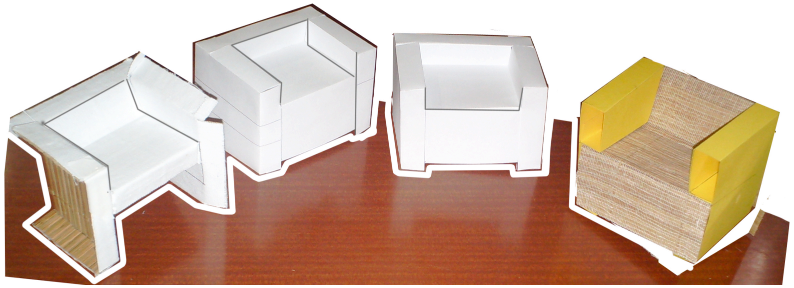
While the funnel analogy for this case study presented on page 4 is a nice and clean picture with a clearly demarcated sequence, the reality is that design has been used as a research tool from the start of this project. Quick sketching in two and three dimensions has been carried out to express and evaluate ideas as they have been triggered. Design techniques have included:

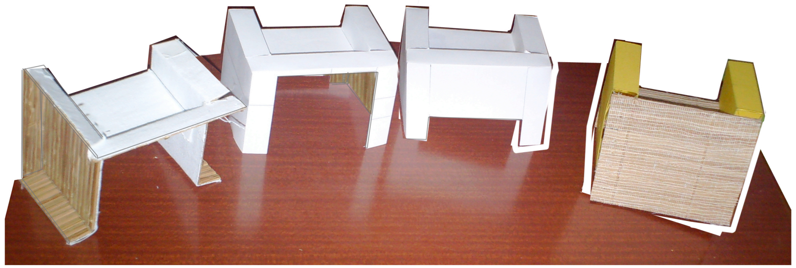
- Hand sketching in ink or graphite,
- Computer Aided Drawing (3D Modelling)
- Three dimensional form sketching in paper, card, plastic, metal, timber and fabric
- Function prototyping.

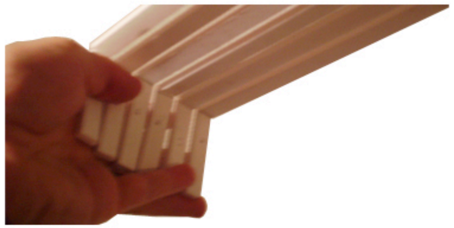
What follows is an overview of the ideas explored and refined as understanding of the issues at play gained momentum and as design criteria were established. Some of the ideas were rejected while others merged together. Inspiration was also gathered from other's work, with collages of diverse images appearing alongside design ideas- an example of which is included for one of the cushioning concepts explored during this process. The emerging design criteria listed on the previous page were used alongside Warrel's PPE tool to evaluate the success of each idea in establishing a perceptible design language of sustainability.

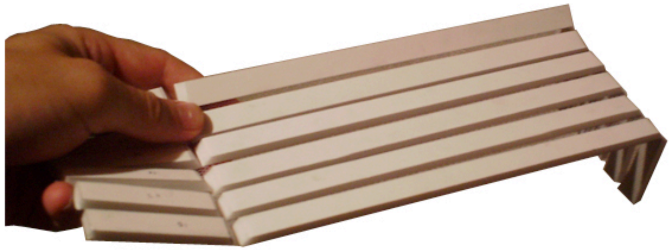
Flat pack initiatives are explored in these concepts, focussed upon how to create a large rectilinear volume in homage of the LC2, but subversively deconstructing the mass with revelation of the hollow structure. The form is created from fabric bonded to bamboo slats, permitting live hinging and upgradeable textile.

Zips on intersecting planes hold the elements in place. Possible forms were quickly explored via card and slat laminate materials. Details of assembly and use are considered through sketching and full-scale prototyping in corrugated card.

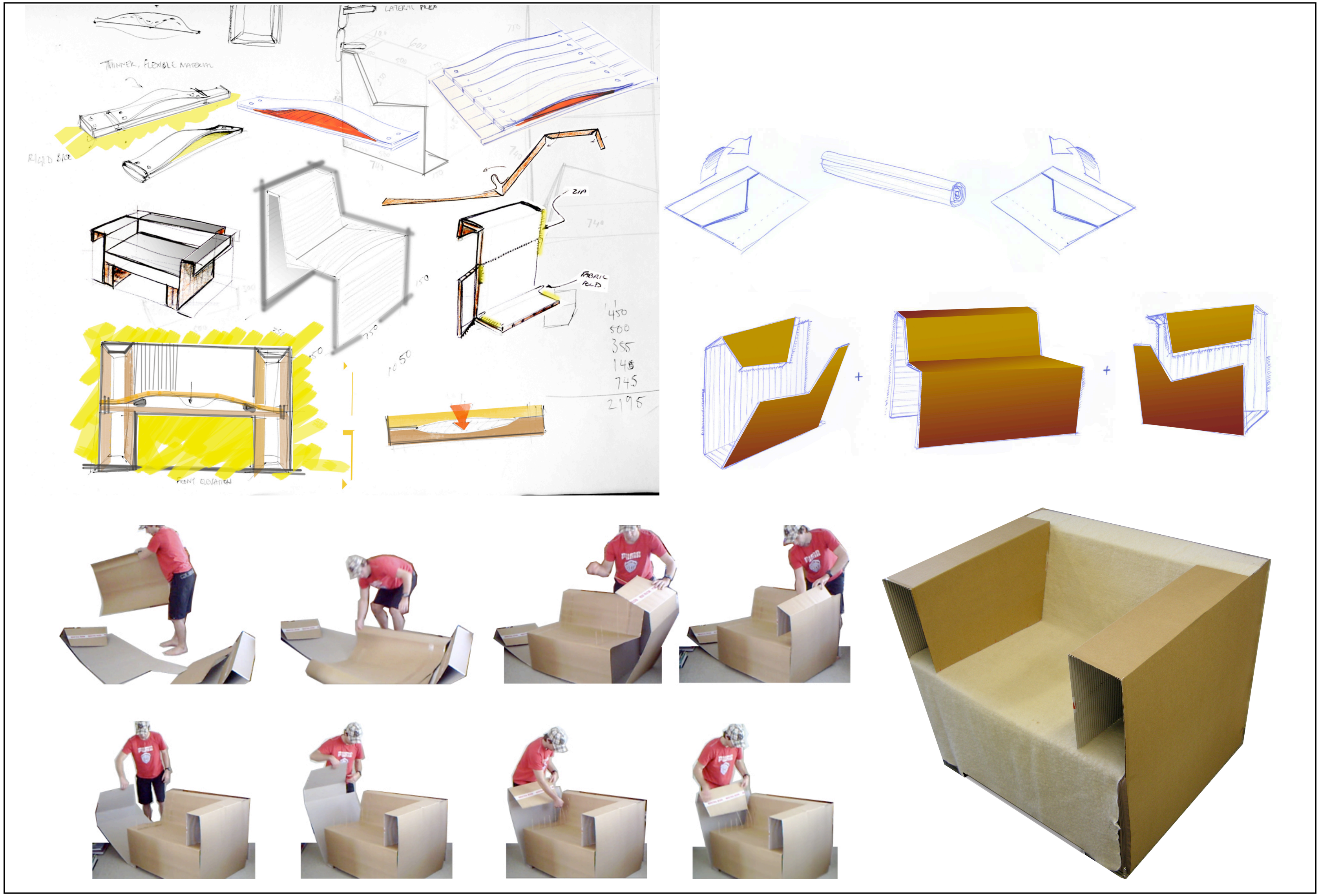








Quick experiments with altering spacing between slats, altering slat thickness, width and angle of end cuts helped understand the behaviour of the materials and how structure could be achieved from a flat plane by bevelling intersecting slat ends.



Analysis of the design using Warrel's PPE tool revealed that while the chair's architecture managed to achieve a balance between novelty and familiarity, the geometric form stifled associations with nature. The explorations into flat pack principles were however informative for future idea development.

Attempts to introduce a curved element into the flat pack furniture were explored through the development of a series of benches and seats. Bamboo strips were bonded to cotton backing with spacing to permit the curve to take shape. The use of artificial turf to upholster the above seat above was perceived as a cheap gimmick that undervalued the sustainability principles being explored. At the same time, it does create a readily recognisable padding. The form is held with a single tensioning cable running in the centre of the legs. Use of woven wool as a surface material was found to hold a greater sense of warmth, a proven history in upholstery and is an abundant local resource. It is also capable of absorbing VOC's, thus improving indoor air quality and has natural flame retardancy. Based on these aspects it was determined that this is the best material option for this concept.

A determination to rethink the concept of upholstery is explored with the following series of designs. By questioning the way in which a surface is created and pattern is presented new possibilities emerged. Taking inspiration from the contemporary use of pixels to build up an image, along with references to mosaic and collage, avenues for use of technical nutrients emerged in a concept called 'Pincushion'. By mounting each pixel on a flexible membrane, cushioning and upholstery could become one element.

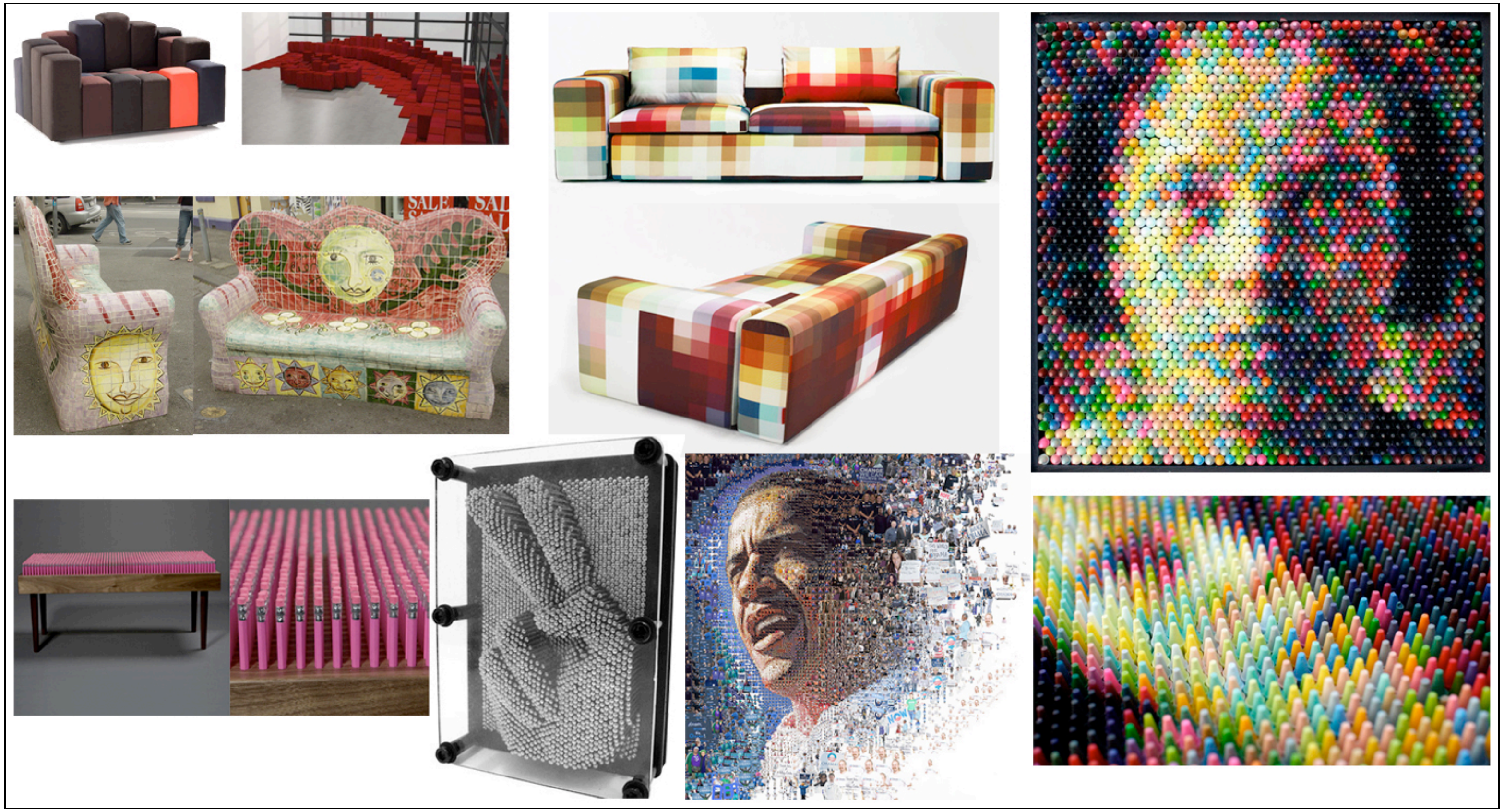


Figure 32: Inspiration for the 'Pincushion' concept includes the work of designers and artists that seek to break down a solid surface into pixels of colour. Clockwise from Top left: 'Do-Lo-Res' and 'Pixel Couch' by Ron Arad, 'Pixel Couch' by Cristian Zuzunga, 'Experiment 5' crayon art by Christian Fuer, mosaic illustration by Tsevis Visual Design, 3 dimensional relief pin art toys and Pencil Bench by Boex 3D Creative Solutions studio. The mosaic couch pictured is an example of handcrafted skill finding an alternative outlet in street art by an anonymous artist.

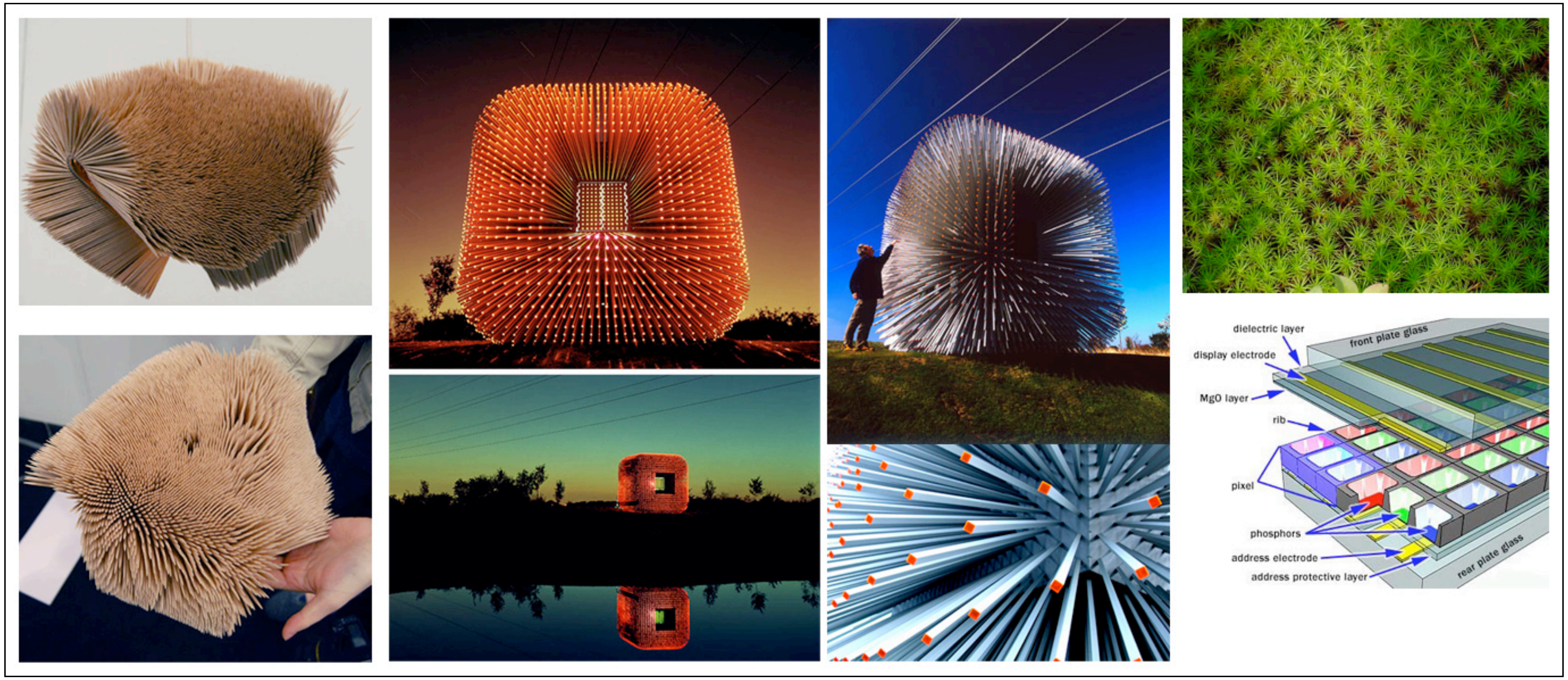
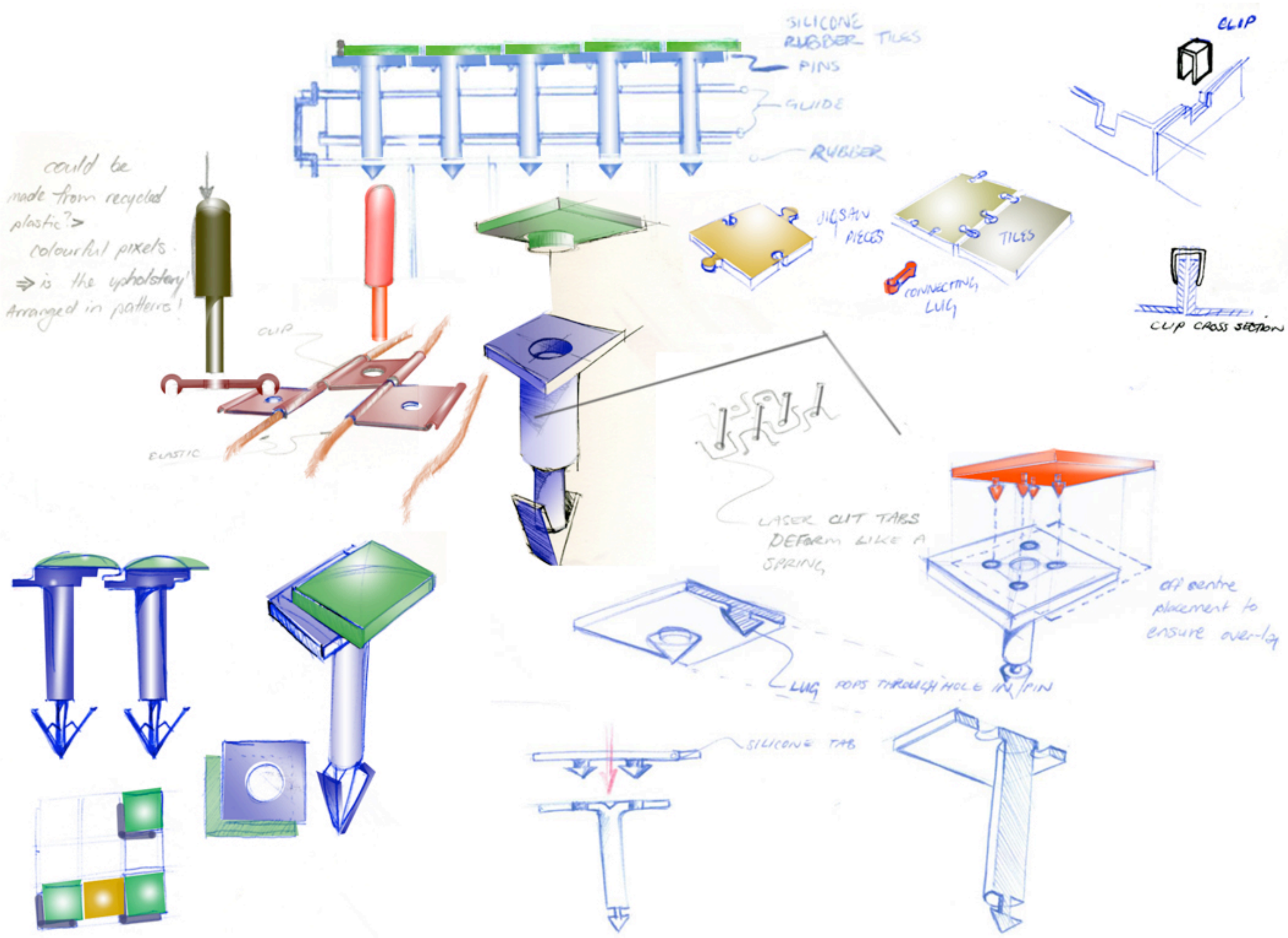
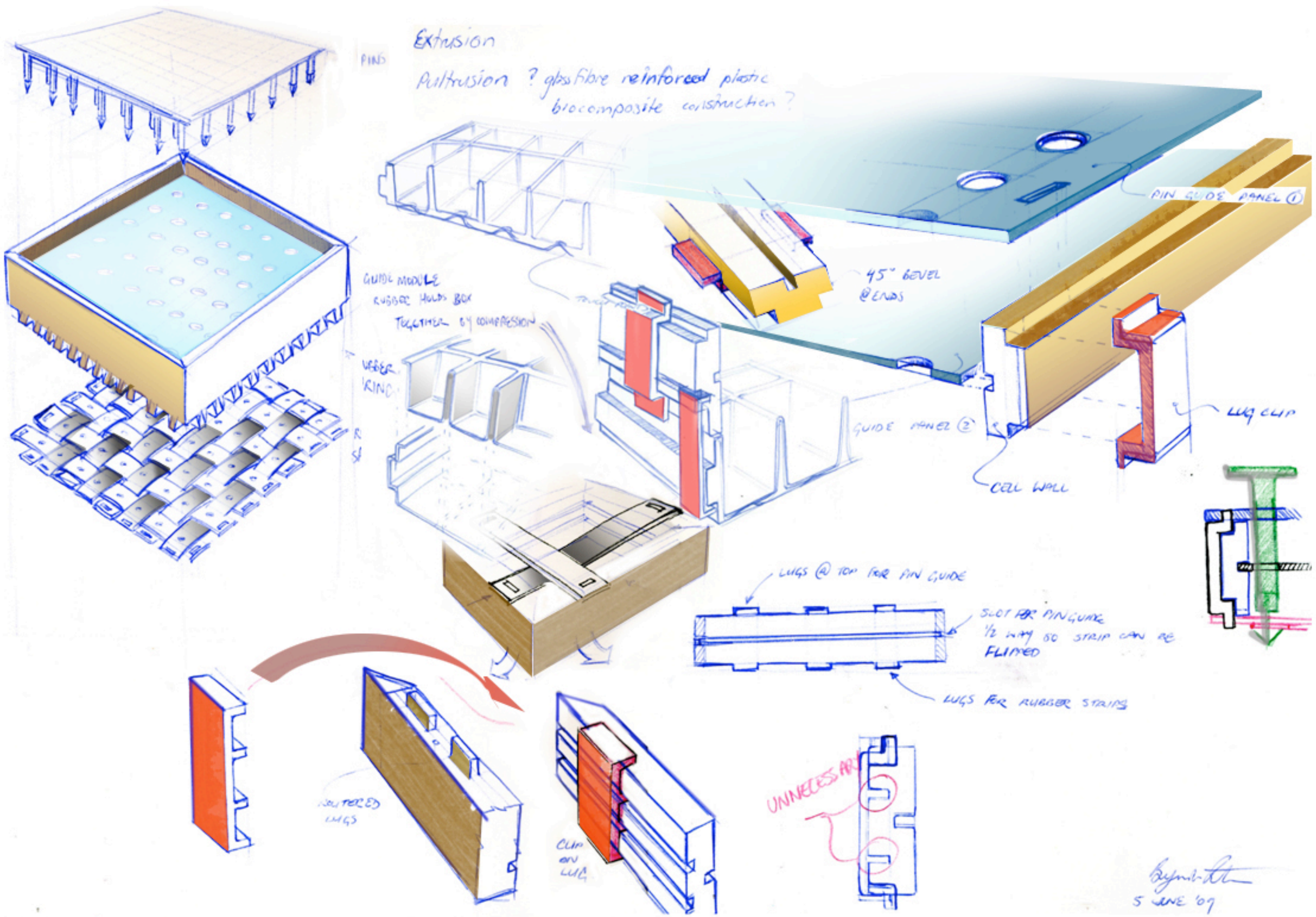


Figure 33: Further inspiration for the Pincushion concept. From Left to Right: 'Toothpick Lampshade' by Daisuke Hiraiwa, 'Sitooterie II' by Heatherwick Studios, Moss plants and plasma screen technology.

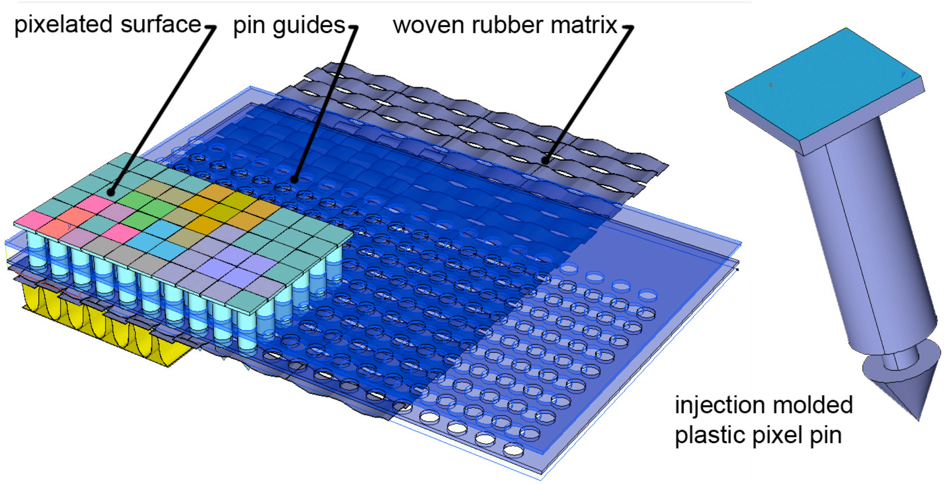
Mounting rigid pins with coloured heads within a supporting frame and flexible base developed as an innovative approach to cushioning. Using mass repetition as a tool to transform a harsh edge into a soft texture, (as seen in the stunning Sitooterie images above) a sort of protective and cushioning surface results. Ideas were sketched out and details considered through CAD and three-dimensional mocking up. This led to the building of a full scale 'pin cushion' to evaluate the practical feasibility and affective impact of the idea. Images of these steps follow.



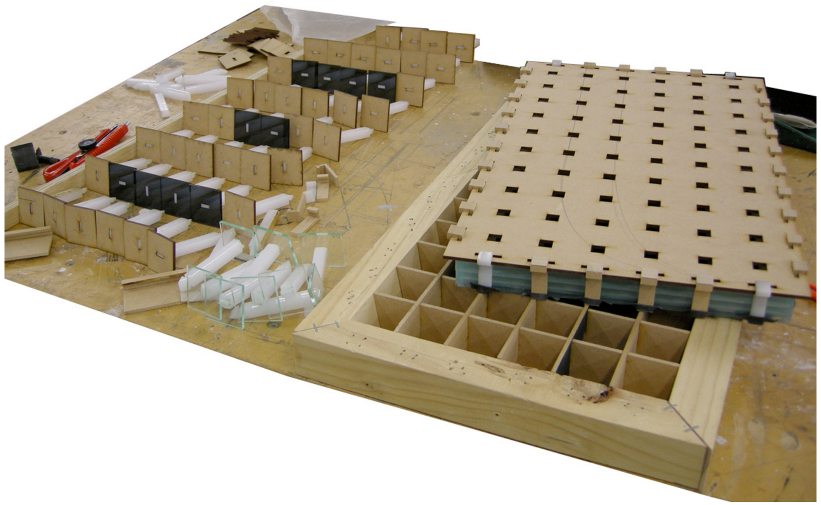
Pin concepts and details of how they are guided, sprung and coloured were considered through pages of ideation visualising. Pins made from a recycled plastic such as Polyethylene or bio plastic with interchangeable coloured silicone pixels emerged as a feasible working solution.

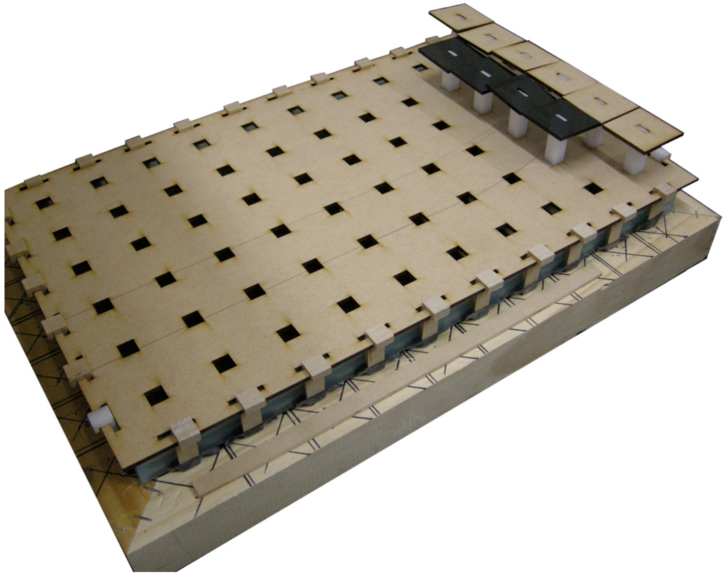


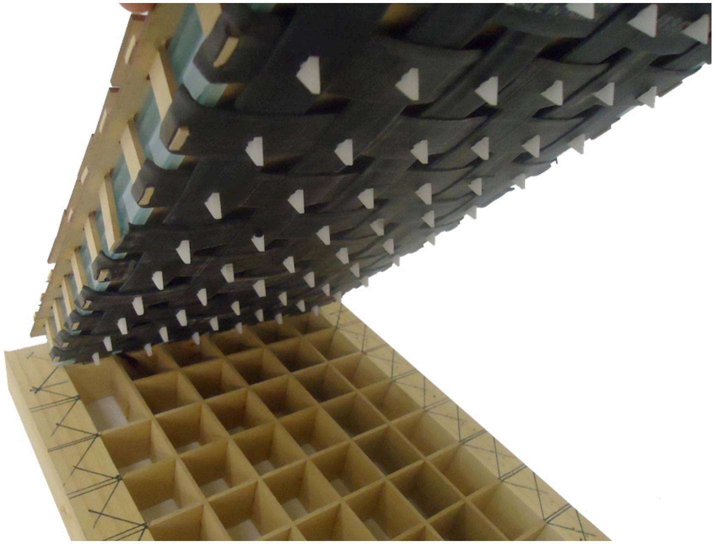
Sketching was also used as a development tool as iterative refinement of the pin base evolved. These images depict details of the pin guides and recycled rubber mount. The use of extrusions/ pultrusions made from bio-composite materials are explored as a means of creating a modular assembly that is held together under tension from the vulcanised rubber. Disassembly is made simple by avoiding use of any fasteners or glues.



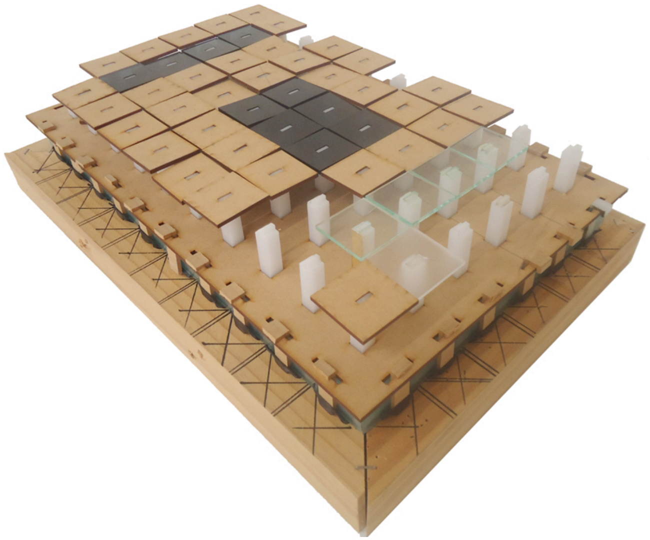
CAD drawings were used to work out positions of components for subsequent laser-cutting of pin guides and the pins them-selves. The Pincushion was prototyped in acrylic, rubber and MDF to create a proof of concept. The components are laid out below left, with the pixel pins beginning to be installed in the supporting frame in the right hand image.

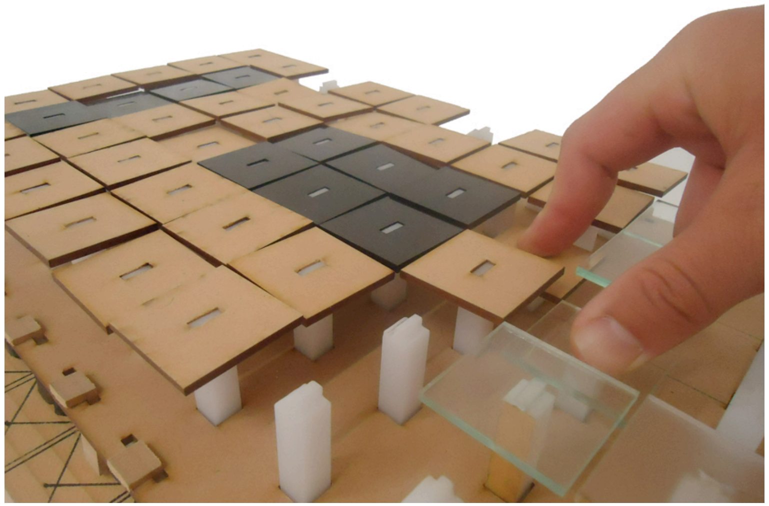


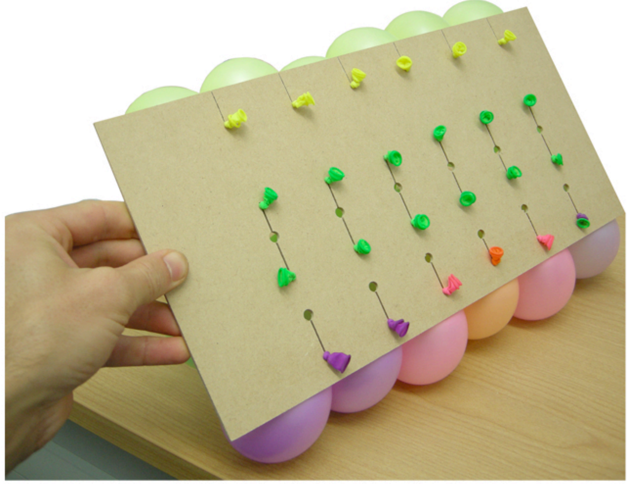


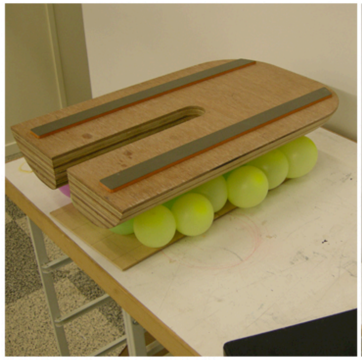


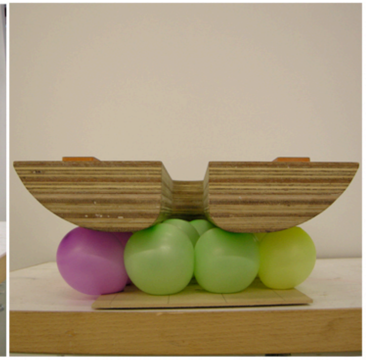
The prototype allows for coloured pixels to be removed and replaced with alternative colours so different patterns can be created or damaged pixels replaced. The localised responsiveness of the pixels to pressure helps create a firm but comfortable cushion. Scaling the size of the pixels down would further enhance this aspect, but as a proof of concept this prototype was a useful tool for gauging the merits of the idea. It became apparent that while certainly different, novel does not necessarily equate to better. The visual and technical complexity of the cushion seemed to be over engineered. While this aesthetic may translate as appropriate for technical nutrients it failed to compete with simpler cushioning in the economic strand of the sustainability measure, along with the practical concern of cleaning. Determining to reduce complexity proved a useful design strategy that lead to further prototyping ideas.



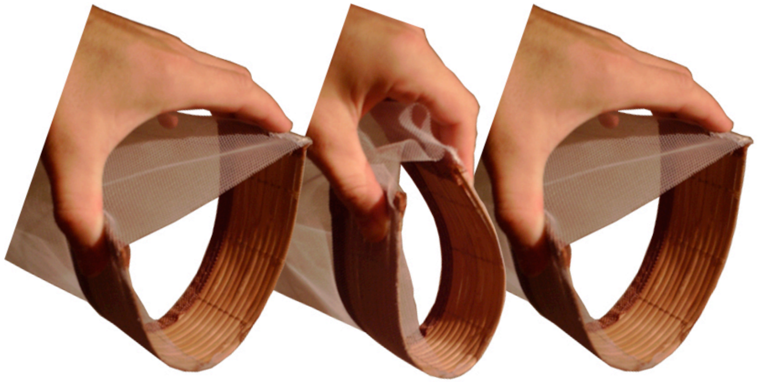


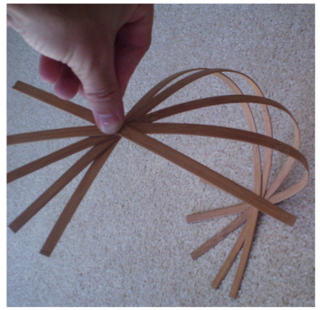




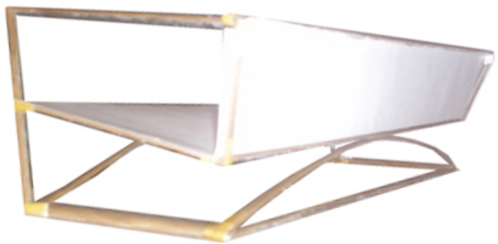


The collection of images above is of one of those less complex ideas being tested with a ‘British standard bottom’ rig- a seat pan padded with inflatable coloured pixel bladders. This concept incorporates flat pack and alternative upholstery ideas in a unique and playful package. The idea of inflatable furniture is not a new one, but they are fraught with ergonomic and aesthetic challenges. This solution addresses those concerns through mounting the bladders on a moldable substrate that can provide appropriate structure and support. Prevention of the unfortunate squeaking sound caused by the cells rubbing against each other would require a barrier coating. This would visually interrupt the pixel effect, curtailing further development of the idea.

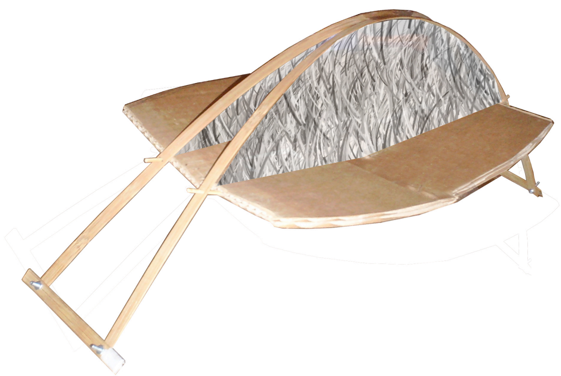




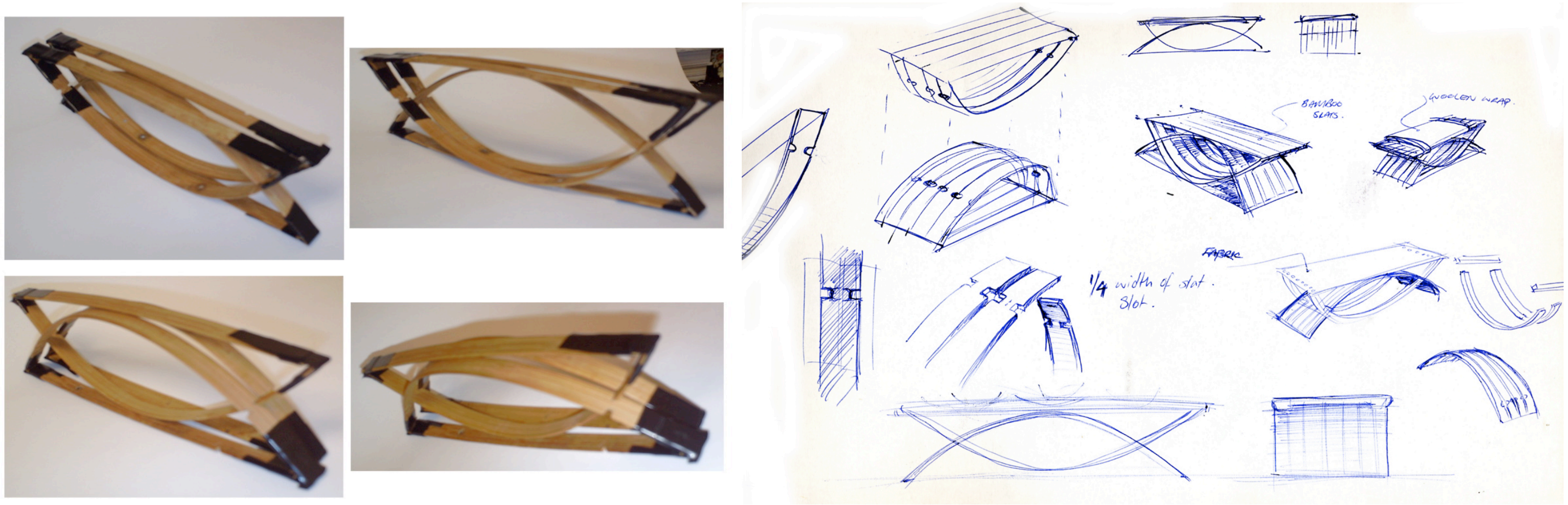
While working with the bamboo slats I observed that the material possesses a tremendous amount of elastic memory, returning to its original form when bent in an arc. Initially this ability was considered in light of creating a springy cushion substitute to foam. Experimentation through manipulation of the material and responding to it's inherent strengths lead to development of an entirely different approach to soft seating- combining the structural element with the cushioning element. This approach was explored through a series of reduced scale mock-ups and form studies, as depicted in the following pages.



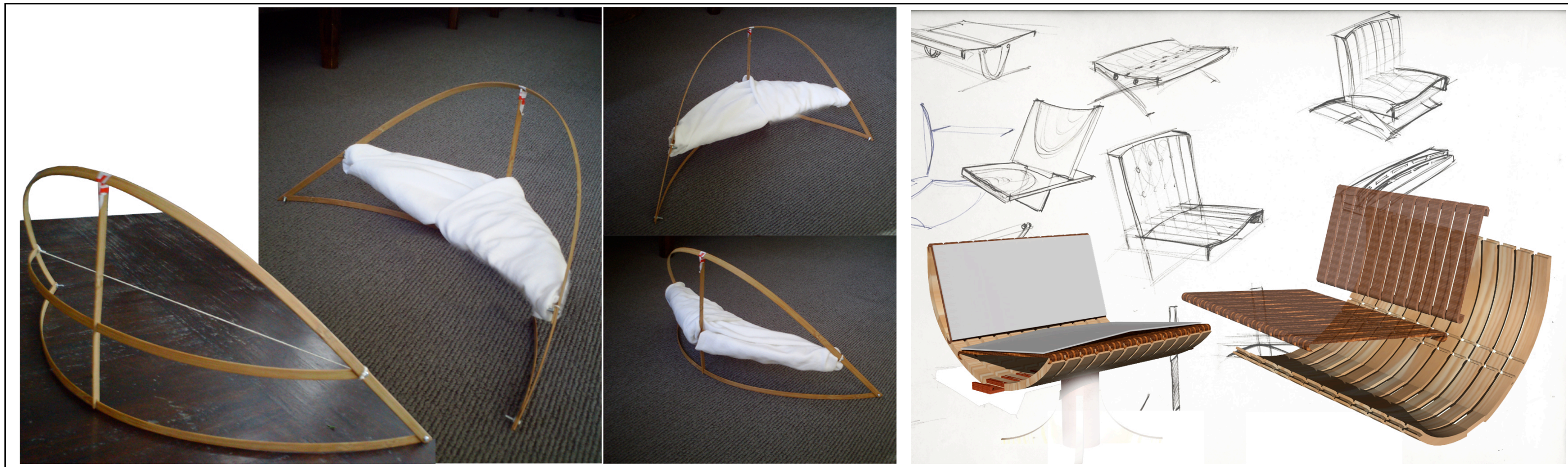
A cantilever couch? This sparse concept plays with archetypes for framing of soft seating, causing a double take. While novelty and familiarity are both present, the largely geometric form fails to draw associations with sustainability. Incorporation of the arc provided an interesting point of departure for the following ideas.



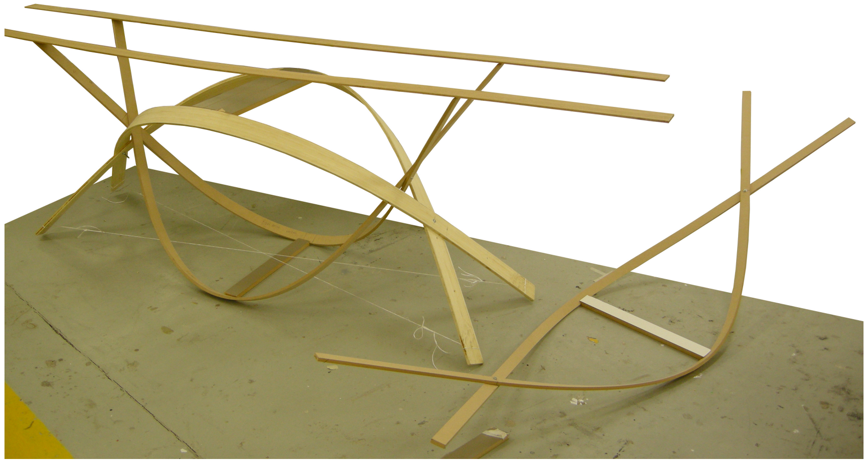
Another take on a cantilever seat, with dual seat pans 180° opposed to one another; the hinging structure of the seat slats interlock and spring against one another. The large double arch provides a mounting point for a hinging bar for the set pan slats and angled backrest. This again seeks to capitalize on the inherent elastic properties of the bamboo slats. The monumental aesthetic present in this form, with visual references to bridges and supporting archways imposes a sense of permanence- however it was assessed as uninviting with insufficient signifiers to assure users of its purpose as a soft seat.



Further exploration of possible form- the above concept seeks to utilize repetition of mirrored arc forms of the slat to create a suspended bench seat. It was found that reduction of the seat to minimal elements and components left a stark feel lacking invitation or warmth.

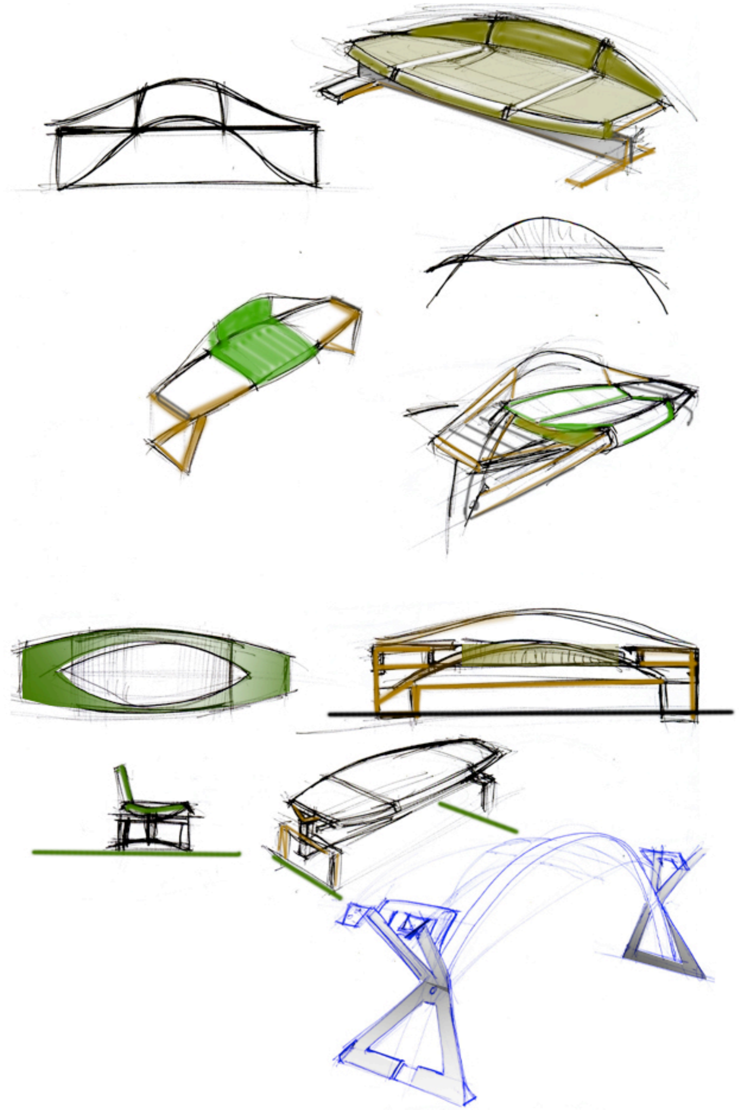


One of the most appealing discoveries made during this process of experimentation was what happens when 2 slats of laminated bamboo, sitting with wide faces one on top of the other, are bolted together one fifth of the length in from either end. When the slats are deformed into an arc the material twists to create a delicate and supple curve. The material retains an ability to flex, but the natural tension in the arc causes it to return to its initial form. Several mock-ups were created to examine how this quality could be capitalised upon in creating a soft seat that challenged convention.

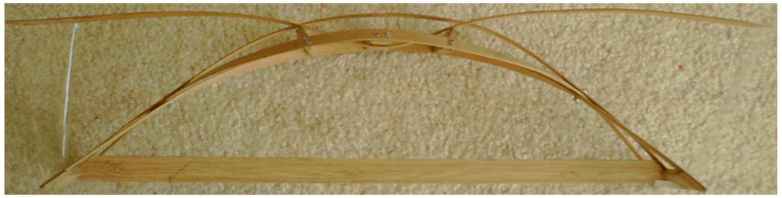


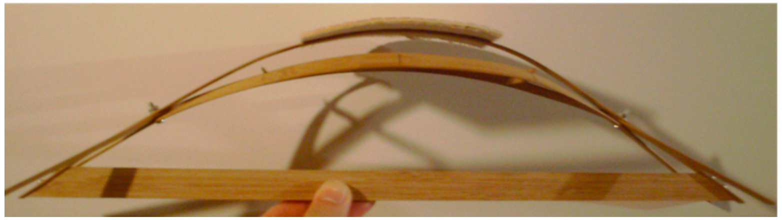
The proportions and delicate footprint this form creates has a strong connotation of nature. While the form appeals as elegant, the ‘delicate’ footprint is also quite long for a single seat pan.

Trials were conducted to evaluate how well the form could be nested, with the analogy of fallen leaf litter used as a source of inspiration.

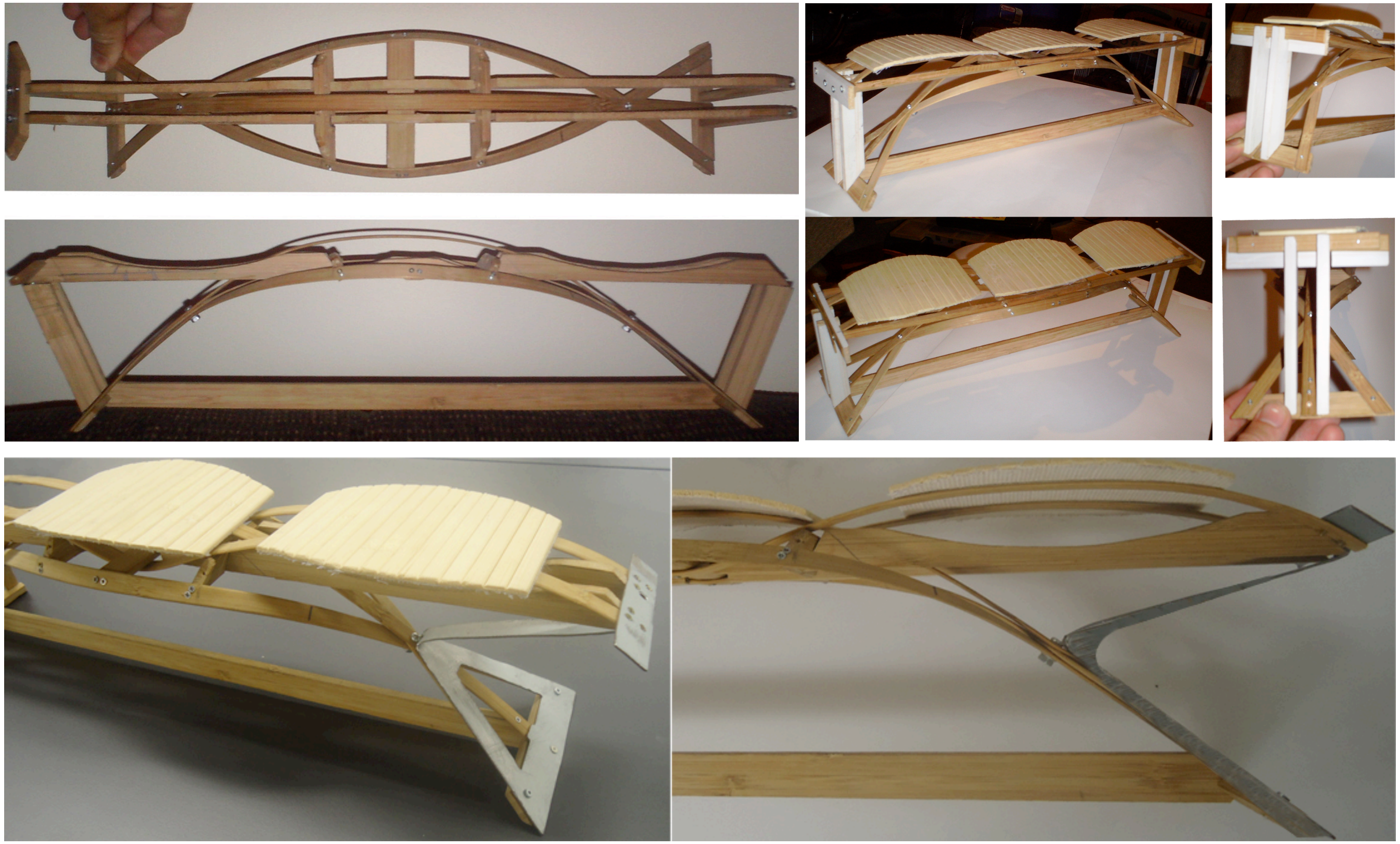


Further exploration of form for the overall product architecture continued through use of scale models and sketching. These helped explore the feasibility of integrating a backrest and multiple seat pans into the same footprint as a single seater.



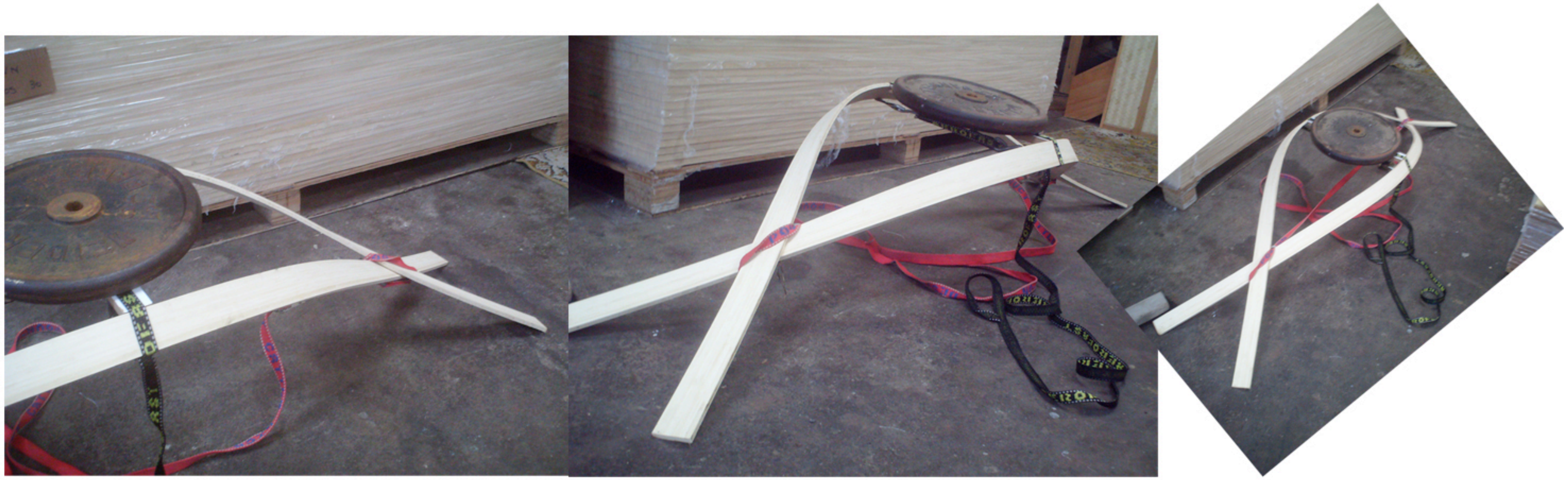


Integrating a backrest seemed to disrupt the flow of the arc and did not easily provide any extra body support. It was determined that an adequate sense of cushioned seating could still be achieved when retaining a seat pan alone.

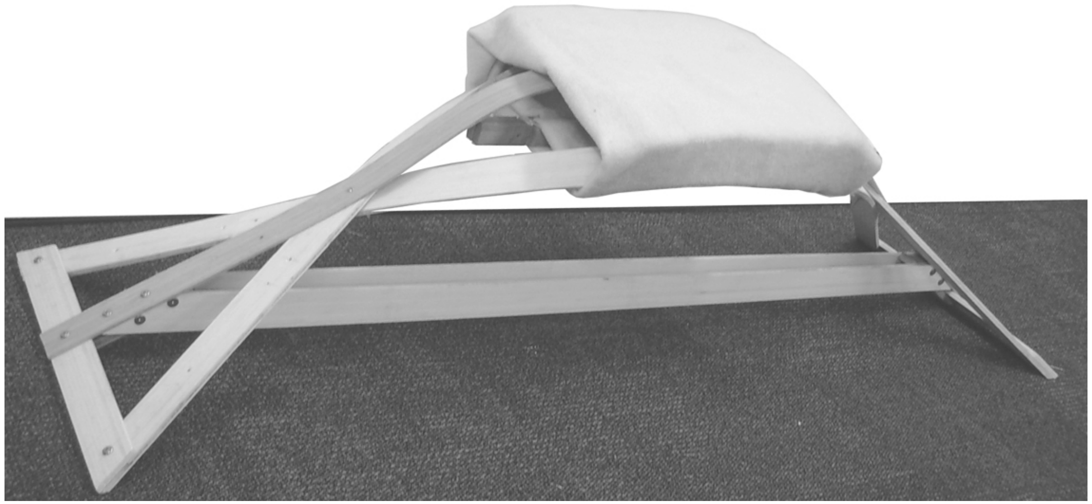


Experimentation with structural elements that support and terminate the seat pan proved difficult to integrate into the overall sweeping form. The linear forms interrupted and clashed with the organic aesthetic, while the exploration of using metal castings or folded sheet metal as anchoring ends seemed to have an abruptness that did not blend with the strong materiality of the bamboo. The large-scale proportions of this component also have an added financial cost that had to be considered. This lead to alternative ideas for achieving multiple seat pans through nesting repeated arcs.

Another of the challenges with the arc form is finding a balance between functional stability and minimal aesthetic interference. Multiple approaches were used in finding an appropriate method of bracing the frame so it could support weight in a consistent, yet unobtrusive manner. Ease of assembly and disassembly remained a key consideration, along with flat pack or self-assembly ideas. This meant that bracing elements had to be easy to install.

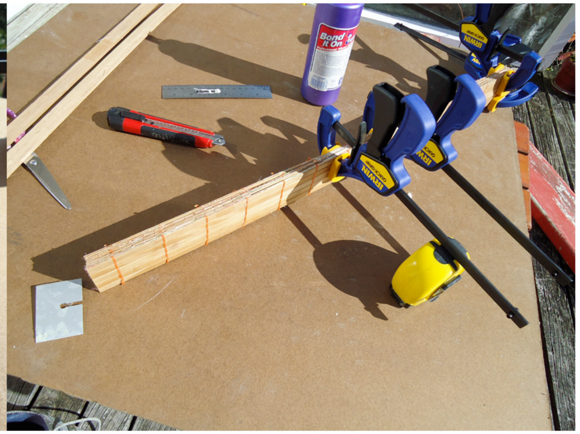


Testing of knockdown style cross- bracing added a sense of craft to the chair, but associations with primitive utility undermine the refined quality sought in a desirable seat.

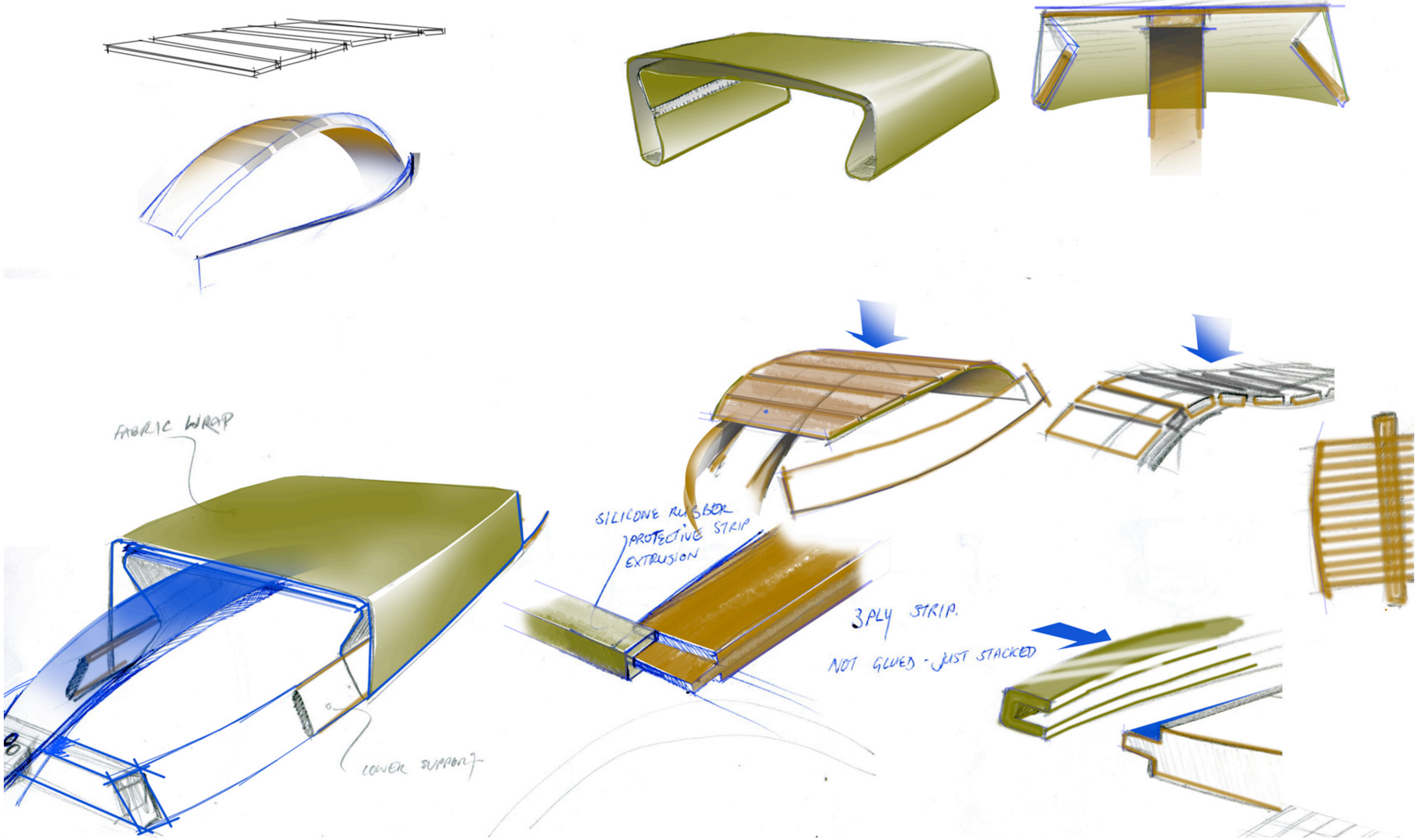


A horizontal beam provided an impression of weight or grounding to the base and helped prevent racking. The addition of a third bamboo arc provided support for the seat pan.

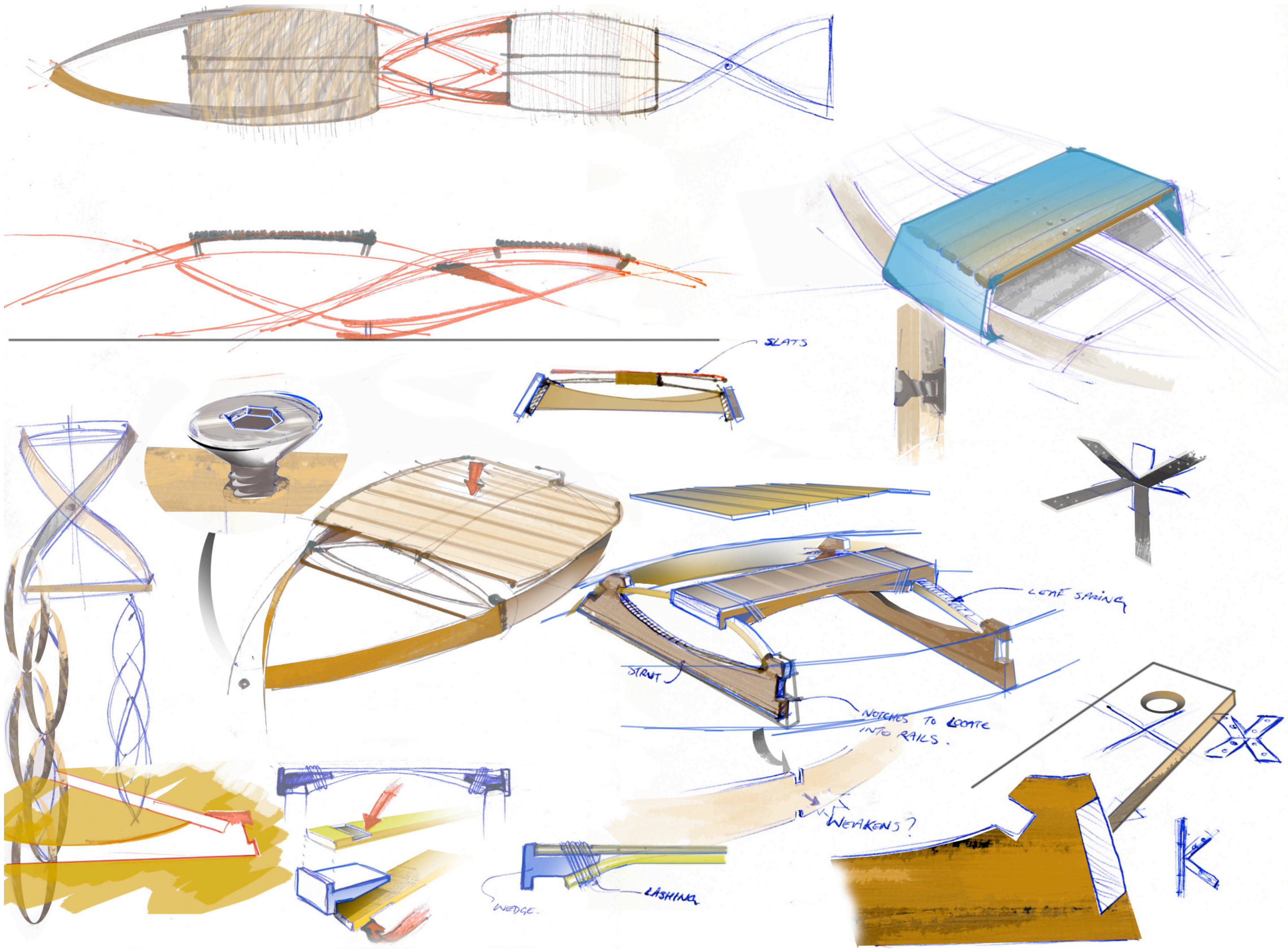
Improving the responsiveness of the seat pan also lead to further research and testing of bamboo slats in laminated assemblies based on principles of a leaf spring. These allowed for compression where desired and stability where not required.



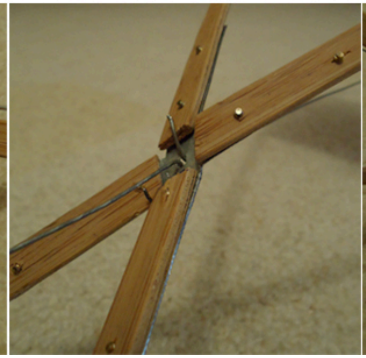
Test rigs featuring these specially laminated slat prototypes were constructed to prove the functionality of proposed use in the seat. Using a layer of upholstery fabric to wrap around the seat pan area and hold the slats in the form of a cushion creates a volume that is perceived as ‘soft’ and inviting. Easy installation or removal of the upholstery layer is facilitated by a simple zip.



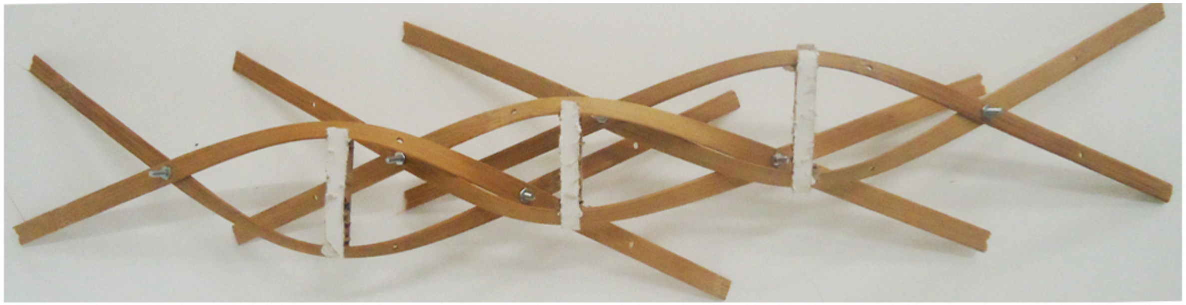
Preservation of upholstery from wear on sharp edges of the bamboo laminate is considered through use of a silicone rubber extrusion that can be threaded over specially profiled butts of the seat pan slats.

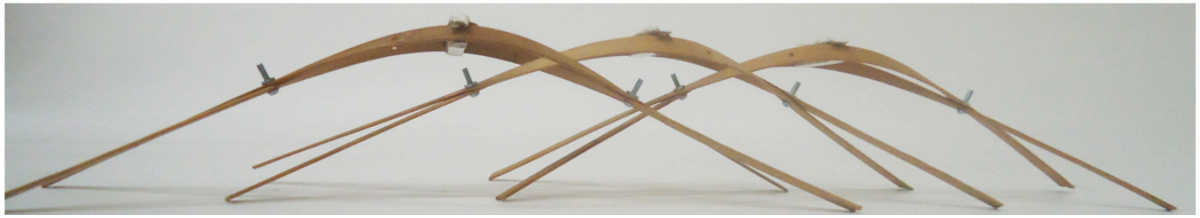


Refinement of details with the suspended slat seat pan and intersecting components were resolved with the assistance of sketching and three- dimensional mocking up. The third central slat was reduced to fit within the seat pan area, providing compressive support for the seat pan without visually interrupting the flow of the arc. This also provides space for other arcs to flow in and out of one another.



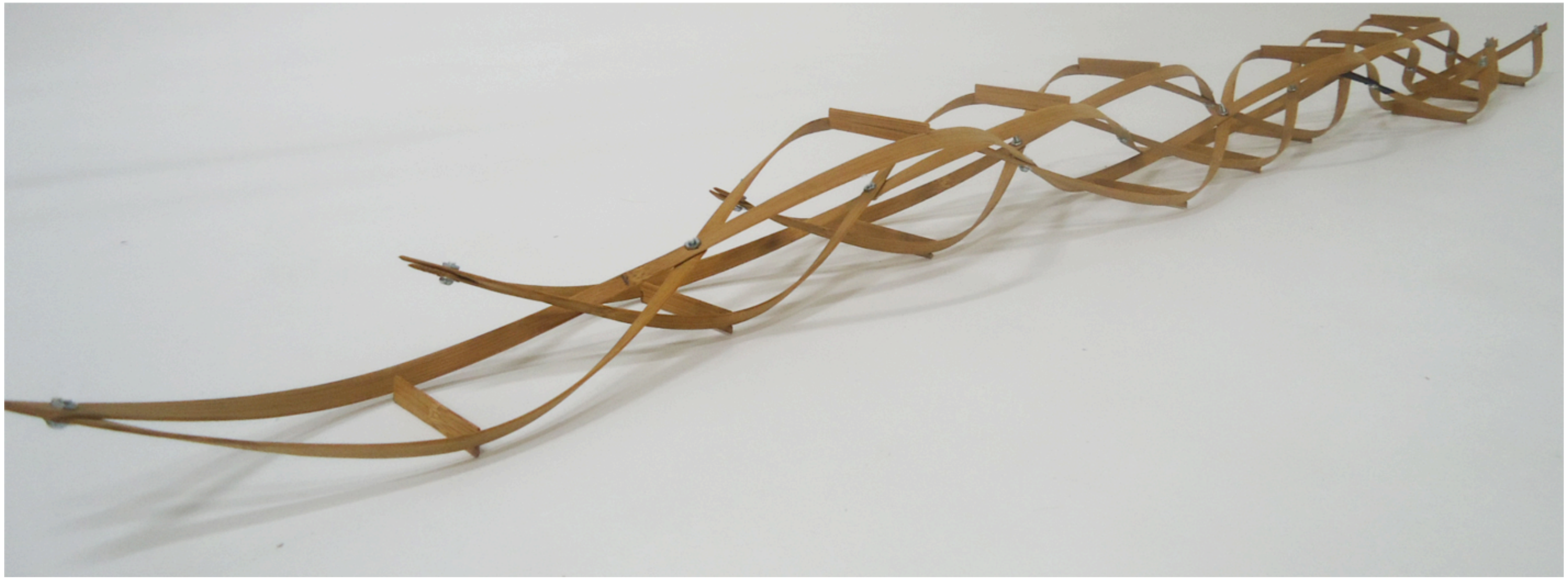
Mirroring of the seat pan curve in the legs added fluidity to the form that had been previously missing. These images reference consideration of use of metal bracketing joints at intersecting points to break the long form down in modular units that can be flat packed and assembled on-site. A tensioning cable is used to hold the form when compression forces are applied to the seat pan. The complex bracing required to support the intersecting arcs prompted exploration of asymmetrical positioning of the arcs. This helps avoid the mass intersection of six slats, as seen in the central image above





Asymmetrically interwoven arcs are explored with these models. The ability to create three seat pans within the length of the central arc was viewed as an improvement without compromising the organic aesthetic. This prompted further exploration to see how far this principle could be pushed.

These images are of a final scale exploration created prior to full- scale prototype construction. It demonstrates the inter-woven seat pan principle well, featuring mounting points for six seat pans.



Finding rest in the Flow

Introducing Flow modular public seating, providing a cushioned rest that sustains people and planet alike.

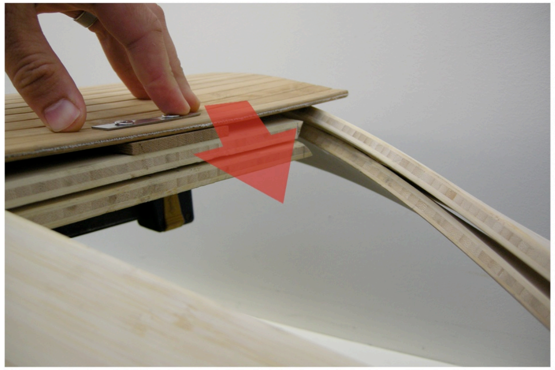
When considering this outcome in light of the design criteria established for this project (see page 35) it can be noted that the seat fulfils the performance and experience aspects with distinction. The sense of dynamism generated by the design is invigorating and suggests an original and engaging manifestation of sustainability principles for a seating prototype. The format of a bench seat lends itself to public spaces featuring high volume foot traffic. This in turn provides opportunity for broad exposure in the public domain and the opportunity to stimulate inquiry within a wide social context. The form has a highly organic appearance that equates to a unique aesthetic and a dramatic departure from the rectilinear volumes so entrenched in the industry. The flowing lines create a rhythm that the eye is drawn along as it seeks to make sense of what is being observed. The contrast between positive and negative space gives the seat a feeling of lightness, yet the symmetrical repetition provides a sense of stability that affirms users in the performance of the seat. The staggered intersecting arcs permit a series of seat pans to be achieved in an original and engaging manner.

The reductive qualities of the design, in which the few materials used are presented in an honest simplicity adds a sense of sophistication and refinement to the object, while also harking back to some of the craft qualities associated with hand-made furniture. While the majority of artisan skills used in contemporary upholstery are not maintained in this object, the attention to detail and materials is an important link that has been sought.

The use of laminated bamboo slats obtained from stock sheets means material wastage in the production phase is minimized and use of industrial production technologies including CNC machining are facilitated. While helping reduce production costs and ensure consistent quality is achieved.

The seat fits the profile of a biological nutrient due to the biodegradable nature of the materials used. Technical nutrients such as fasteners are easily removed for salvaging.

Above: seat-pan deflection generated during use is shown, demonstrating how the cushion slats respond to localized pressure in a manner similar to polyurethane foam.



The use of laminated bamboo throughout the seat, in both structural and cushioning applications is an innovative use of the material that capitalizes on the inherent strength and suppleness it possesses. The seat pan cushioning is firm but responsive and easily disassembled for refurbishment in the event of damage or product retirement. The hollow structure of the seat pan creates a visibility of its constituent parts- a feature previously absent in soft seating- enhancing the sense of integrity the design carries. The seat pan is suspended over the arc, being held in place by the opposing compressive forces of the central bamboo slat and the wedge-like effect of the seat mount arms.

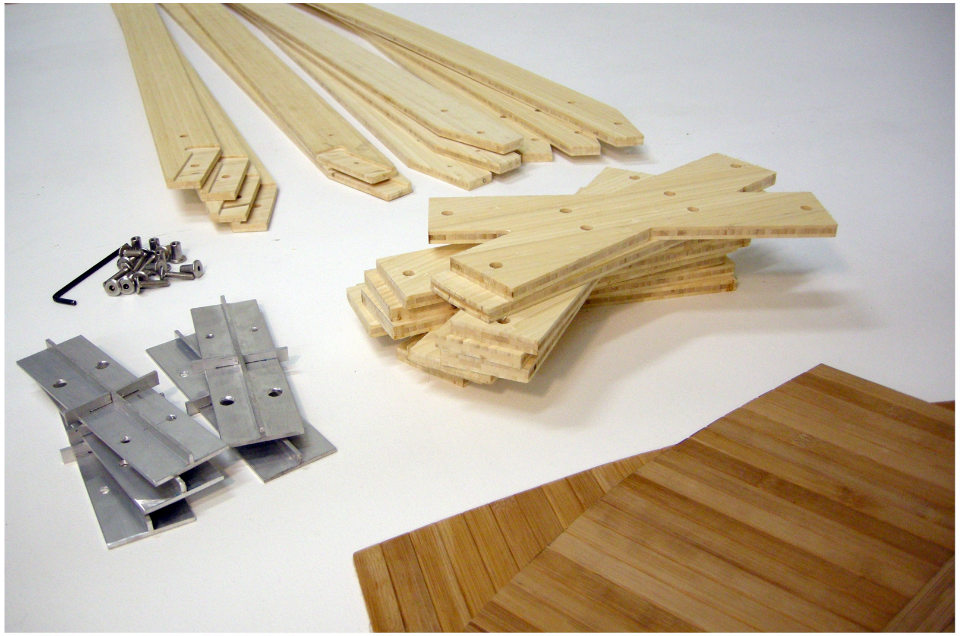
The volume created by the wrapped seat pan is a useful semiotic signifier for informing users where to sit and comprehend the seat as providing a cushioned rest. While this feature provides opportunity for customization of colour and surface texture, the chair also functions effectively without a seat cover.

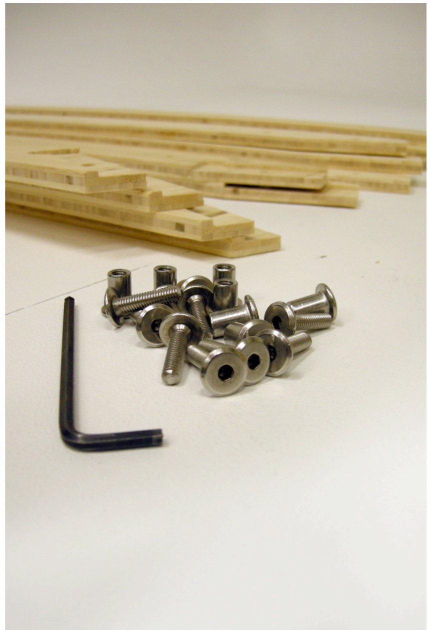
The removable upholstery wrap that connects onto itself is an innovation for the soft seating industry. The fabric can be either woven or felted wool or hard-wearing canvas and is readily replaceable for maintenance or refurbishment. Flame-retardants have been designed out of the chair by creating cushioning that does not trap air. The natural flame-retardant property of the woolen upholstery further ensures the seat pan is not a fire hazard.

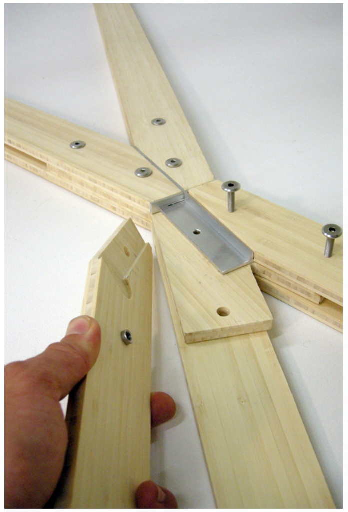
Images above depict the development of the seat-pan cover and one in place on the prototype.

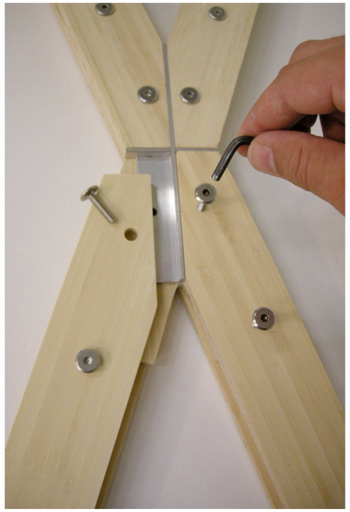
The modular nature of the design facilitates flat pack shipping and enables easy disassembly at the end of its useful life. One aspect of the design requiring further research is how to make the assembly process intuitive and achievable for lowly-skilled users, as it is currently relatively difficult to form the distinctive arc from the flat components. The components are held in the arc form under tension, providing the frame with a spring-like reflex that is difficult to form without specialist jigs.

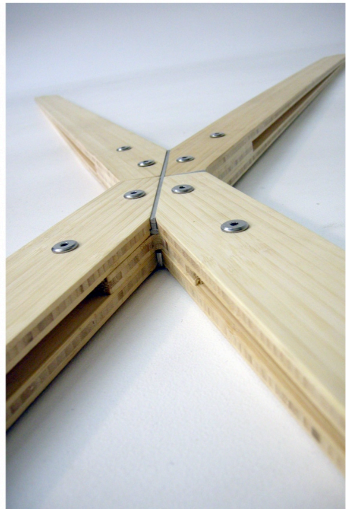
This selection of images depicts the components being assembled to form a seating section. The cross shaped bracket is bamboo, while the metal spacer is machined aluminium.

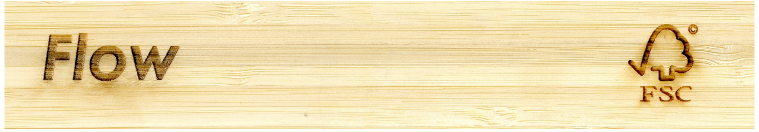












The bamboo products used in constructing the final design are sourced through a New Zealand distributor who import product from Hangzhou Zen Bamboo and Hardware Products Ltd. Zen Bamboo is Forestry Stewardship Council certified for the stewardship of their plantations (the first in China to do so). The boards utilize a non- urea formaldehyde glue and meet stringent international air quality standards including European Union’s E1 and America’s LEED MR6 and EQ4 requirements. This means that the glues used do not off gas toxic compounds. One potential criticism regarding this material is the carbon footprint associated with shipping it half way around the world for use in New Zealand. Research by van der Lugt at Delft University addresses this concern for Chinese bamboo imports into Europe, and notes that the rapid growth and high biomass (i.e. - excellent carbon sequestering ability) of the plant goes some way to offset these negative aspects when compared to alternative wood products.[67] When a broader view of sustainability encompassing social aspects is considered the use of bamboo gains further credibility as a catalyst for economic and social development, as previously discussed.

To help preserve and seal the bamboo laminate from moisture exposure a natural Danish oil finish has been applied.

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[67] van der Lugt, *Design Interventions for Stimulating Bamboo*, p. 18.

It was with pleasure that the final full-scale prototype was unveiled as part of the Master of Design exhibition in February, 2011, with observations and impressions on the design discussed at that point with examiners and the wider public. The exhibited prototype features a single seat pan, with connecting brackets extending out to either side to infer the continuation of the form.

Concluding thoughts

Coming full circle, when I consider the outcome of this research journey in relation to the blocky foam origins and philosophical musings where I started out, it becomes quite apparent how far this project has travelled. In his comment in *The Design Journal,*[68] Stuart Walker discusses the 'cage of aesthetic convention' that holds design in a state of regurgitation of form and function- a cycle of 'mutual pastiche'. I began this journey wanting to find a way to break free from the shackles of a genre's customs and precedents, to grapple with the personal significance of the sustainability discourse and find a way to communicate what I learned to others through an engaging and affective design object. I did not know what this object would look or function like, but by starting with these aims in mind it has been an exciting discovery process.

I have found that the role of material choice and experimental manipulation has had a significant influence over the aesthetic and ethical values embodied in the work. A supple material used as a structural member engenders a certain fragility that rests in contrast with the contemporary upholstered seat. Rather than relying on upholstery to conceal the means of support, Flow has a vulnerable honesty about the materials used that imbues a sense of authenticity that I had been yearning for. The reductive process of searching for the essence of the soft seat and the way the bamboo material naturally facilitates the simultaneous support and comfort of an occupant, as documented within these pages, has enabled the innovative design response. This shift in definition of what constitutes 'soft seating' is a significant departure from the norm and pushes the boundaries of aesthetic and performance familiarity.

Like most design journeys, I can appreciate that the Flow object remains a work in progress, with this point being a reflective lull in the current of design iteration. I will continue to refine details, seeking ways to enhance function and polish aesthetic nuances.

While this case study has been focused upon the design of a soft seat, the principles discussed and approaches utilized have transferable values for future design work. I have found the process of researching through design experimentation, material manipulation and form study richly rewarding for exploring the application of sustainability principles and development of a sustainable design language. Utilizing Warrel's PPE tool to explore the affective qualities of each design and guide product semantic and aesthetic development proved an enriching aspect of the study. The associations made to nature and natural rhythms with the final design are strong indicators that the design has successfully communicated the values embedded in the design. The capacity of the design to elicit desire for interaction is equally compelling.

[68] Walker, *The cage of aesthetic convention,* pp. 3-6.

Gaining a better grasp on the content of the sustainability discourse and comprehending the way it impacts on the development of a new three dimensional design has been both informative and incredibly challenging. The complexities at play in this process of evaluation and specification have produced its share of frustration, but also inspiration for ongoing design activities. While it is acknowledged that the triple bottom line of economic, ecological and social concerns need to be balanced in the development of a product, this case study has favoured the ecological and social aspects over economic concerns.

In many ways the interwoven elements of the Flow soft seating prototype poignantly reflect the complexity of weaving together the multiple streams of design consideration into a holistic product. The piece is a voice of hope, a sign that a way forward can be navigated in an engaging and beautiful way.

Through this research I have gained fresh optimism about the contribution I can make as a designer. This project will be a springboard for a fresh aesthetic and conscious approach to design that will sustain my career and passion for design.

Figure List

Image source

Figure Number	Source
Figure 1	Readymade magazine. Retrieved April 9, 2009 from http://www.readymade.com/projects/article/sprout_a_couch
Figure 2	Image retrieved 12 November, 2009 from http://img.archiexpo.com/images_ae/photo-g/bauhaus-design-armchairs-238560.jpg
Figure 3	Image retrieved 30 March, 2009 from http://www.johnangelobenson.com/work/selectedwork4.php
Figure 4	Image reproduced by Author, based on illustration from Laurel, *Research Methodologies: Methods and Perspectives*, P. 148.
Figure 5	Illustration by Author, 2009
Figure 6	Image retrieved on 6 May, 2009 from http://www.thenaturalstep.org/en/system/files/images/NewFunnel.jpg
Figure 7	Ottman, *Design: Green. Greener Products. Better Business.* P. 30
Figure 8	Image retrieved on 5 August ,2009 from http://alessionardi.com/tag/handcraft/
Figure 9	Image retrieved on 31 March, 2009 from http://www.plidesign.co.uk/wp-content/uploads/2008/08/reee-lca.jpg
Figure 10	Image retrieved on 21 August, 2009 from http://www.edmontonjournal.com/news/rebuilding-canada/closeup+edmonton+garbage/1082615/1086836.bin?size=620x400
Figure 11	Illustration modified by Author, based on image from Ottman, *Design: Green. Greener Products. Better Business.* P. 8

Figure 12

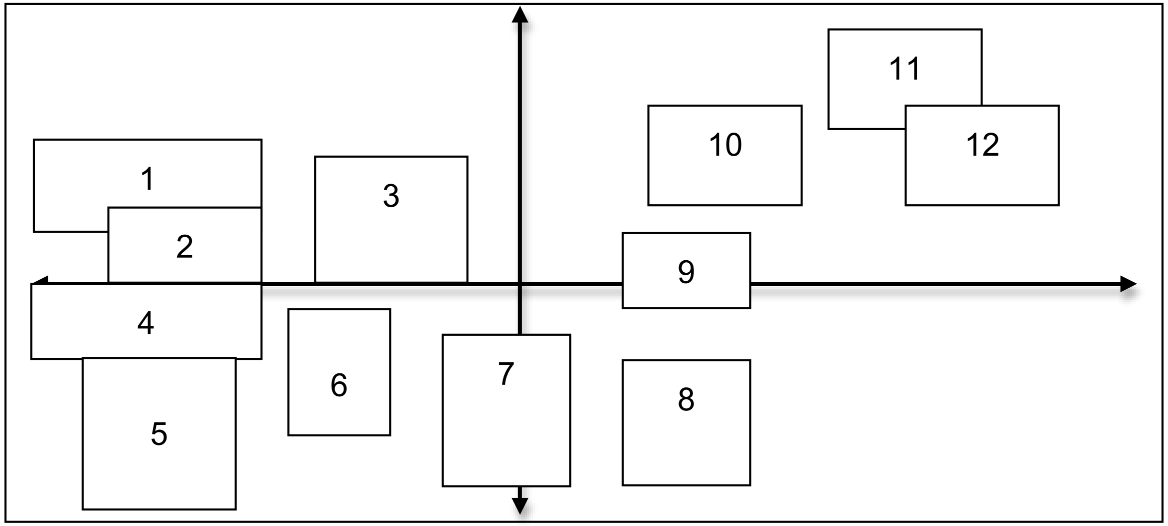

	Illustration composed by Author, 2010
12.1	Image retrieved on 13 December, 2010 from http://www.sillabarcelona.com/images/BARCELONAYOTTOMAN.jpg
12.2	Image retrieved 9 December, 2009 from http://www.portfoliobydesign.co.nz/commercial/item/95-miss-m-chair-sofa
12.3	Image retrieved on 27 November, 2009 from http://www.inhabitat.com/wp-content/uploads/greentiochair.jpg
12.4	Image retrieved on 13 December, 2010 from http://www.kadima.co.nz/KadimaShowroom/ProdID/20/RtnTab/174/PageIndex/1/CatID/-1.aspx
12.5	Image retrieved on 27 November, 2009 from http://www.eco-terric.com/betula-chair.html
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12.7	Image retrieved on 30 March, 2009 from http://www.unicahome.com/catalog/item.asp?id=23813&PartnerID=SHOPZ
12.8	Image retrieved on 12 December, 2010 from http://2.bp.blogspot.com/_2JrKyRMcVU8/SZ2OjVJp7UI/AAAAAAAALcY/XIq6awhqcCk/s1600-h/Chaos+by+Konstantin+Grcic+for+ClassiCon.png
12.9	Image retrieved on 15 November, 2009 from http://www.stylepark.com/es/dedon/leaf-side-table
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Figure 21	Composite and photography by Author, 2009
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Figure 23	Image modified by author, original image retrieved on 29 November, 2009 from http://i.ehow.com/images/GlobalPhoto/Articles/4851808/sofacushion-main_Full.jpg
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Figure 25	Illustration modified by author, based on original retrieved from Art van Vurre, *Natural Fibre Composites; Recent Developments*, P. 11.
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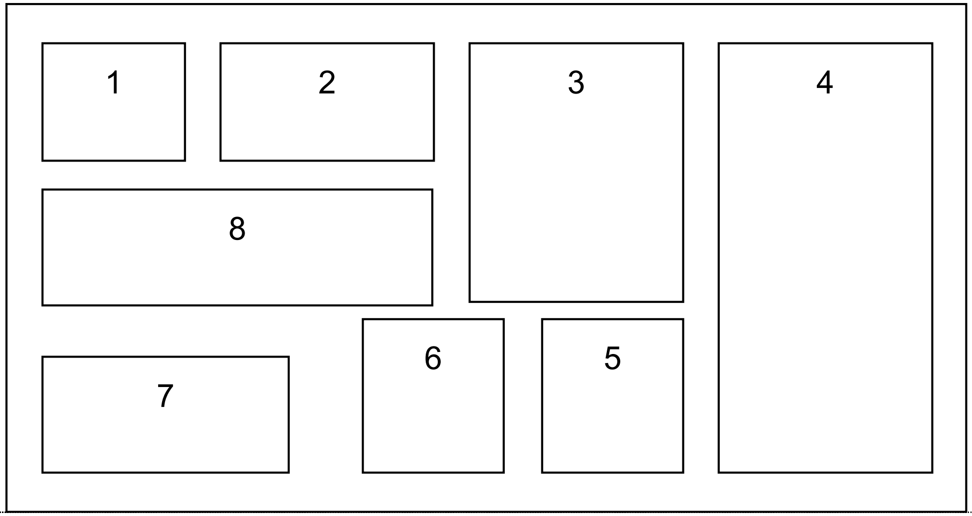
Figure 32



32.1	Image retrieved on 21 April, 2009 from http://simplydecoration.com/wp-content/uploads/2008/06/original-sofa-design.jpg
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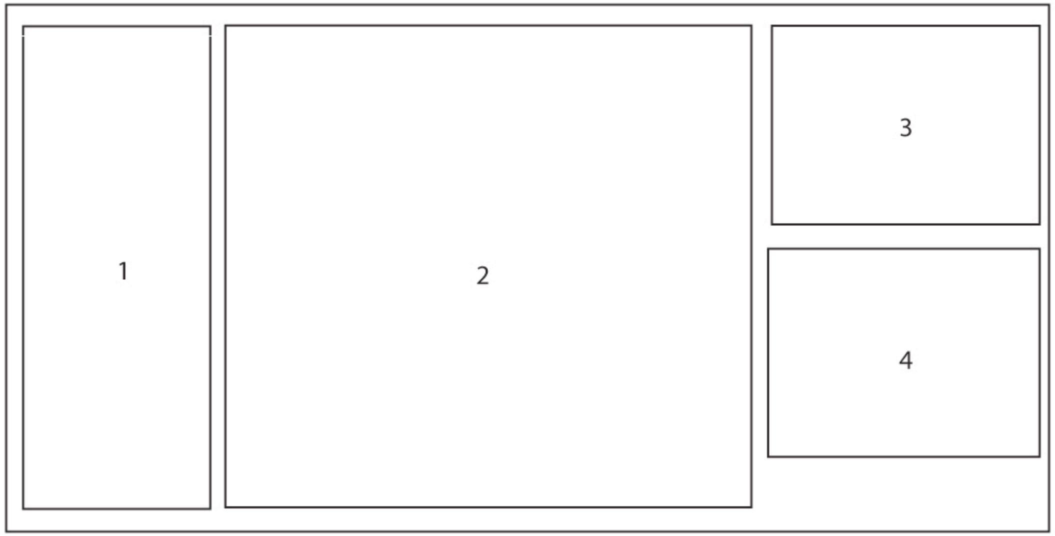

Figure 33

33.1	Images retrieved on 17 April, 2009 from http://www.designboom.com/weblog/cat/8/view/6441/toothpick-lamps-stamen-by-daisuke-hiraiwa.html
33.2	Images retrieved on 17 April, 2009 from http://www.archicentral.com/wp-content/images/img_sitooterie_1.jpg http://rawartint.files.wordpress.com/2008/07/sitooterie-ii.jpg http://www.yankodesign.com/2007/02/13/sitooterie-cube-with-5000-long-windows-by-heatherwick-studio/
33.3	Image retrieved on 4 June, 2009 from http://www.lehsd.k12.nj.us/Summer2003/watershed/Swamps%20and%20bogs.htm
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Following images, including sketches and photographs are the work of the author unless otherwise stated.

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Appendix One

The seats featured in the bi-polar chart in Figure 12, (see page 12) as examples of soft seating are introduced in this appendix. Reference is also made to the assessment of the affective qualities of each one, as analysed by Warrel's Perceptual Product Experience tool on page 30. The results of this analysis are included below.

1

Barcelona Chair and Stool by Mies van der Rohe, 1929

Constructed from Stainless Steel frame with polyurethane cushions covered in leather. Requires a high level of handcrafting. Originally designed for the King of Spain to sit it upon while attending the German Pavilion at the International Exposition

Table 3

PPE analysis	**Presentation**	**Representation**
	Impression Sophisticated, refined Polished metal legs contrast with luxurious black leather Thick, plush padded cushion	**Recognition** A reclining seating surface
	Appreciation Minimalist Quality materials Craftsmanship is evident- looks strong but light	**Comprehension** Slanted seat pan is for reclining back on
	Emotion Reverence	**Association** Throne- royalty exclusivity

2

Miss M Chair by Simon James, 2008

Constructed from pine, steel and multi-density elephant foam, the legs are brushed stainless steel. Can be finished in a range of upholstery fabrics. Made in New Zealand.

Table 4

	Presentation	Representation
PPE analysis	**Impression** Thick padded seat pan and low backrest Thin metallic tubular legs.	**Recognition** A simple and uncomplicated seating surface, like waiting room furniture
	Appreciation Appreciate contrast between solid seat and light-weight supporting frame, visual simplicity	**Comprehension** Slanted seat pan is for sitting back on, padded backrest is there for comfort.
	Emotion Friendly, safe, welcoming, innocent	**Association** Barby doll furniture?

3

Tio by Conscious Design, 2006

Made from pinus radiata, polyurethane foam, and replaceable cotton upholstery covers. Covers feature patterns contributed by some of New Zealand's top fashion labels. Has been a recipient of the New Zealand Designers Institute Best Design award for sustainability. Made in New Zealand

Table 5

PPE analysis	**Presentation**	**Representation**
	Impression Appears low and wide- no arm rests Thick cushioning looks comfortable Timber sweeps up from seat pan to form backrest	**Recognition** A stable and solid chair Proportions like a Barcelona chair by Mies van der Rohe
	Appreciation Clean lines and visual simplicity. Upholstery is in season	**Comprehension** Fabric areas are for resting body, timber areas are structural
	Emotion Appeals as contemporary- affirming values of owner Concern from elderly about ease of egress	**Association** Relaxing, reclining Scandinavian?

4

Big Rig by Kadima, 2010

Constructed from timber, polyurethane foam, leather or synthetic upholstery. Company emphasis is upon making to order and quality craftsmanship. A typical example of a mass produced soft seat. Made in New Zealand

Table 6

PPE analysis	Presentation	Representation
	Impression Large simple rectangular form, fully upholstered surface. Indistinguishable from other makes of sofa.	**Recognition** A familiar form, typical of a padded seat. No excess frills suggests a functional utility
	Appreciation Simple rectilinear aesthetic Looks solid and durable Large padded volumes	**Comprehension** Appears to be a safe, comfortable place to rest
	Emotion Pacified	**Association** Relaxing Recreation

5

Betula by Cisco Brothers, 2000

Constructed from FSC certified Timber, certified Organic cotton and wool, latex foams, 8-way tied coil springs. Company emphasis is upon supporting craft techniques and artisan skills to create quality, durable and ecologically sound seats.
Made in Los Angeles, United States of America.

Table 7

PPE analysis	Presentation	Representation
	Impression Big soft seat	**Recognition** A large, soft seat with stability and comfort.
	Appreciation Traditional aesthetic Large padded cushions Craftsmanship is evident in detailing	**Comprehension** Large padded areas are soft and supportive
	Emotion Security,	**Association** Corporate, hotel room, conservative

6

Myst by Fletcher Vaughan, 2007

Constructed from certified FSC Plantation plywood and low emission glues. Uses recycled rebonded foam. A large range of certified ECO fabrics is available to cover the chair. Comes with a standard powder coated steel or bead blasted stainless steel leg. Made in New Zealand.

Table 8

	Presentation	**Representation**
PPE analysis	**Impression** Lightweight, slender seatpan and backrest with strong horizontal patterning Tall narrowing back	**Recognition** A restrained and sophisticated chair suitable for corporate settings and public spaces
	Appreciation Minimalist aesthetic Stability	**Comprehension** Felted and ribbed upholstery appears soft for sitting on. Splayed legs provide stability
	Emotion Confidence/ security	**Association** Corporate, Business

7

Cubica by Tito Agnoli, 2002

Constructed from powder coated aluminium or chromed steel frame, polyurethane foam, nylon cover, replaceable upholstery textile. A key feature of this design is its ability to fold flat for transportation or storage, courtesy of hinged joints on the side of the arm rests.

Table 9

	Presentation	Representation
PPE analysis	**Impression** Rectilinear form Visual simplicity	**Recognition** A conservative simple seat. Utilitarian, no nonsense.
	Appreciation Symmetrical proportions of seat and legs Appreciate discovery of hidden locking mechanism	**Comprehension** Although padded, hard edges are not comforting to sit in.
	Emotion Indifference Contained	**Association** Corporate, restraint

8

Chaos by Konstantin Grcic, 2001

Constructed from Steel tubing, rubber webbing, Polyurethane foam, polyester fibre, stainless steel foot, fabric or leather cover. Grcic wanted to create an uncomfortable upholstered chair, to challenge conventions of correct, formal seating and leave it up to the user to perch, readjusting body position to find something that works for them.

Table 10

PPE analysis	**Presentation**	**Representation**
	Impression Dynamic, geometric form Appears awkwardly balanced- tipping back	**Recognition** An irregular slanting seating surface, cantilever base makes it looks like its tipping backwards
	Appreciation Different aesthetic Upholstered cover pacifies concerns	**Comprehension** Angled seat pan is for sitting on, angled back rest is unusual
	Emotion Curiosity Playful	**Association** Whimsical Solidity Sculpture

9

Leaf by Frank Ligthart for Dedon, 2009

Constructed from bent steel tube and woven polyester synthetic cord. For outdoor use.

Table 11

PPE analysis	Presentation	Representation
	Impression Dynamic, organic form supple structure	**Recognition** A curved seating surface, like a wave suspended in mid flow, like leaf, balancing lightly
	Appreciation Different aesthetic Woven fabric is pronounced	**Comprehension** A seat pan for perching on- not sure which way to face Springy frame? Not sure how comfortable as looks like it has quite a thin seat pan
	Emotion Curiosity Pleasure	**Association** Nature Fluidity, lightness Sculpture

10

Nananu by David Trubridge, 2000

Hoop Pine Plywood and Ash slats, Stainless Steel 316 screws. This is an occasional chair intended for indoor use. It is made from sustainably sourced materials and crafted using boat building techniques. Made in New Zealand

Table 12

	Presentation	Representation
PPE analysis	**Impression** Organic form Hollow Structure Horizontal lines from slats	**Recognition** A seating surface made by an impression, like a deflating ball, like a timber boat frame or woven basket
	Appreciation Different aesthetic Natural material Craftsmanship is evident- looks strong but light	**Comprehension** Scalloped dip is for sinking into, visible structure is rigid and securely grounded
	Emotion Curiosity Contentment	**Association** Nature Lightness Relaxing

11

Knotted Chair by Marcel Wanders for Droog, 1996

Hand knotted (macraméed) aramid braid with carbon core set in epoxy resin. This lightweight (5kg) seat is a result of Wanders experimentation with novel materials and processes. The structural parts are set rigidly while interior parts where body contact is made a free to move. This chair is more about exploration and interpretation of what a chair could be, rather than being focussed on comfort.

Table 13

	Presentation	Representation
PPE analysis	**Impression** Unique construction, unusual materials. Hollow Structure	**Recognition** A throne-like chair with lots of knotted details. Original material use.
	Appreciation Different aesthetic Unknown strength- seem to defy gravity Appreciation of avant-garde approach	**Comprehension** Recognisable seat pan and backrest inform where user should sit. Unknown comfort
	Emotion Curiosity Concern Apprehension	**Association** Surrealist playfulness Lightness Sculpture

12

Rag Chair by Tejo Remy, 1991

Formed from the contents of 15 bags of rags, held together with steel bands. Each is unique and can be customised with an owner's own discarded clothing included in the pile. This chair makes very obvious statement about the origins of its materials and the way they are assembled.

Table 14

	Presentation	Representation
PPE analysis	**Impression** Colourful, haphazard layers of cloth Steel bands pulling everything together.	**Recognition** A large throne-like chair Like piles of washing or unfolded clothes
	Appreciation Different aesthetic Original Witty simplicity	**Comprehension** The form of a chair is discernable, with back support and seat pan.
	Emotion Happy, playful Apprehension over stability	**Association** Recycling Wrapped presents

Appendix Two

Summary of existing cushioning materials for soft seating. It is important to note that this list is not intended to be read chronologically, as all options are still available to be used.

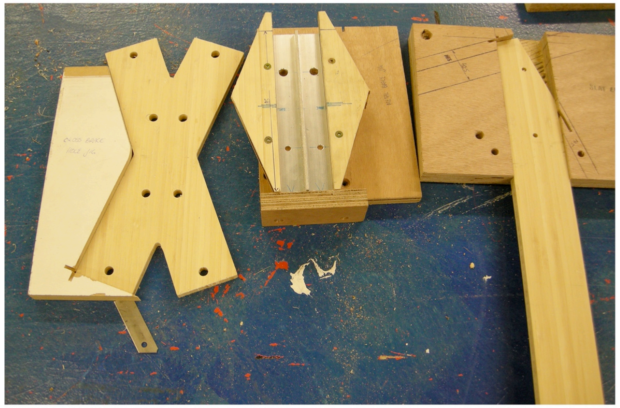
Material	Description	Strengths	Weaknesses
Animal hair 	Protein based organic fibre. Traditionally horse hair, but may also be swine or bovine hair	• Provides resilient, firm cushioning • Is biodegradable, if not rubberized. • Rapidly renewable.	• Susceptible to breaking down, and hosting invertebrates such as the furniture carpet beetle. (Anthrenus Scrophulariae)
Down 	Protein based organic matter. Feathers are a by-product of culling poultry for food industry	• Soft. • Easily reshaped. • Biodegradable. • Rapidly renewable. • Abundant resource.	• Highly compressive. • Requires frequent re-fluffing. • Quill tips can puncture enclosing bag causing unpleasant surface texture
Cotton 	Cellulose based organic fibre, felted to provide a compressive mat called batting.	• Soft texture. • Rapidly renewable. • Can reuse old scrap cloth.	• Highly compressive • Requires frequent re-fluffing • Questionable environmental impact from high water and pesticide use. • Recycled cloth may have toxic dyes
Coir 	Cellulose based organic fibre produced by coconut palm as an outer husk around the coconut. Fibre is separated and needle felted into pads	• Biodegradable. • Resistant to moisture. • Rapidly renewable. • Abundant resource. • Contributes to social development via its production.	• Coarse, requiring wrapping in a protective shroud, • Not easy to shape.

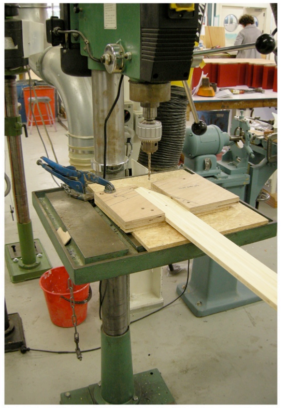
Table 15: Cushion/ padding material options currently used in soft seating

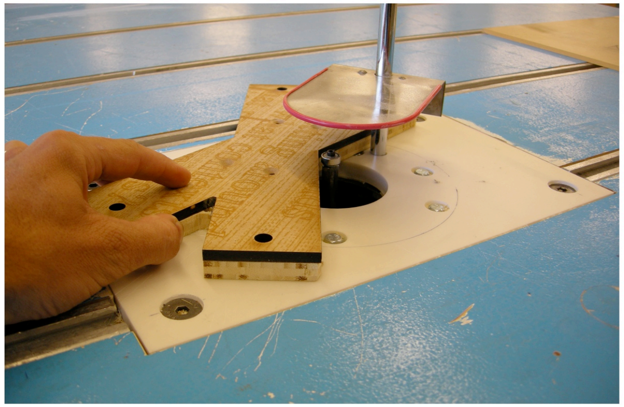
Material	Description	Strengths	Weaknesses
Latex rubber 	Organic compound, derived from the rubber tree (Castilla elastica) as a sap that is then distilled and cast into blocks or mats	• Biodegradable • Easily shaped/ molded • Contributes to social development via its production	• Expensive relative to polyurethane foam • Can aggravate allergies • Heavier than alternative foams, meaning increased freight costs.
Open cell Polyurethane Foam 	Petroleum based inorganic foam. Is the preferred padding material for contemporary seating	• Easily shaped with a knife blade • Durable • Cheap • Convenient • Soft texture • Customisable firmness	• Inherently unsustainable, for reasons mentioned above • Open cell structure is abrasive on upholstery fabric, requiring shrouding by a barrier layer
Steel coil spring 	An hourglass shaped spring made from tempered steel wire fixed in an array within a frame void	• Durable. • Reusable • Prized as a high-end solution for even distribution of support • Customisable firmness	• Complex and time consuming manual assembly • Not easily disassembled
Anti-sag spring 	A wave shaped tempered steel spring that is held in a flat plane by tensioning clips on the frame	• Durable • Reusable • Customisable for application • Resists sagging	• Complex manual assembly • Not easily disassembled

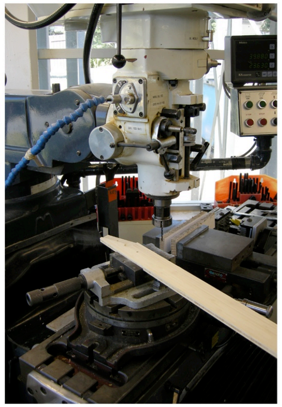
Table 16: Cushion/ padding material options currently used in soft seating continued

Appendix Three






Selection of images from fabrication of the prototype components, showing various jigs for drilling pilot holes in the bracket and slats (above), routering the bracket component and milling the slat recessed for accommodating the bracket reinforcing (below).

Appendix Four

Areas for further research:

An aspect of the design warranting further exploration is the ergonomic impact of various seat pan slat densities. While a variety of options are possible, the impact upon waterfall beneath the seated hamstring area and body pressure distribution from the buttocks through the seat pan has not been fully explored within the scope of this study.

Also of interest would be a full LCA of the object, featuring an account of the embodied energy compared to an industry standard soft seat.

Appendix Five

Ethics Approval statement

"This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher Benjamin Paton is responsible for the ethical conduct of this research.

If you have any concerns about the conduct of this research that you wish to raise with someone other than Benjamin Paton, please contact Professor John O'Neill, Director (Research Ethics), telephone +64 6 350 5249, e-mail humanethics@massey.ac.nz".

Appendix Six

Massey University
COLLEGE OF CREATIVE ARTS

Thesis DECLARATION

Author's Name (student):	Benjamin Paton
Title of Thesis	Flow. A case study in integrating sustainability values with affective design
Student number	00112941
Degree	Master of Design
Year	2011

Except where specific reference is made in the main text of the thesis, this thesis contains no material extracted in whole or in part from a thesis, dissertation, or research paper presented by me for another degree or diploma and has not been submitted for the award of any other degree or diploma in any other tertiary institution.

No other person's work (published or unpublished) has been used without due acknowledgment in the main text of the thesis.

Availability of Thesis

I hereby consent to the above report being consulted, borrowed, copied or reproduced in form time to time in accordance with the provisions of the Library Regulations made by the Academic Board.	YES NO
The Assistant Vice-Chancellor (Research) has approved an embargo for this thesis. Note: The period of the embargo will not exceed two years from the date on which the thesis is presented in its final format. During the period of the embargo the thesis will be treated as confidential and access restricted to supervisors, examiners and student. The Library will hold the completed thesis securely until the end of the agreed period; it may be released earlier with the approval of the Post Graduate Director or nominee.	YES NO

Candidate name: Benjamin Paton Candidate signature: Benjamin Paton

Date: 18 February 2011