Dualism: an investigation of Thai and Tasmanian environmental and cultural heritage through contemporary furniture

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Signed statement of originality

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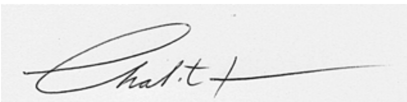

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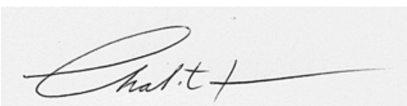

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Abstract

This project presents a novel consideration of two quite different cultural approaches to the challenges of design, heritage, materials, form and function. The resulting furniture objects demonstrate a model of 'dualism' that recognises distinct elements of Thai and Tasmanian culture, design and use of natural materials within a contemporary design aesthetic.

Synthetic materials, imported know-how, imitative design and mechanised manufacture dominate Thailand’s contemporary commercial furniture industry. In contrast, contemporary Tasmanian furniture is distinguished by bespoke design and handcrafting with local materials and a strong sense of originality and authenticity.

Through this project I have considered my own cross-cultural circumstances and Buddhist heritage as driving influences for designing and making furniture that incorporates representations of elements in Buddhist thought, Thai vernacular and aristocratic design and contemporary Western cultural practices within a broadly Modernist aesthetic.

My studio-based research investigated the attributes of traditional Thai design, especially the floating, reflective and contrasting effects of architectural construction and ornamentation, and the dynamic expression of overlapping roof tiers, and sought to find ways of re-introducing these cultural characteristics through contemporary furniture. These influences have guided the choice of materials, technological application and an aspiration for local sustainability, durability, transportability and affordability.

In undertaking the project, I have considered the contrasts between Western and Thai customs for utilising furniture, most notably the high-raised platform of Western furniture and the traditional mode of Oriental floor living. These apparent incompatibilities stimulated me to attempt to synchronise the pace of my own cultural and design heritage with native Tasmanian timbers, cross-cultural experience and progressive technologies.

Following experiments and reflection, I have resolved a strategy to assimilate vernacular Thai content with pared down aesthetics, hands-on execution, mechanical production and Buddhist 'dualism'. I extracted the trapezoidal connection between traditional Thai walls, cabinets and revealed joinery to evolve planar, linear and volumetric designs. The processes of realisation included sketched designs, computer-aided design (CAD), computer modelling, miniature models, full-scale prototypes and final fabrication.

The context of my research was informed by the works of architects, designers and sculptors who demonstrate methods of combining geometric abstractions and austere aesthetics, the interplay of opposites, and multi-cultural and spiritual influences. These practitioners include Modernists George Nakashima, Constantin Brancusi, Isamu Noguchi and contemporary architect I. M. Pei. I also looked into cantilever furniture, Kinetic Art and Op Art influences for spatial, dynamic and illusory connections.

The results of the project comprise series of benches and demountable shelving units. All pieces embody Buddhist dualism – complementary opposites, immingled with cantilever structure, multiple functions, changing visual effects in plane and line and contemporary fabrication. Individually and collectively they are intended to elicit the sense of place and nostalgia associated with regional Tasmanian timber, characteristics of Thai architecture, ornamentation and floating volume of typical Thai boats providing a riparian connection between Hobart and Bangkok.

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Finally, I would like to dedicate all the merits of this PhD Project to all Thai ancestors who sacrificed their life for the stability of nation, religion and the king, and also to my parents Chalermchai and Lamom Kongsuwan from whom I inherited the Sacred Three Jewels; the Buddha (the Enlightened One), the Dhamma (the Doctrine) and the Sangha (the Order).

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Introduction

If 'Yin' (dark) and 'Yang' (light) were truly the complementary opposites that govern the universe, my creative impetus would be driven by the polarisation between the contrived precision of mechanical production and the free spirit of handcraft.[1]

The Japanese-American woodworker, architect and a pioneer of the American Crafts movement, George Nakashima (1905-1990) said of the synergic combination of these two polar forces:

> *There was something intrinsically wrong with the practice based on form, even form following function. The interest is an intense craft approach... to evolve into a spirit of Zen, which goes beyond "less is more" ...the reality of operating a completely integrated activity; relationship with loggers, knowledge of fine hand-tools and machines. (Nakashima 2003, p.119 & 121)*

Fig. 1: The Chinese symbol of yin and yang (Wallpaper magazine October 2010, p.170)

After completing a Bachelor of Fine and Applied Arts from Rangsit University in the field of product design, I worked for two of the biggest industrial furniture firms in Thailand as an in-house designer. To impress my colleagues, I eagerly put all my

[1] Yin and yang is an ancient Chinese symbol, used to describe how polar or seemingly contrary forces are interconnected and interdependent in the natural world.

effort into creating new designs. But they did not meet either the machine capabilities or the commercial goals of the organization. My manager warned me that I could be fired before the end of my probation period. After two years of trying to fit a square peg in a round hole, I became unemployed and then a Buddhist monk. When I resigned from my steady job, my mother asked me a simple and profound question: 'Should you follow the environment or should the environment follow you?' I spent eighteen months unsnarling this knot during my monkhood. Then, due to the uncertainty of my religious commitment and my higher career expectations, I put on a white-collar shirt and started working for smaller companies again. Yet, my creative action was still dictated by machinery and commercial conditions.

Fig. 2: I and a senior designer at S.B. FURNITURE COMPANY in Thailand designed this bedroom set about thirteen years ago. All were made of particleboard and medium-density fibreboard (MDF) covered by printed foil (made of paper and plastic) often imported from overseas. The design and wooden pattern was directly influenced by the latest design trend from Milan furniture fair at that year. (Kongsuwan 1998)

Being involved in the highly competitive market in Asia inevitably means being subject to mechanical limitations such as designing to the limits of existing plant and equipment (often imported from Europe), and tight price and time restrictions. Synthetic materials, imported know-how and European design trend are fundamental keys to achieving commercial success in Thailand.

My experience influenced me to explore independent ways of synchronising my national cultural and design heritage with indigenous resources and progressive technologies. I sought to find eclectic ways of reconciling the incompatibility between an optimal quantity of machine-made production and a sentimental value of bespoke design and handmade furniture.

Nowadays, local references – especially the use of native materials, lifestyle and traditional beliefs – have been superseded by the use of machinery and the latest design trends. Intricate patterns of wickerwork have been overshadowed by the flamboyant colour of plastic wares. The rustic appeal of fishing traps made of plaited bamboo has also been eclipsed by the metallic shine of tin openers.

Is a decrease in the ability of living in harmony with environmental, cultural and spiritual surroundings caused by following exotic influences without regard to local references?

During one of the most disastrous floods in Thailand in late 2011, Thai houses that omitted the use of an elevated structure on posts were inadaptable to natural and climatic changes. Modern furniture on the ground floor had to be left in water due to its built-in installation: a feature that never appears in the lifestyle of Thais in the past. The concentration of industrialisation and the over-embracing of foreign design trends directly separate most Thais from the adaptable design and construction methods that our ancestors learned and passed on.

Fig. 3: **The top row** shows the raised floor of traditional Thai houses protecting the house from flooding (Chaichongrak 2002, p.48); **The middle row** shows the hybrid function of the ground floor of Jim Thompson's Neo-traditional house[2] which was adapted according to Western functional utility (Sthapitanonda 2006, p.239); **The bottom row** shows the damage on the ground floor of modern houses and built-in furniture during and after flooding in 2011, Nonthaburi, Thailand. (Kongsuwan 2011)

Since the shift from an agrarian to an industrial economy, traditional Thai craftsmen have been forced to compete with the mass production and precision machinery of Western industries. Currently, there are a number of schemes being undertaken by royal, governmental and private sectors to preserve traditional arts and crafts in

[2] Jim Thompson (1906-1967) was the expatriate American bon vivant who helped revive and promote the Thai silk industry in the 1950s and 1960s. He established his company Thai Silk Co., in 1948. Currently, Thai Silk Co is one of the world's largest craft enterprises, making hand-woven silk as well as hand printed textiles with some 3,000 employees in five countries. Due to the success of Jim Thompson's brand, there are approximately 20,000 families in Thailand gaining their income from the silk industry. (Mertens & McLeod 2007, p.202-205)

Thailand by helping them keep pace with industrial advances. However, due to heavy reliance on conventional methods and materials, most handicrafts are highly priced. The majority of Thais cannot afford these premium products, hindering the appeal of Thai products among local people.

Fig. 4: New interpretations of Thai handicrafts

From top to bottom; **the first row** shows barge-shaped nielloware inspired by the Suphannahong ceremonial barge made by the craftsmen of the support foundation under Her Majesty's patronage (Van Beek 2004, p.133 & Jamornman 2004, p.35); **the second row** shows Jim Thompson's printed silk based on the decoration of 19th century Siamese penta-chromatic ceramics (Warren 1989, p.35 & Mertens & Mcleod 2007, p.202); **the third row** shows modern vase inspired by the glass tiles that decorate traditional Thai temples & palaces designed by Eggarat Wongcharit 2004 (Mertens & Mcleod 2007, p.190 & 191); and **The fourth row** shows Mae Fah Luang's hand-woven textiles inspired by a geometric facade of modern shop houses in Bangkok designed by Lawana Poopoksakul (Mertens & Mcleod 2007, p.139 & 208).

The obstacle of promoting modern Thai crafts (based on traditional approaches) equates with the view of Elisabeth Frolet, the expert of Japanese arts and crafts, who comments on the reality of the Mingei (the Japanese folk craft movement in Japan during the first half of twentieth century)[3] led by the pioneer of Japanese Arts and Crafts movement, Soetsu Yanagi (1889-1961):

> *Some people might argue that Mingei is an anachronism, that [it] is impossible these days to make great numbers of objects inexpensively by hand, and that the Yanagi intended for ordinary people is now an art of the elite and not of the common people. Yet it remains to be seen to what extent the craftspeople who fled from the straitjacket of the Mingei group and who are active at present (for example, Issey Miyake, Kiyoshi Awazu, Sori Yanagi, and many others) will be inspired to produce outstanding works based in spirit. (Nihon Mingei-kan 1991, p.17)*

Fig. 5: From left to right; Teapot made of glazed porcelain and bamboo (height 21.5 x diameter 14 cm.) designed by the Japanese designer, Sori Yanagi (1915-2011) in 1958, made by Kyoto Gojozaka Klin Kyoto; and Dress & scarf-coat for spring summer collection in 1977, made of screen printed silk, designed by the Japanese designer, Issey Miyake (1938-present). (Hiesinger & Felice 1994, p.72 & 129)

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[3] The objectives of Mingei movement are to promote the austere aesthetics of Japanese folk craft and to continue the practice of handcraft in traditional ways. The characteristics of art works that fit the criteria of Mingei, include:

- Forms and decoration that were not contrived but arrived at unconsciously and intuitively over time;
- Designs that evolved from practical considerations and long familiarity;
- Reliance on local and natural materials; and
- Prizing the natural character of the media. (Nihon Mingei-kan 1991, p.7-8)

The incompatibility of the optimal quantity of mass-produced productions and the spiritual value of conventional handicrafts stimulated me to investigate the attributes of my own national design heritage and seek to find ways of merging traditional and vernacular content with the pared down aesthetics and production of Modernism. There were four main features of traditional Thai design that I concentrated on within my investigation: the floating qualities of architectural components, a dynamic expression of multi-layered elements and the reflective and contrasting qualities of ornamentation.

The context of my research lies in three key areas: environment, culture heritage and spirituality.

The section on environment will describe how indigenous awareness, spatial concern and aesthetic quality are interrelated in the field of contemporary design. I will refer to traditional Thai buildings such as houses, temples and palaces. These conventional modes will be compared to modern design principles, in particular architecture and cantilevered elements in furniture.

Within my discussion of cultural heritage I will consider how the utility of Western furniture and the flexibility of Oriental floor seating can be combined for hybrid functionality. I will examine the assumed incompatibility between Western and Eastern customary lifestyle such as relaxing, eating and dressing and suggest the possibility of connecting the two conventions in eclectic ways.

My discussion of spirituality will illustrate how two opposite elements can be interconnected harmoniously to embody the dual aspects of Buddhism in regard to synergetic compositions of line, plane and volume.

In summary, therefore, the main aims of this PhD project are to explore the possibilities of:

- Reintroducing the features of traditional Thai arts and crafts in the design and production of locally sustainable, durable, transportable and affordable furniture;
- Bridging the strict distinction between the rigid standards of Western ergonomics and the unconstrained function of Oriental floor seating for flexible usage;
- Combining native Tasmanian materials with the conventional heritage of Thai craft and beliefs to convey an intercultural spirit between Tasmania and Thailand; and
- Offering alternative choices for a large number of people who are restricted by the incompatibility of short-lived mass-produced products and high cost handmade furniture.

Chapter One: design inspiration and project description

The chapter considers the attributes of traditional Thai design and explores ways of re-introducing my cultural design heritage into the design and production of contemporary furniture. The field of investigation in this chapter ranges from architectural to ornamental components, with a selection of exterior and interior decoration, utensils, mural paintings and revealed joinery, as well as selected contemporary furniture and sculpture.

This chapter also investigates the distinction between aristocratic and folk Thai ornamentation. Furthermore, I will describe how the abstracted representation of decorative inlay relates to the highly visible characteristics of inlaid joint and the trapezoidal Thai form. To pave the way for contemporary design, I examine the works of George Nakashima (1905-1990), the Japanese American woodworker who used the butterfly joint for both decorative and structural purposes.

At the end of this chapter, I will illustrate how the planar representation of revealed joints was shifted from a two-dimensional motif to a three-dimensional form of furniture and sculpture. Three exemplary works were inspired by the combination of trapezoidal abstraction, re-compositions and opposite interplay. Then, I will show how trapezoidal geometry (as a thematic design tool) was incorporated with the three combined elements above as a means of reconstituting new decorative patterns and functional forms from my previous designs. After that, I will describe the context of my PhD project.

Design inspiration

The hallmark of traditional Thai design

Nithi Sthapitanonda (1947-present), the Thai architect who is one of the National Artists of Thailand states:

> *The deepest layers of traditional Thai building such as temple layouts and memorial towers were initially drawn from the antecedents of Buddhist architecture among west Asian countries including India, Ceylon and Burma since the 6^{th} century. From the period of 13^{th} century onwards, the influence of Chinese architectures widely spread in Thailand. During the 19^{th} century, Western and Chinese styles played an influential role on Thai architecture. (Sthapitanonda 2006, p.187 & 213)*

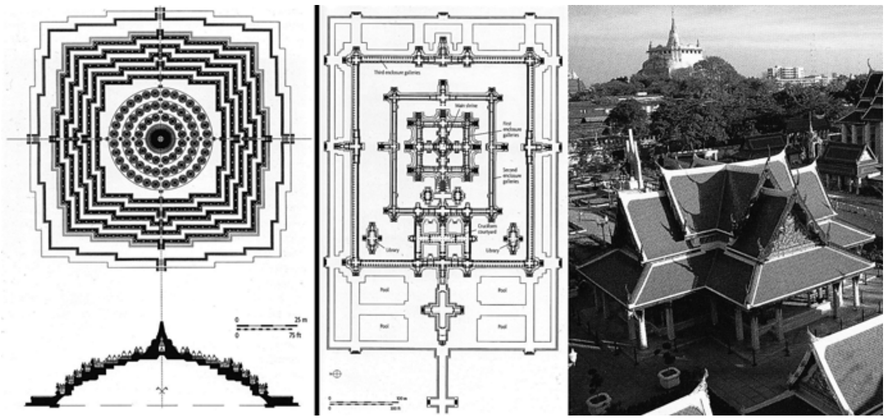

Fig. 1: From left to right; plan and half-section of the Great Stupa shrine at Borobudur Java, ca.800-50 (Moffett 2003, p.75); the layout of Angkor Wat at Cambodia, begun ca.1120 (Moffett 2003, p.83); and the cruciform roof of the ceremonial pavilion of Bangkok near Ratchanatdaram temple, the late 20^{th} century (Sthapitanonda 2006, p.136)

A 1999 study by the Thai industrial design researcher, Dr. Aurapin Pantong, from Chulalongkorn University, Thailand concluded that:

> *The old style of Thai design during Rattanakosin period (1782-present) was formal and orderly. It was characterised by symmetry, uniformity, ornamentation, set pattern as well as the use of multiple layers and contrasting colours. (Mertens and McLeod 2007, p.14)*

According to Pantong, these three main elements create the character of traditional Thai designs:

- **Composition** (symmetry and uniformity);
- **Ornamentation** (traditional and set pattern, the use of multiple layers and contrasting colours); and
- **Metaphor** (depicting celestial sense through floating structures, cruciform layouts and hierarchical orders).

By collaborating Pantong and Sthapitanonda's opinions, claiming that symmetrical composition and metaphorical aspects are unique features of traditional Thai design does not seem appropriate: these two characteristics are also obvious in the religious architecture of other Asian design traditions. For instance, the composition of most Buddhist temples in Asia appears symmetrical and orderly. These temples also reveal the sense of lightness through floating roof ends. Similarly, multiple layers, concentric patterns and cruciform layout were widely used as miniature abstracted representations of the cosmological system. As time went on, these features became unique characteristics of Asian architecture.

Fig. 2: The similarity of Japanese, Chinese and Thai architecture is obvious in the upward curves of projecting roof ends, the overlap of multiple roof tiers and the symmetry of structure.
From left to right; the Eastern Great Temple at Todaiji Nara, Japan, ca. 1200; Hall of Supreme Harmony (McArther 2002, p.201); Forbidden City Beijing 15th century (Moffett 2003, p.96); and the Marble Temple built during the reign of the King Rama V 1868-1910 Bangkok, Thailand (DeVoss 1994, p.93)

Fig. 3: The similarity of religious architectures in China, India and Indonesia is apparent in multi-story building with layered roofs.
From left to right; the pagoda at Horyuji temple Nara Japan built around late seventh or early eight century (McArther, 2002 p.22); Pagoda at Fogong Temple, Yingxian, China, 1056 and Pagoda at Dazu, India, 12th century (Moffett 2003, p.89); and the shrines of Pura Besakih, Gunung Agung, Bali, Indonesia (Freeman & Shearer 2000, p.97)

In Thailand, there has been a long tradition of using auspicious signs and symbols for honorific and hierarchical purposes. Among many symbolic representations, multi-elemental layers and concentric patterns play a significant role in symbolising Buddhist cosmology. This can be seen in the stupas and roof spires of temples and palaces and royal regalia such as crowns and parasols. Nithi Sthapitanonda clarifies the religious significance of consecutive layering, concentric pattern and Thai architectural components:

> *A deeply Thai world-view was shaped by a 13th-century Hindu-Siamese treatise known as the Traiphum or The Three Worlds, which envisions time and space as layers of oceans and peaks encircling the mythical Mount Meru. For living beings, time comprises cycles of birth and rebirth in which one hopes to attain an ever higher form of existence through the accumulation of merit by doing good deeds. This progress through oceans of time can be plotted in space.*[4] *(Sthapitanonda 2006, p.13)*

[4] The doctrine of Theravada Buddhist cosmology explains time, space and human existence within a system of hierarchical layers. In this case, the mythical Himalayan abode of the gods called ‘Mount Meru’ is assumed to be the centre of universe. Consequently, the consecutive progression of multiple tiers, which tend to diminish in size toward the sky, is a major element within ceremonial Thai architecture and regalia. The spire signifies the peak of Mount Meru, surrounded by concentric elements, which signify layers of mountains and seas. (Sthapitanonda 2006, p.13)

Fig. 4: The two-dimensional representations of Hindu-Buddhist cosmological iconography

From left to right; the concentric diagram of The Three Worlds appears in a 1776 manuscript version commissioned by the King Taksin (1734-1782) (Sthapitanonda 2006, p.13); and the scene of cosmological myth is depicted through gilded lacquer painting applied on Ayutthayan manuscript cabinet doors from 18th century (Warren 1994, p.54).

Fig. 5: The three-dimensional representations of Hindu-Buddhist cosmological iconography are reflected through the multiple tiers of pagoda, spired roof top and overlapping roof tiers

From foreground to background; the Ceylonese style Memorial tower built during the reign of the King Rama IV (1851 to 1868); and the spired roof form of scripture hall and the Royal Pantheon (Sthapitanonda 2006, p.121)

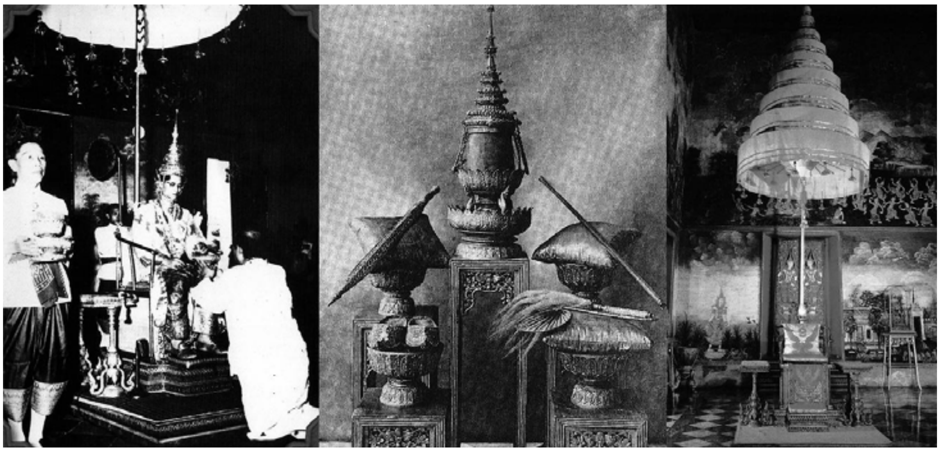

Fig. 6: The influence of Buddhist cosmology upon royal regalia
From left to right; the King Rama IX (1927-present) while sitting on a high raised seat under a royal parasol in a full ceremonial dress on the occasion of his coronation in 1950 (Van Beek 2004, p.107); items of the royal regalia including crown and sword (Warren 1994, p.46) and a nine-tiered parasol (Sthapitanonda 2006, p.120)

According to fig. 1 – 6, the similar appearance of ancient Buddhist edifices in Asia has been influenced by human's desire to reference the mythical world on an architectural scale. This can also be seen within the design of ceremonial utensils. However, there is clear division between each Asian design heritage. This distinction is obvious in the field of ornamentation. In this field, local artisans incorporate their native inspiration within a diffusion of the Buddhist architectural style. Sthapitanonda makes a metaphorical statement:

> *If the cake's ingredients were compared to the uniformity of symmetrical compositions and symbolic expression among Asian architectures, the cross-breeding ornaments with Thai application would act like an icing on the last layer of the cake. (Sthapitanonda 2006, p.187 & 213)*

Over time, this ornamental crossover became the most recognised character of national design heritages. Consequently, the attributes of Thai architectural ornament have become an initial source of my design inspiration.

Fig. 7: The trapezoidal connection between Buddhist architecture in West Asian countries and the typical Thai forms

From left to right; the temple of Arunchaleshvara South India (Freeman & Shearer 2000, p.77); the Potala Palace Tibet (McArther 2002, p.194); tapering manuscript cabinet with gilded lacquer decoration mid-19th century (Dansilp & Freeman 2002, p.83); and The Luang Pu Tao Museum in Nakhon Phanom Thailand built around the late 20th century (Sthapitanonda 2006, p.245)

The repertoires of Thai architectural ornaments

Fig. 8: From left to right; the gilded lacquer door of the Royal of Pantheon at the Temple of the Emerald Buddha, seen from far, medium and close distance (Sthapitanonda 2006, p.128 & 155) and (De Voss 1994, p.101)

Fig. 9: From left to right; the glass mosaic decoration on the exterior walls at the Temple of the Emerald Buddha, seen from three different distances (Sthapitanonda 2006, p.155 & 190) and (Dansilp & Freeman 2002, p. inner cover)

As seen in fig. 8 & 9, the traditional Thai temples and palaces reveal the different effects of decoration from different distances. By viewing from a distance, the reflective qualities of the lustrous surface of ornamental components such as mother-of-pearl inlay, gilded works, glazed tiles and glass mosaic can be seen. On closer examination, contrasting colours and intricate detail become apparent. Anna Leonowens (1831-1915), the English teacher of the King Mongkut’s children, eloquently describes the uniqueness of Thai architectural ornaments:

> *Perhaps the most unique and graceful object of architecture in Siam; shining like a jewel fantastic and gilded, flashing back the glory of the sun, and duplicated in shifting, quivering shadows in the limpid water below. (Moss 2007, p.84)*

Over time, the reflective and contrasting qualities of Thai architectural ornamentation became attributes of traditional Thai arts and crafts. Both mother-of-pearl inlay and gilded lacquer play a significant role in decorating the final layer of interior walls, religious sculpture, furniture and even utensils. However, due to the confusing optical effect of highly reflective glazed tiles and glass mosaic, it is rare to find them in interior decoration. Sometimes, the contour of royal utensils borrows from architectural outline. For example, the mother-of-pearl receptacle with a conical redented lid echoes the redentation of memorial tower. These examples illustrate how exterior and interior were carefully interconnected by ancient Thai craftsmen.

Fig. 10: From left to right; the overview and details of gilded lacquer painting on the interior wall of a scripture pavilion at Suan Pakkad Palace. Notably, gilded lacquer also appears on the panel of a trapezoidal wooden cabinet used for storing Buddhist manuscripts. (Chaichongrak 2002, p.13) and (Sthapitanonda 2006, p.195)

Fig. 11: From left to right; the overview and detail of mother-of-pearl inlay, presented on the feet of the Reclining Buddha image at Pho temple (Sthapitanonda 2006, p.196 &197)

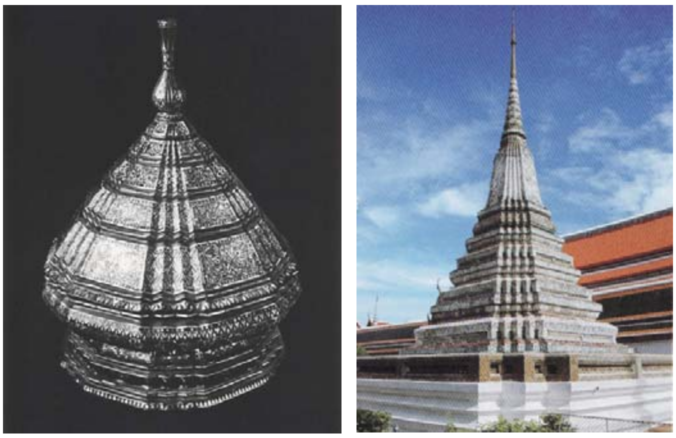

Fig. 12: The relative form between royal utensil and religious architecture
From left to right; a redented receptacle made of wood and decorated by mother-of-pearl inlay from Suan Pakkad Palace Bangkok (Beurdeley 1980, p.30) and the memorial tower at Arun temple with its redented corners (Sthapitanonda 2006, p.95)

Distinctions between aristocratic and folk ornaments towards sustainable design

Without the presence of ornamentation, it is almost impossible to establish a clear division between aristocratic and folk craft. Figure 13 illustrates that if gold and silver colours were not painted on the surface of ceremonial baskets, they would be no different to those ordinary wicker works that are used in the everyday life of villagers. This coincides with the perspective of the American anthropologist, Robert Redfield (1897-1958) who stated: *'Culture can be influenced by both the ruling and ruled class.'* (Kanokpongchai 1991, p.20)

Having been continuously governed by absolute monarchy for seven centuries, it seems that many arts and crafts within Thai culture bears the influence of the ruling class, the origins of trend and popularity having spread out from the royal court. However, there are restrictions: ostentatious ornamentation has been reserved for honorific and hierarchical purposes and reflective opalescent and gilded ornaments are used exclusively by aristocrats and monks.

Fig. 13: From left to right; silver and gold painted baskets suspended from elegant carrying poles while being used by celestial maidens at the annual Ploughing Ceremony in Bangkok and unpainted baskets suspended from rustic carrying poles while being used by female villagers in the northwest of Thailand (Dansilp & Freeman 2002, p.116)

While aristocratic crafts are more ostentatious they do not surpass common folk crafts in all aspects. Three exemplarily works in figure 14 demonstrate how natural forms and simple approaches create a harmonious relationship between material, utility, beauty and locality with effortless ornamentation.

Fig. 14: The naïve beauty of daily utensils such as Thai ladles and water bottles is based on the natural shape of coconut and gourd's shell. (Warren 1989, p.39) and (Dansilp & Freeman 2002, p.109)

In Tasmania, the combination of functional form and simple aesthetics also emanate from the use of endemic materials, especially timbers that demonstrate intrinsic and 'rustic' qualities. While early Tasmanian furniture design and making were heavily guided by and reliant on English and European traditions, local materials began to influence furniture design soon after European settlement. Perhaps the most distinctive and relevant example can be found in 'bush furniture' and what is known as the 'Jimmy Possum Chair'[5] (late 19th and early 20th centuries), which drew on the 'stick-back' chair traditions and the Windsor Chair,[6] most importantly utilising readily available timbers. (Cochrane 1992, p.54 & Plate11; and McWilliams 1978) An exemplary model can be seen from David Ralph's armchair, made in Richmond, Tasmania from 1977.

5 The uniqueness of the Jimmy Possum Chair is obvious in the legs that protrude through the slab seat to support the arms and are secured with wooden wedges. (McWilliams 1978, p.10)

6 The Windsor Chair originated in England in the early eighteenth century. Although there are various forms of Windsor Chair, they all have three main common features: a spindle back, a hollowed solid wood seat and protruded legs.

Fig. 15: The rustic beauty is represented through the bark of horizontal scrub tree used in the structure of the armchair (1996). Although the design derived from the colonial style of the English Windsor Chair, the intention of retaining natural vestiges (especially bark and lichen) makes Ralph's armchair original. Due to the care of selecting a particular diameter and curve of tree branches for integrating utilitarian and aesthetic qualities, Ralph's armchair is only suited for limited production.[7] (Ioannou 1997, p.223)

Fig. 16: From left to right; the English Windsor Chair and the example of the Jimmy Possum Chair (McWilliams 1978, p.4 & 10)

[7] Horizontal scrub (Anodopetalum biglandulosum) is not a commercially viable timber of Tasmania because its trunk does not have a big diameter. As a result, it is mostly cut without any value such as for clearing bush tracks before logging big trees. In earlier times, this small tree was used in bush furniture, axe-handles and also firewood. However, horizontal scrub has a dense and straight trunk which is appropriate for stick chairs and hand turning works such as buttons, knobs or small decorative items.

The primitive touch of horizontal scrub timber was reinterpreted through a suite of furniture pieces in the Barkwood Collection.[8] The final outcomes suggest the sense of synergy through complementary opposites such as rough versus smooth surface; symmetry versus asymmetry; machine versus hand-made; and ‘wabi’ versus ‘sabi’.[9]

Fig. 17: A suite of furniture pieces in the Barkwood Collection, made in 1992, photographed by John Farrow
From left to right; the Wellington cabinet, the Ladder-back table & stool designed by Kevin Perkins (1945-present) and made by Kevin Perkins, Phillip Blacklow (1962-present) and Greg Smith Joinery; and the Kanangra chairs designed by Kevin Perkins and made by Stuart Houghton (1958-present)

Fig. 18: The detail of the Wellington cabinet shows the opposite interplay between the rustic appeal of horizontal scrub’s bark and the smooth touch of veneered surface. (Farrow 1992)

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[8] The Barkwood Collection was a project of the Tasmanian School of Art’s, Centre for Furniture Design, the University of Tasmania, (1991- 1992) accompanied by a promotional pamphlet.

[9] ‘Wabi-sabi’ is a literary term suggestive of the idea of material deprivation. In the context of the tea ceremony it has come to mean the rejection of luxury and a taste for the simple, the understated and the incomplete. (Faulkner 2003, p.50) and (Koren 1994)

Similarly, anonymous craftsmen in Japan also find a basic approach to utilise a single segment of bamboo stem to make tea whiskers (Cha Dogu). Its restrained elegance explicitly reflects the spirit of Zen Buddhism through the functional simplicity of a utensil used in everyday living.

Fig. 19: Japanese tea whisker made of a single cut bamboo stem (Bornoff & Freeman 2002, p.135)

Sustainable design activist Victor Papanek (1927-1998) made an interesting observation about extraordinary and ordinary objects and their spiritual value:

> *We excel in ornamentation, visual braggadocio and excess. Our natural sense of order and simplicity makes us overly impressed by the austere, yet we flaunt the flashy and ostentatious. In order to extract the essence from ordinary objects, we must examine them against the cultural and social matrix from which they developed. When we do so, we find that all of them are related to spiritual values in some sense. The tea whisk is pure ceremonial gear. Powdered green tea is not normally consumed as refreshment; it is reserved for the traditional tea ceremony. Nor is tea-water whipped in Japan, except as part of this rite. (Roth 1998, p.42)*

In fact, utilising the form and properties of natural materials can facilitate the production process and lead to sustainable design characterised by renewability, biodegradability and non-toxicity. In addition, unadorned materials can evoke a sense of place through texture, colour, fragrance and warmth. Furthermore, folk crafts made from indigenous materials are durable because they naturally suit being used in their geographic and climatic provenance. For instance, fishing traps made from plants grown along sea coast are more durable and suitable for seaside activities than those made from plants grown inland.

In comparison with the raw material of mother-of-pearl inlay (a snail-shaped Turban mollusc which can only be found in the Gulf of Thailand); the ornamental inlay of folk craft is made of abundant materials such as wood and bone. According to fig. 19, it is significant that the inlaid motif of the royal court's receptacle is styled in natural form such as flames, leaves, flowers and vines. In contrast, the inlaid motif of ordinary betel tray shows the simple abstraction of geometric form. This distinction reveals that geometric motif was utilised as a means of paring down the floridness of ornamentation.

Fig. 20: From left to right; elaborate mother-of-pearl receptacle from the early period of Rattanakosin (1782-present) and rustic lacquered betel tray with a decorative inlay of bone (Dansilp & Freeman 2002, p.14 & 26)

The two-dimensional expression of Thai ornamentation

Although the technique of mother-of-pearl inlay and gilded lacquer came from China, Thai ornamental inlay and gilded works were distinguishable through treatment of spatial elements in a two-dimensional manner. Professor Silpa Bhilarsi (1892-1962), the founder of Silpakorn University in Bangkok said of Chinese and Thai designs:

> *The two conventions were incompatible, as Chinese design treated spatial elements in a three-dimensional manner. Yet, during the early 19th century, the popularity at court for things Chinese encouraged the introduction of this Chinese form of expression, to the detriment of two-dimensional, complex Thai art. (Dansilp & Freeman 2002, p.10)*

Fig. 21: **The top row** shows the writing desk with the detail of gilded black and gold lacquer from Qing Dynasty, Circa 1840 (Moss 2007, p.128). **The bottom row** shows a Thai scripture cabinet with the detail of gilded black and gold lacquer from Ayutthayan Era (1351-1767). (Dansilp & Freeman 2002, p.83)

Similar to the spatial elements of conventional Thai ornamentation, early Thai mural paintings in the 18th century also treated spatial elements in a two-dimensional manner.

Fig. 22: Three examples of Thai mural painting in the 18th century (Sthapitanonda 2006, p.166, 168 & 169)

Although mother-of-pearl inlay and gilded lacquer share a similar method of recessing a number of contrasting elements into a ground work layer of solid material, they produce different optical effects. When the translucency of the thin lining of the mollusc's shells is caught by light, it adds shimmering layers of colour, giving depth to the planar surface. In contrast, the gilded lacquer produces a reflective optical effect through its shimmering golden colour. Due to the lustrous and translucent characteristics of mollusc's shells, mother-of-pearl inlay became my major interest.

The connection between decorative and utilitarian inlays

In order to make inlays pronounced, the object is covered by black lacquer. This traditional approach disguises the natural colour of raw material.

Are there any inlaid works that keep contrasting qualities without distorting the natural colour of material?

The utilitarian and decorative qualities of butterfly joint

Fig. 23: butterfly keys and joints (Nakashima 2003, p.2)

I am particularly interested in the revealed butterfly joint because it shares the same principle as mother-of-pearl inlay. The butterfly joint has polarised characteristics: the positive inlay contrasts the recessed ground work while the dark colour of the butterfly key contrasts the light colour of primary boards. Additionally, the motif of the butterfly key represents reflection through the reflective trapezoid shapes. This mirror image can replace the reflective character of Thai ornamentation. In comparison with the shimmering effect of mollusc's shells, the undulating nature of wood effects such as fiddle back effect gives an impression of depth to a planar surface.[10]

[10] Fiddle back effect refers to a highly shimmering feature of veneer which is selected for covering the back of a bowed string musical instrument.

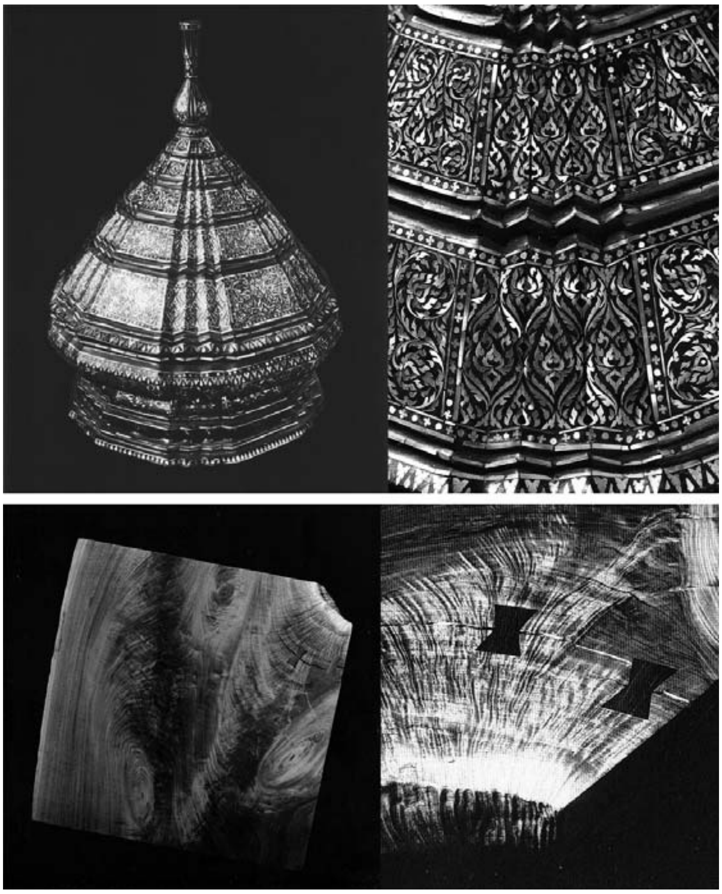

Fig. 24: **The top row;** from left to right; redented receptacle with a conical lid made of wood with intricate mother-of-pearl inlay from the Rattnakosin period and its delicate detail (Beurdeley 1980, p.30 & Dansilp & Freeman 2002, p.15); and **The bottom row**; from left to right; the top of Frenchman Cove I Table and the detail of two butterfly keys on table top, made by George Nakashima (Ostergard 1989, p.70 & 113)

Furthermore, the basic geometry of the butterfly key motif coincides with the geometry of inlay of Thai folk craft. This austerity is connected to the pared down aesthetics and production of Modernism.

Fig. 25: **The top row** from left to right; a circular box made of lacquer wood with elaborate mother-of-pearl inlay from Rattanakosin Era (1782-present) and a rustic lacquer wear with bamboo inlay (Dansilp & Freeman 2002, p.12 & 14); and **The bottom row** from left to right; Japanese portable charcoal braziers (Hibachi) with various sizes and shape of butterfly inlay (Bornoff & Freeman 2002, p.30); and a simple geometric butterfly joint on the top of the Trestle Table made by George Nakashima (Nakashima 2003, p.69)

The connection between the butterfly key motif and traditional Thai walls

When considering conventional Thai forms, I found that the trapezoidal geometry of the butterfly key shares a resemblance to the inward and outward slopes of the walls of traditional Thai buildings. This trapezoidal connection highlights the potential to integrate functional, decorative and symbolic expressions in contemporary Thai furniture.

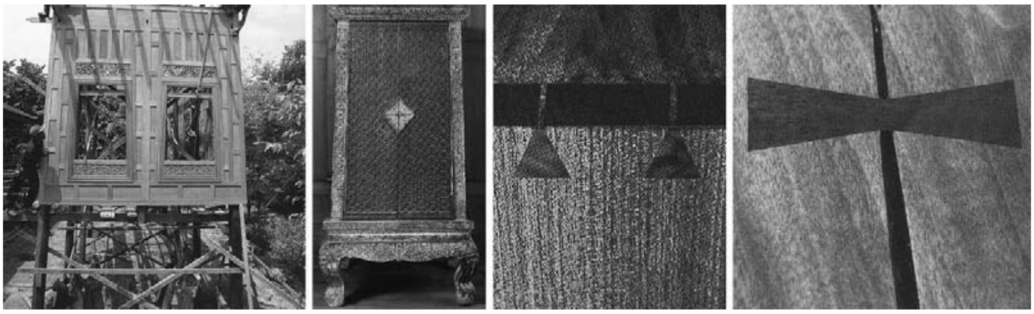

Fig. 26: The trapezoidal connection

From left to right; the end view of tapering Thai walls and columns (Chaichongrak 2002, p.96); scripture cabinet (Warren 1994, p.57); dovetail joints (Nakashima 2003, p.132); and a butterfly joint (Stone 1985, p.27)

The auspicious nature of the butterfly joint

Historically, the butterfly joint has been widely used in joinery for decorative and structural purposes. Additionally, the butterfly key motif represents the dual aspects of Buddhism: a sense of lightness and auspiciousness (good fortune). The equal size and shape of the opposite sides of the butterfly key recall the harmonious symbol of yin and yang. Moreover, the word butterfly literally suggests floating and animation. According to Chinese homonym, the first syllable of the word for butterfly 'hudie' can be pronounced like the sound of the auspicious word 'fu'.[11]

Fig. 27: A pair of butterflies is used as a decorative and symbolic element in conventional Chinese furniture. (Knapp 2005, p.87)

[11] Fu represents a constellation of felicitous elements that are sometimes translated as happiness but perhaps better rendered as good fortune, blessing, luck or wealth (Knapp 2005, p.85 & 86).

The characteristics and evolution of revealed joints

A butterfly joint looks like a double V or bow tie. Similarly, when two identical trapezoids are connected at the narrow part, they also depict the form of a butterfly. As a result, this butterfly shaped piece of wood has been called a butterfly key. (Ostergard 1989, p.180)

Functionally, a recess of the bow shaped hole is trenched at the edge of two pieces of wood in order for the butterfly key to be fitted firmly in place, joining the two sections. The thickness of the key and the depth of the recess must be equal in order for a key to hold separate wooden sections together. A butterfly joint is recognised as revealed joinery because of its highly visible nature. Consequently, the type of wood used for the butterfly key is usually contrasting.

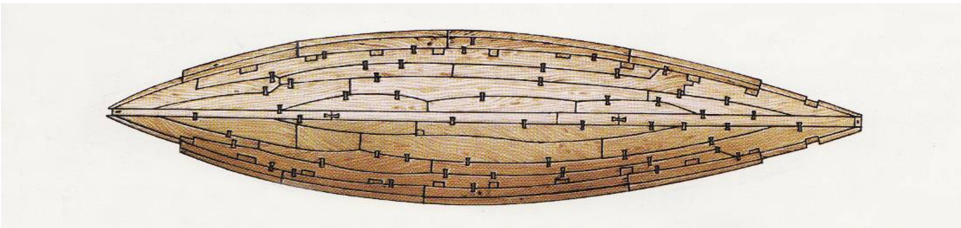

Fig. 28: an Egyptian boat was built by employing small separated planks which were joined like patchwork by butterfly keys. (Johnson 1976, p.175)

The butterfly joint has been used as a structural method to join small separate pieces of wood since the early Egyptian period. This traditional approach has been passed across continents by craftsmen. In Western Europe and the United States, the butterfly joint has frequently been used to fix a split or broken piece of wood; for example, when single-board seats of chairs split through heavy usage. This was always executed with the grain direction of the butterfly key running against that of the primary piece of wood. Similarly, the usage of revealed joints appeared widely in conventional Thai houses and boat building. (Ostergard 1989, p.70 & 71)

Fig. 29: Butterfly and dovetail joints in traditional Thai joinery
From left to right; dovetail and butterfly joints were commonly employed for joining the structural elements of vernacular Thai house as well as constructing the wooden components of ceremonial Thai barges. (Kongsuwan 2009)

However, the development of industrial technology, materials and better quality glues has made the use of the revealed joint obsolete. However, even though incorporating butterfly and dovetail joints into furniture and boat building are labour intensive and time-consuming and require high experience and skill, both conventional joints are still used despite recent technological advances.

The influence of revealed joints upon contemporary furniture

In the mid of 1940s, George Nakashima, the Japanese-American furniture maker, began using the butterfly joint as a functional element in his design. Two obvious examples can be seen from figure 30. The seat of the Straight-Backed Chair is made of two separate boards of wood. In order to securely join and reinforce the seat's structure, two small butterfly keys are inlaid at the top of seating surface. This is similar to the Brogren stool where dovetail pins are incorporated as the structural part of the stool's legs.

Fig. 30: The usage of butterfly and dovetail joints for functional purpose
From left to right; the early version of the Straight-Backed Chair, ca. 1944 and the Brogren stool, ca. 1945 (Nakashima 2003, p.51 & 67)

As time went on, the butterfly key's decorative aspect became as significant as its functional purpose. By the 1970s, Nakashima adopted butterfly keys to stabilise the unpredictable grain of the burls and root woods and to decorate furniture. Subsequently, Nakashima has become recognised in the global market by the integral character of these revealed joints. (Ostergard 1989, p.70 & 71)

Fig. 31: Minguren I Table's Top view, made by Nakashima (Ostergard 1989, p.128 & 129)

Revealed joints have since been reiterated widely by many practitioners as an aesthetic means, a structural solution as well as the symbol of traditional craftsmanship.

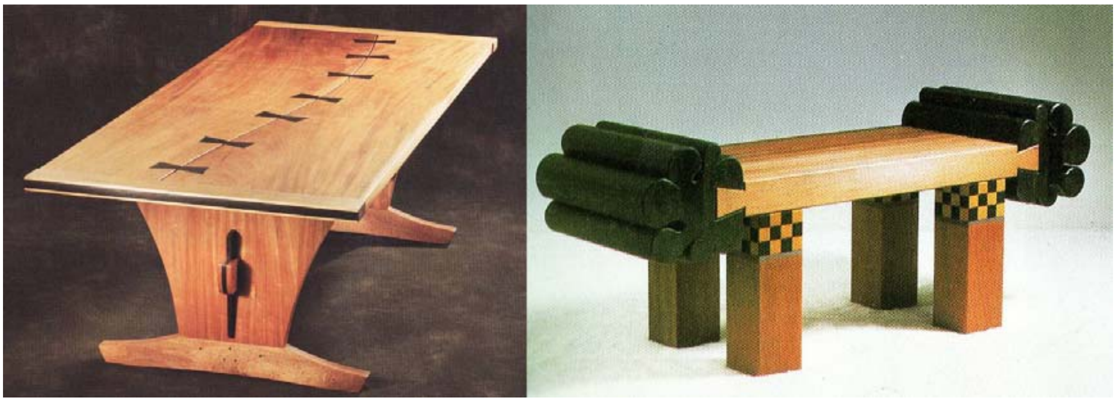

Fig. 32: From left to right; Butterfly table made by the American furniture maker, Brian A. Hubel in 2002 (Hemachandra 2009, p.139); and The Checkerboard Bench made by the American furniture maker, Garry Knox Bennett, in 1982 (Stone 1986, p.134)

The restriction of planar representation

Looking at the selected works of Nakashima as well as his followers, it can be seen that butterfly and dovetail joints can only be viewed from horizontal and vertical planes. This characteristic is caused by the planar quality of the joinery motif and is utilised for aesthetic as well as structural purposes. Garry Knox Bennett (1934-present) observed that:

> *Generally, when I design a piece I am concerned with how it looks from the front. If it is a bench, I do not even consider how it looks end on because I assume it will go against a wall. (Stone 1986, p.132)*

The shift from two-to-three-dimensional representation

The planar representation of joinery motifs stimulated me to look into the works of designers and sculptors who are influenced by the volumetric trapezoid. These examples are ranged from monumental sculpture to furniture.

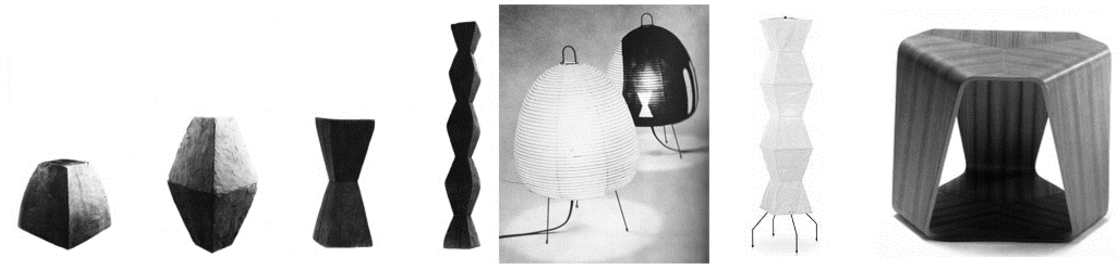

Fig. 33: From left to right; the evolution of the Endless Column, made by the Romanian sculptor, Constantin Brancusi in 1918 (Varia 1995, p.97); Akari lamps, designed by the Japanese sculptor, Isamu Noguchi during the mid-twentieth century (Hunter 1986, p.76); and Stool designed by the Japanese designer, Reiko (Murai) Tanabe in 1960 (Hiesinger & Felice 1994, p.74)

One of the most iconic sculptures with a solid volume of trapezoid is the Endless Column, by the Romanian sculptor, Constantin Brancusi (1876-1957). The single module of a truncated pyramid echoes the trapezoidal geometry of dovetail pin. After joining two pyramids at their decapitated heads, it resembles the shape of butterfly key in three-dimensional form. The Endless Column is embodied when the multiple modules of butterfly-shaped volume are joined at their widest base in ascending progression.

Fig. 34: The progressive evolution of the Endless Column, made in 1918 (Varia 1995, p.97)

More than three decades after the completion of the wooden Endless Column, the Japanese-American sculptor, Isamu Noguchi (1904-1988) was one among those who applied the basic abstraction of the Endless Column for a number of his functional objects. Awarded a Guggenheim Fellowship, Noguchi was able to work as an apprentice in Brancusi's Paris studio from 1928 until 1929. This opportunity allowed Noguchi to absorb new inspiration, particularly the pure abstraction of the trapezoid form. A series of Noguchi's Akari lamps (circa 1951) is obviously indebted to Brancusi's work.

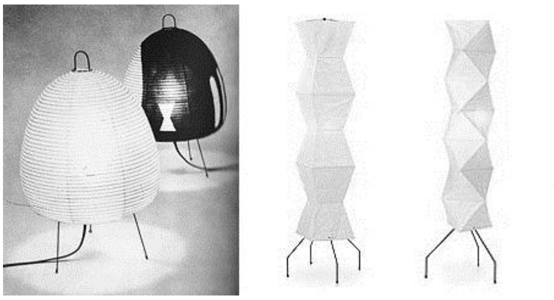

Fig. 35: The evolution of Akari lamps, designed by Isamu Noguchi. These three models are still being manufactured by local craftsmen in Japan. However, the patent belongs to the Vitra Company. (Hunter 1986, p.76)

Initially, Noguchi adopted the trapezoid as an ornamental motif upon lampshades. He then used the trapezoid within the three-dimensional form of the lamp's outline. Noguchi's Akari lamps demonstrate how sculptural, aesthetic and repetitive modules of the trapezoid are combined for economic efficiency. His lamps were traditionally produced by assembling the internal mould and template, followed by coiling the round bamboo ribs in the grooves on the outside of the template, and then applying the mulberry paper sheets to the ribs, drying them, and collapsing the lantern for a flat packaging. Both bamboo and mulberry paper are locally available in the city of Gifu to where Noguchi was invited after the Second World War. (Hunter 1986, p.76)

Fig. 36: Noguchi working on the mould of Akari lamp, Gifu, Japan 1978 (Fiell & Peter 2005, p.545)

Although Noguchi successfully suggested the volumetric quality of the trapezoid and triangle by letting the light and shadow manifest on three-dimensional objects, the orthodox aesthetics can still be seen from their static appearances.

Fig. 37: Stool designed by the Japanese designer, Reiko (Murai) Tanabe (1934-present), made by Tendo Mokko in Tendo in 1960, Teak plywood, Dim: 36x45x43 cm. (Hiesinger & Felice 1994, p.74)

Unlike Brancusi and Noguchi's works, Reiko (Murai) Tanabe's stool is distinguished by the interplay between positive and negative trapezoids in different postures. This makes the symmetrical object deceptively kinetic. This lightweight stool is made up of three identical moulded plywood sections that are glued together to produce multi-functional platforms – a seat, table or step stool. The acute connection of the three pieces of veneer suggests the interplay of linear conflict and produces a sense of reflection. The success of Tanabe’s stool is not only evident by its numerous reproductions; the reverse composition of solid-void trapezoids also proves that dynamic expression can be achieved in a symmetrical composition as well.

Conclusion

Religious architectures across Asia are similar in both compositional and metaphorical aspects. This similarity stimulated me to investigate the hallmarks of traditional Thai design. I found that the uniqueness of Thai architectural heritage lies in the contrasting and reflective qualities of ornamentation such as mother-of-pearl inlay and gilded lacquer. These two decorative approaches treated spatial elements in a two-dimensional manner, which became a prominent characteristic of traditional Thai art and design. Significantly, there was a technical and geometric connection between the inlaid motif of Thai folk craft and the butterfly joint. This connection guided me to explore both conventional and contemporary works that are influenced by the polarised character of reverse identical form as well as the abstracted representations of trapezoidal planes, volumes and spaces.

During my Master of Fine Art and Design studies (MFAD 2005-2007) in the Tasmanian School of Art, I used the trapezoidal shape seen in vernacular Thai walls, cabinets and revealed joinery to create a design theme for a series of benches. In order to assimilate this vernacular content with pared down aesthetics, dynamic expression, contemporary production and Buddhist ‘dualism’, I combined geometric abstraction, re-composition and opposite play as a means of seeking synergetic compositions in planar, linear and volumetric modes.

Fig. 38: From foreground to background; the Male and Female Benches. The Female Bench won the first prize of ‘the inaugural Accommodation Services Acquisitive Art Prize’ in 2007. (Farrow 2006)
Medium: solid Blackwood, Myrtle beech, stainless steel and terracotta
The Male Bench’s dimension: W 500 x L 2454 x H 450 mm.
The Female Bench’s dimension: W 540 x L 2436 x H 450 mm.

The Male and Female Bench Seats represent the complementary opposites of Yin and Yang through the dark and light tones of Tasmanian timber, and the rectilinear and curvilinear elements of the benches’ structures. Moreover, the shiny quality of stainless steel frames highlights the matte surface of wood. The pieces also illustrate how the planar, linear and spatial elements of trapezoid can be interrelated in a three-dimensional form. (See fig. 38)

Another distinctive feature of these benches is the use of the same components over and over again within opposing compositions. There are both kinetic and illusory effects, and this design is economic to manufacture. (See fig. 39)

Fig. 39: From left to right; The Blackwood Bench (Kuruvita 2007); and the Myrtle Bench (Farrow 2006)
Medium: solid Blackwood & Myrtle, Blackwood & Myrtle bonsai and stainless steel rod
The Blackwood Bench's dimension: W 500 x L 2454 x H 450 mm.
The Myrtle Bench's dimension: W 540 x L 2436 x H 450 mm.

To introduce a spiritual aspect, I incorporated native Tasmanian plants 'Nothofagus Gunnii' and 'Nothofagus Cunninghammi' (Deciduous and Myrtle beech) into the furniture to let people observe and appreciate the three common characteristics of nature in regard to Buddhist philosophy: birth, existence and disappearance. The cycle of care, growth and transplantation will be repeated throughout the very long life of the bench, and passed on again and again from owner to owner.

Fig. 40: Due to being notably mentioned by the panels of Georg Jensen Design Awards 2009, The Blackwood Bench was selected to publish on the Australian design magazine 'Belle'. (Belle magazine, Holiday Issue, December 2009/ January 2010, p.104)

Project description

In my PhD project, I aim to further extract the trapezoidal geometries to create a cohesive link between each individual design. There are five significant reasons why I prefer using the trapezoid form as a thematic design key.

- To magnify the diminished scale of revealed joinery (butterfly and dovetail joints) into the large scale of furniture and reverse the concept of reducing the large scale of the mythical world to an architectural scale;
- Referencing the inward and outward tapers of vernacular Thai walls and cabinets and the way in which these external and internal elements are coordinated with one other through the use of the trapezoidal shape.
- The possibility of reflecting dynamic expression through the opposite play between acute and obtuse angles;
- Providing a comprehensible message for the viewer; and
- Facilitating manufacturing processes: geometric reference is necessary when being fabricated by machinery.

Through studio practice, I will combine the abstraction, re-composition and opposite play of the trapezoid to construct new decorative patterns and functional forms in my design. To characterise Asian religious architecture, a part of my inspiration will be drawn from the floating qualities and overlapping feature of Oriental roof tiers. To reintroduce the attributes of traditional Thai design through contemporary furniture, I will refer to the reflective, contrasting and dynamic effects of architectural ornamentation. My design experiments will be based on volumetric, planar and linear modes that treat the spatial elements of traditional Thai design in various manners.

Within a broad context of integrating elements of Thai culture in contemporary furniture, made from Tasmanian materials by hand and using digital technologies, the aims of the project design experiments are to:

- Suggest how various scales of the conventional trapezoidal form are coordinated in both two and three-dimensional manners;
- Examine ways to enliven the static appeal of symmetrical trapezoidal forms by using both reverse and asymmetrical compositions;
- Integrate environmental awareness, cross-cultural function and dualistic expression into contemporary furniture; and
- Convey the spatial qualities and illusory effects of furniture by referring to cantilever furniture, Kinetic Art and Op Art influences.

A secondary aim of the project is to explore options for creating affordable as well as sustainable design objects. Within my project I aim to produce three collections of work – premium, medium and economy – using different types of native Tasmanian timber to suit various levels of affordability. Sustainability, durability and transportability are also significant concerns, for example local timber that is already suited to the climate and will therefore maintain condition, care to preserve non-renewable energy by not importing exotic materials, and developing furniture able to be flat-packed to save space in shipping containers.

Chapter two: design survey

There are three keys areas that I am interested in: living in harmony with nature, cultural adaptation and embodying the Buddhist perspective towards dualism. My narrative is outward-to-inward. I begin with the outward: what is outside and in nature, and then discuss the inward: what is within our spirit and mind. This order illustrates how environment, cross-culture and the dual aspects of Buddhism are interconnected in the context of architectural and furniture design.

Environmental influences

Both Traditional Thai artisans and modern architects adapted an integrated set of design principles according to their natural and social milieu. In this section I will compare vernacular Thai houses to modern architecture; consider the visual lightness of traditional Thai temples and the progressive development of cantilever design during the period of 1920 to 1960; and evaluate the successful and unsuccessful adaptations of cantilever influences in Japanese design, and the designs of Charlotte Perriand and George Nakashima.

Vernacular Thai houses and modern architecture

Traditional crafts and architecture differ in accordance with geography, climate and social surroundings. For example, Eskimos lock in warmth by building igloos from blocks of compacted snow whereas traditional Thai houses were built on stilts to provide spaces beneath, to circulate air during summer, and provide reprieve from flooding during the raining season.

Fig. 1: From left to right; Eskimo's house called Igloo (http://www.alaska-in-pictures.com/inupiat-eskimo-igloo-438-pictures.html); and a traditional Thai house called Baan (Warren 1989, p.106)

Ancient Chinese geomancers considered built structures in harmony with the environment, through a concept called 'feng-shui', which literally means 'wind and water'. The essential elements of feng-shui directly involve the interaction of yin and yang and an ethereal property known as *qi*, translated as 'life breath' or 'cosmic energy.'[12] (Knapp 2005, p.56)

According to Buddhist principles, all creatures are made of the four natural elements: earth, fire, wind and water. The reason that only wind and water become the essence of feng-shui is due to their kinetic qualities, which can be activated by either natural or artificial power. The concept of positive energy flow has been applied widely to properly ventilate air and to let light or water flow through living spaces, graves, gardens, temples as well as in urban landscapes.[13]

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[12] *Yinzhai* or 'abode for the dead' is a common expression for a grave or tomb whereas *yangzhai* or 'adobe for the living' is a quest for benefits and comfort. There are sometimes remarkable resemblances in the outward appearance of *yangzhai* and *yinzhai* in term of layout and structure. The arrangement of rooms in larger tombs is often similar to those of spaces in house. (Steinhardt 2005, p.12-35)

[13] There are three basic approaches to feng-shui:

- Cosmic patterns and esoteric principles;
- Topography of an area, as defined by detailed calculations and an intricate compass measurements; and
- Landscape, the broader more readily identifiable features such as mountains and waterways.

These feng-shui practices often appear idiosyncratic and lacking in consistency but always focus on a search for equilibrium and harmony in order to avert misfortune and insure good fortune. (Knapp 2005, p.58)

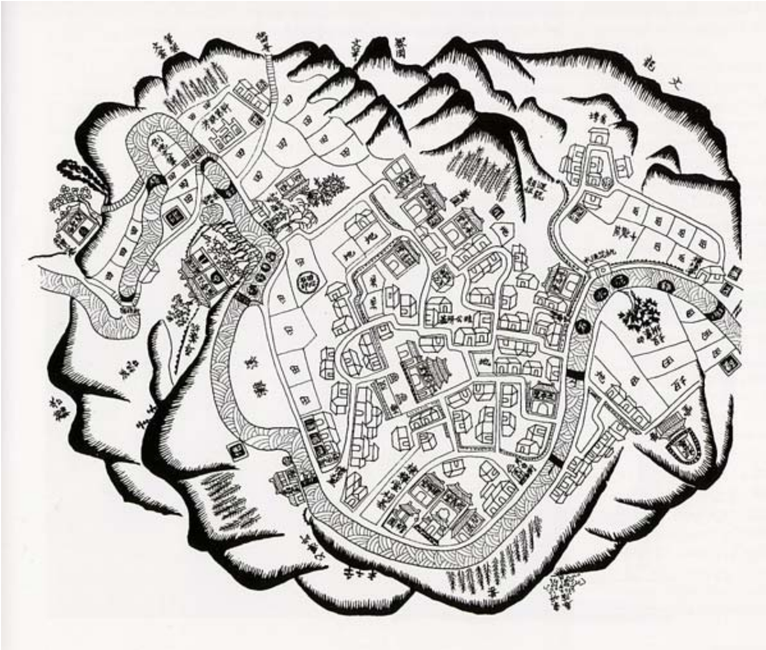

Fig. 2: The feng-shui layout of Zhifeng village, Jiangxi province (Knapp 2005, p.57)

Andrew L. March, the author of *An appreciation of Chinese Geomancy*, exemplifies an auspicious characteristic of residential site:

> *At a true site…there is a touch of magic light….The hills are fair, the waters fine, the sun handsome, the breeze mild; and the sky has a new light: another world. Amid confusion, peace; amid peace, a festive air. Upon coming into its presence, one's eyes are opened; if one sits or lies, one's heart is joyful. Here the breath gathers, and the essence collects. (March 1968, p.159)*

Another interesting observation was made by Ole Bruun, the author of *Feng-shui in China: Geomantic Divination between State Orthodoxy and Popular Religion*:

> *A good site for a Chinese house, according to feng-shui prescriptions, is one that is well-drained, well-watered, and reasonably sheltered from cold winds and intrusive heat. Feng-shui principles, in this regard, have led to construction of building sites where flooding and erosion are minimised, restraining reckless environmental damage, and helping to limit building on cultivate land. (Bruun 2003)*

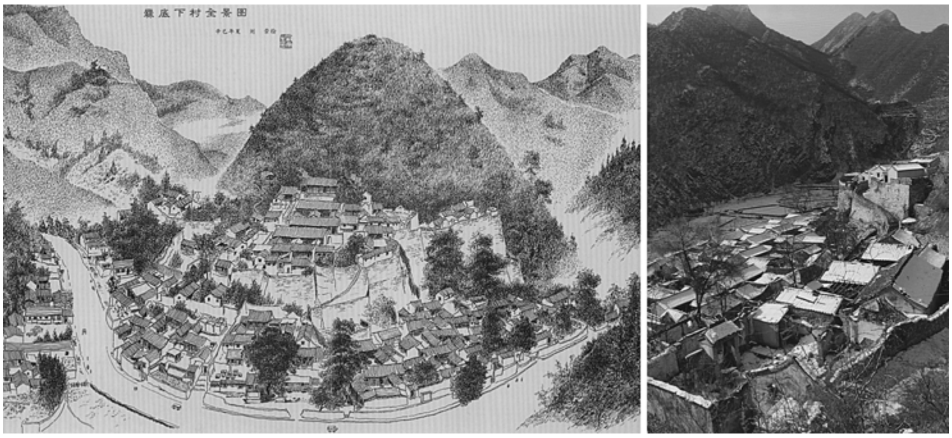

Fig. 3: The benefits of feng-shui application are obvious in the landscape of Chuandixia village where the dwellings are arrayed across the steep slope, enabling villagers to take advantage of the winter sun and summer breezes as well as protect them from the cold winds that blow from the north.
From left to right; the drawing of Chuandixia village, drawn by Liu Chong; and the hilly landscape of Chuandixia village (Knapp 2005, p.112 & 113)

The advantages of feng-shui practices remind me of the beneficial location of Hobart, a city embraced by water and backed by mountainous landscape. Although some regard feng-shui with scepticism, the grandeur of Mount Wellington, sweep of the river and summer breezes or winter wind on the Derwent River are deeply memorable. Perhaps, a relative flow between wind and water can be seen as a vital factor that binds the spirit of place and people together; setting the mood of the day.

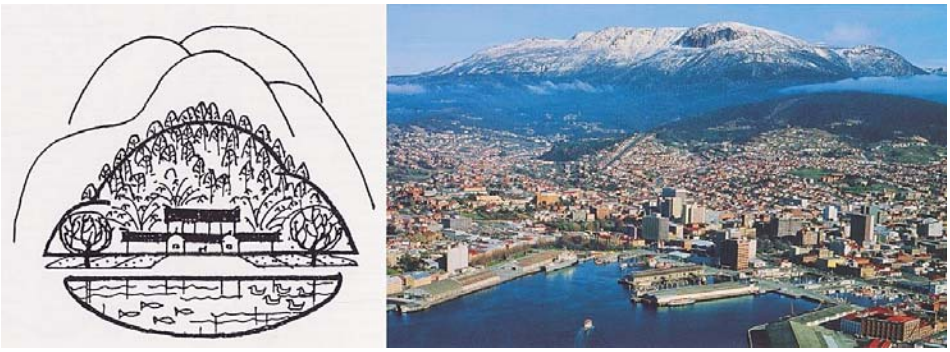

Fig. 4: From left to right; an exemplary feature of positive feng-shui with encircling hills and a crescent pool (Knapp 2005, p.55); and an aerial panorama of the city of Hobart with a mountainous background and a riparian foreground (Tasmanian Film Corporation)

The most important reason that Bangkok was established as a capital city of Thailand was its location on the heart of the Chao Phraya Basin, an area of approximately 117,500 square kilometres (23 per cent of the country’s total land area). From the northern border to the gulf of Thailand, the Chao Phraya River and its myriad tributaries becomes one of Asia’s most essential irrigation systems.[14] This geographical advantage has bound much of Thai life with rivers and canals.

However, situating between the Tropic of Cancer and the Equator makes Thailand hot all year round. As a result, the principles of incorporating felicitous flow and circulation within housing and landscape design were also evident in the traditional Thai house.[15]

Fig. 5: The riverine scenes of Bangkok in early days depicted the popularity of locating habitations along rivers and canals. (Sthapitanonda 2006, p.35) and (Chaichongrak 2002, p.12 & 44)

[14] This claim is guaranteed by having ranked as the world’s largest exporter of rice during the late twentieth century.

[15] The Chao Phraya River has four major tributaries: Ping, Wang, Yom and Nan. Due to the abundance of rivers and canals in Bangkok, this metropolis was once recognised as the Venice of the East.

The five prominent features of vernacular Thai houses

In order to live comfortably in a tropical and humid area, four basic elements of the traditional Thai houses arose: elevation on stilts; inward and outward sloping walls; high gables sloping downward into long projecting eaves; a large raised verandah connecting separate rooms and cabins; and transportability.

Fig. 6: The elevation of a traditional Thai house (Sthapitanonda 2006, p.48)

Being elevated on stilts

Conventional houses in Thailand are built on stilts of various heights in relation to the geographical and climatic condition in different regions. Creating circulation beneath the house provides resistance to flooding, ventilates the building in summer and offers protection from dangerous animals. The shady under-the-house space can be used as a working area, or for storing farm tools and a Thai vehicle called ‘kwien’, or mooring a boat during flood season. Notably, the posts of central Thai houses slant slightly inward, making the entire structure more stable and visually higher, whereas the posts of traditional Thai houses in other regions stand perpendicularly.

Fig. 7: From top to bottom row; each horizontal row illustrates both **the various heights** and **wall's posture** of traditional Thai houses from four regions through front and end elevations.

The first row shows **the two elevations of the northern Thai house**;

The second row illustrates **the two elevations of the north-eastern Thai house**;

The third row depicts **the two elevations of the central Thai house**; and

The bottom row portrays **the two elevations of the southern Thai house** (Sthapitanonda 2006, p.24, 29, 30 & 33)

Having inward and outward sloping walls

Differences across regions due to the influence of geography, climate and social surroundings can be seen in the angles of the panels of conventional Thai houses. The panels on the narrow ends of the central Thai house tilt inward for structural and ventilative purposes whereas the walls on the lateral sides of the northern house tilt outward due to retain the heat during the cool season. (See fig. 7 & 8)

Unlike central and northern regions, the panels of both the north-eastern and southern houses stand perpendicular due to the ease of construction. (See fig. 7 & 9)

Fig. 8: From left to right; the outward splay of the Northern Thai walls and the walls of the Central house leaning inward toward the roof (Sthapitanonda 2006, p.57 & 74)

Fig. 9: Similar perpendicular panels and stilts can be seen from the exterior structure of the North-eastern (left) and Southern Thai house (Sthapitanonda 2006, p.30 & 33)

Fig. 10: The inward and outward taper of conventional Thai furniture echoes the trapezoidal geometries of traditional Thai architecture.

From left to right; the scripture cabinet and clothing chest, both were made during Ayutthaya period (1351 – 1767) (Dansilp & Freeman 2002, p.83) and (Moss 2007, p.111)

In fig. 10 the panels of a scripture cabinet and clothing chest lean in and out. This characteristic resembles the oblique and acute angle of conventional Thai houses.

Most northern Thai houses have smaller and fewer windows in comparison to most central and southern houses. This shows that early Thai architects paid attention to geographical and climatic condition. Additionally, the wooden panels of common Thai houses remain unpainted. The absence of artificial colour lets manmade buildings blend harmoniously into their surroundings. Sometimes, the multi-rectangular patterns that appear on traditional Thai walls recall the geometric landscape of rice fields, similar to the way worn corrugated walls of Australian houses mimic the natural patterns of sand dunes.

Fig. 11: A relative geometric pattern between the aerial landscape of rice fields and the classic pattern of vernacular Thai panels called ‘fa pakon’ (Chaichongrak 2002, p.22 & 84) and (Van Beek 2004, p.164)

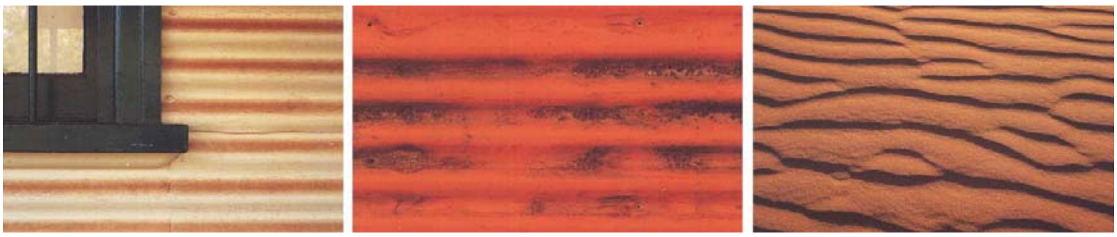

Fig. 12: The similarity between corrugated iron and the landscape of sand dunes (Bachman & Winton 1994, p.125)

High gables sloping downward into long projecting eaves

High gables extend the height of rooms to reduce heat during summer. The concave shape of the gable roof is normally sloped downward into long projecting eaves. This steep slope sluices rain off quickly, preventing leaking through the roof coverings. The overhang eaves below the main roof protect walls from additional rain and sunrays.

The slope of the houses' roofs also differs by region. The roof of a typical northern house is not as steep and curved as that of a typical central house because of the cooler northern weather. A greater amount of rainfall in the south calls for a straight slope to cope with heavier rain and wind. The roof of a north-eastern house has a gentler slope due to a more arid condition during summer and a lower temperature after hot season.

Fig. 13: The exterior feature of gable roofs in the four regions of Thailand
From left to right; northern, north-eastern, central and southern roof's from (Sthapitanonda 2006, p.29, 31, 48 & 49)

A large raised verandah connecting the separate rooms and cabins

Large verandahs provide communal living areas for the inhabitants and offer versatile space for ceremonies, feasts, drying food and growing plants. This multi-functional platform is an important component, allowing separate rooms and cabins to be connected as a new family grows. According to ancient Thai custom, new grooms disassembled their inherited houses to relocate to the new brides' land. Consequently, transportability became one of the quintessential characteristics of a traditional Thai house.

Fig. 14: From left to right; the aerial view of a cluster Thai house represents a spacious space of huge verandah and the spacious feature of Thai terrace. (Sthapitanonda 2006, p.64) and (Chaichongrak 2002, p.52)

Transportability

Due to being entirely built of wood, every component can be assembled by traditional joinery practices such as the dove-tail joint. Traditionally, no nails were used. Consequently, the house can be easily disassembled and moved and reassembled on new land. Furthermore, the gaps in the floors, wall panels and gables provide breathability because of the efficiency of circulating air.

Fig. 15: From left to right; the sequence of stages in the assembly of traditional Thai house (Chaichongrak 2002, p.94-97) and (Warren 1989, p.80)

The regional variations of vernacular Thai houses demonstrate how Thai craftsmen gradually developed design knowledge according to their geographical, climatic and social surroundings.

Feng-Shui and modern architecture

Good land is not as abundant as it previously was and modern architects dealing with a poor site face other challenges like hazardous climate, visual disturbance and noise pollution. How are traditional principles such as feng-shui applied to solve negative landscape and conservative beliefs for designing a contemporary building? A possible answer could be found from the Bank of China in Hong Kong, designed by the Chinese-American architect, I.M. Pei, (1917-present), opened in 1988.[16]

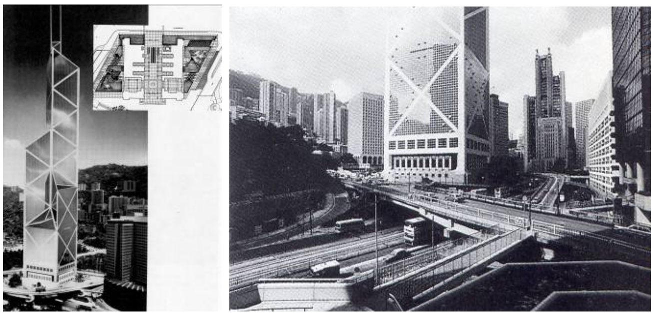

Fig. 16: the Bank of China, surrounded by chaotic roadways (Rossbach 1991, p.101) and (Wiseman 2001, p.289)

This well-known building was situated in an inauspicious and chaotic site surrounded by highway overpasses and was a place for the torture of prisoners during the Second World War. A series of tranquil pools and active sloped waterfalls was placed around the building to counter traffic disturbance. Strands of bamboo were also planted amid artificial pools and waterfalls to symbolise the flourishing prosperity of business.

[16] The date of the official opening of the building, the eighth of August, 1988, was auspicious according to traditional Chinese belief: the figure eight has two full circles, which is considered to be a fortunate form.

According to Chinese belief, the bamboo shoot aspiring upward after a spring rain is an auspicious symbol of renewal and hope.[17]

Fig. 17: artificial pools and waterfalls (Wiseman 2001, p.297)

Due to its location near Hong Kong harbour, which is vulnerable to typhoons, the building needed to have a strong structure to resist powerful winds and storms. Pei used a triangular design motif as a structural and aesthetic solution, which manifests in an X form: crosses on the skin of the building.

Fig. 18: the X form appeared on the building's skin. (Wiseman 2001, p.295 & 298)

[17] The symbol of bamboo was incorporated as one of the auspicious motifs of ancient Chinese furniture because it signifies adaptable characteristics and the ability to survive during adversity. According to Buddhist thought, bamboo symbolises humbleness and natural revival. (Berliner 1996, p.114 & 116)

Pei’s X form was criticised and opposed by local feng-shui geomancers because the cross is a traditional Chinese symbol for death and failure. However, this inauspicious symbol was positively reinterpreted by Pei’s advocates as the facet of a diamond, used by Tantric Buddhism in Asia to represent a meditative technique called ‘Kongo-Kai’: diamond-like transparent wisdom. This reassured Pei’s clients and the feng-shui masters.

Fig. 19: The auspicious Chinese ideograph is usually written in the shape of diamond due to being considered as a propitious configuration. (Knapp 2005, p.85)

By viewing Pei’s building at different angles, a visual kinetic movement is revealed through an ever-changing sequence of the repetition of multi-faceted triangles. The continually moving composition is animated by the building’s reflective surface, a contemporary touch that was accepted as good structural and aesthetic solutions. Distortion and deflection by reflective materials redirects the influences around the building, such as the active roadways and taller skyscrapers, so these negative influences are declined by the kinetic effect of the building’s skin.

Nearly twenty-five years old, Pei’s building demonstrates how technological advances can be adapted to traditional design principles and beliefs. In fact, the two can and should complement each other to strengthen both the structure of a building and the spirit of the local people and place.

The visual lightness of traditional Thai temples versus cantilever design

Like the Bank of China, traditional Thai temples and palaces also convey the relationship between environmental awareness, visual quality and auspicious symbols. The evidence can be classified in five categories according to aesthetic considerations:

- Subduing a single massive volume of the Thai roof's form;
- The redentation of a building's base and corner;
- Tapering and redenting massive columns;
- The evolution of supporting projecting roofs; and
- Incorporating a floating structure in reference to Buddhist mythology.

Fig. 20: Multi-tiered roofs in coloured glazes (Sthapitanonda 2006, p.136 & 205)

This aesthetic improvement can be carried out in two ways. The first method involves breaking up the massive volume of a single roof into multiple tiers to gain a sense of lightness through a series of telescoping roof ends. The second method is segmenting each individual tier into multiple sections by coloured ceramic tiles in a concentric pattern. When tiles in multi-coloured glazes are caught by the change of light, their glittery effects and contrasting colours make the roof's large plane less heavy and more dynamic. However, the presence of colour in traditional Thai architecture is almost exclusive to religious and royal edifices.

Functionally, the spacing between each tier allows air to ventilate more efficiently. Recently, multiple tiered roofs have been adopted widely by Thai and international architects.

Fig. 21: The modern adoption of multi-tiered roofs in Thailand
From left to right; a conference hall at Khon Kaen University, Khon Kaen and the United Nations Conference Centre in Bangkok (Sthapitanonda 2006, p.231 & 245)

Fig. 22: The modern adoption of multi-tiered roofs in Australia is conspicuous in The Sydney Opera House (1975), designed by the Danish architect, Jorn Utzon (1918-2008). The spherical geometry of the individual roof vaults actually came from a segmented orange, not from white sails. (Drew 1995, p.14) and (Kongsuwan 2005)

In fact, the objective of traditional Thai architecture was to make buildings seem celestial in regards to Buddhist myth. Significantly, the four corners of an architectural base were divided into multiple segments in order to make its huge volume appear taller, lighter and more dynamic akin to the gigantic podia of pagodas. A square layout was softened with fractional layers to generate multi-redented corners. Each fractional layer diminishes in size from base to spire in order for viewers’ eyes to be led to the sky.

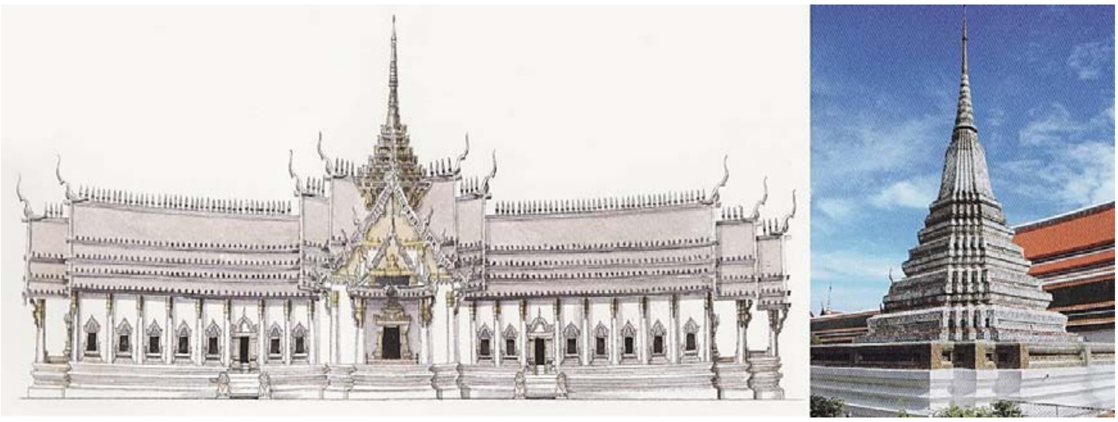

Fig. 23: Two examples of redenting structures
From left to right; a bowed, ship-like shape of a redented base is shown in the front view of Sanphet Palace and the memorial tower at Arun Temple is redented from base through the spire. (Sthapitanonda 2006, p.16 & 95)

Ancient Greeks also lightened a massive volume of exterior columns, by relying on two methods: a change in column diameter, which slightly curves outward from column base toward the capital, called 'entasis'; and a fluting on a column shaft.[18]

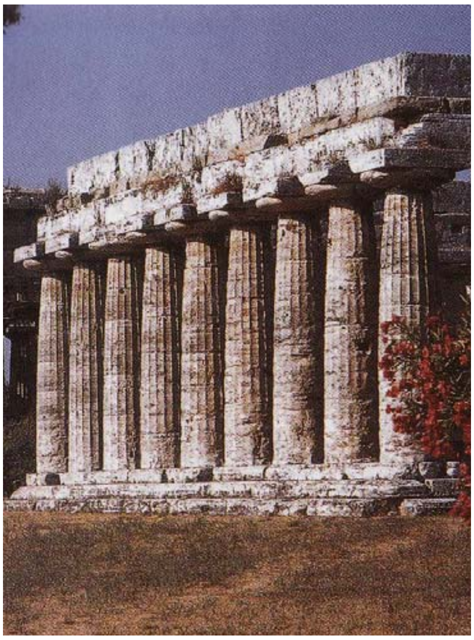

Fig. 24: Greek columns with entasis, Temple of Hera, Paestum, ca. 550 BCE (Moffett 2003, p.50)

[18] Entasis is a change in column diameter that curves slightly outward from the bottom of the shaft to the top. Entasis was widely applied in archaic Greek architectures.

When the fluting texture is cast by shadow, it enriches the sense of volume. Employing taper and fluting details aims to enhance the visual lightness of Greek peristyles and also averts the misperception of orthogonal geometry. Significantly, the convex shape of the Greek column parallels the classical shape of Thai pilasters, which uses a linear taper instead of curve.

In Thailand, between the eleventh and the thirteenth centuries, the overhanging roofs of ancient Thai temples and palaces were supported by an exterior row of columns. Although the massive volume of each column was lightened by being tapered and redented, it still disturbed the appearance of building. Since the mid sixteenth century, this visual disturbance was resolved by the use of eave brackets. Today, post-and-lintel construction based on bracketed support is still being used for structure, decoration and mythological expression for Thai Temples and royal palaces. (Sthapitanonda 2006, p.150)

Fig. 25: The evolution of bracing projecting roofs in traditional Thai temples and palaces
From left to right; the columns of Phimai Palace, built in 12^{th} century; exterior columns at Rachapradit Temple; the combination of tapering redented columns and eave brackets at Daowadeungsaram Temple; and bracketed construction in serpentine shape at Dusit Throne Hall. (Sthapitanonda 2006, p.125 & 160)

Metaphorically, the complementary opposite between the lightness of Utzon's Sydney Opera House roof vaults and the massive earthbound podium of the whole building (See fig. 22) can be compared to the interplay of yin and yang, whereas the whole structure of Thai temples seem to float from the ground as they are constructed on a boat-like base.

Marine influences upon religious architecture and contemporary Thai design

The attempt to present a buoyant character through Thai architecture began in the Ayutthaya period: 14th to 18th centuries. The evidence is obvious in the boat-shaped podium and the sagging roof of the miniature model of Ayutthayan temples, which were prevalent during 18th century.

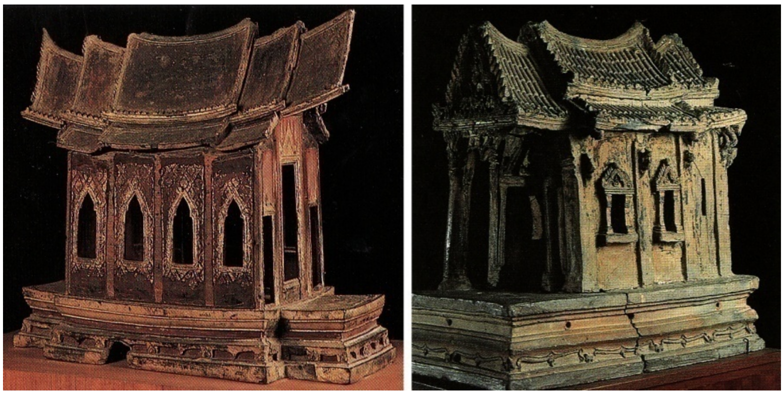

Fig. 26: The bow shaped base and the sagging roof form of Ayutthayan architectural models around 18th century (Warren 1989, p. 27) & (Dansilp & Freeman 2002, p.77)

During the reign of the King Rama III Period (c.1824-1851), the infusion of Buddhist metaphor through the shape of a ship's hull was more literal. The hull of a Chinese junk called a 'thawng-samphao' was replicated to form the memorial tower's base at Yannawa temple. This boat-shaped podium aimed to compare Buddhism to a vessel of enlightenment.

Fig. 27: The memorial tower at Yannawa temple was influenced by Buddhist metaphor and the shape of Chinese junk’s hull, built during the reign of the King Rama III (c.1824-1851). (Chutintaranond 2002, p.21)

Recently, the image of the ceremonial Thai barge has been used for occasions to promote the superiority of Thai craftsmanship and to reflect an intimate relationship between Buddhism, royalty and the water-based culture of Thai people.

Fig. 28: The influence of the ceremonial Thai barge upon contemporary Thai design
From left to right; the Suphannahong Royal Barge; the image of Suphannahong barge was painted on the hull of a Thai Airways aircraft; and the feature was used as a stage background during the anniversary of the king’s Coronation in 2010. (Kongsuwan 2010)

Within the construction, appearance and metaphorical expression of conventional Buddhist temples and royal palaces, the methods of segmenting, redenting and tapering a single massive structure into multiple sections and facets can effectively enhance the sense of lightness. In addition, the buoyant structure, delicate decoration and Buddhist symbols can be integrated within one architectural element. For instance, the serpentine shape of elaborately bracketed supports creates ambiguity about its functionality because its undulating curve does not seem to bear the load of the lower edges of projecting roofs.[19]

Fig. 29: The combination of buoyant structure, delicate decoration and Buddhist symbol can be seen simultaneously from Thai eave brackets. (Sthapitanonda 2006, p.151)

Cantilever influence

In other countries, structural systems that generate the sense of space and lightness appear in architectural elements such as bridges, balconies, roofs and stands. These overhanging constructions are called cantilevers.[20] The cantilever design evolved from corbelled construction.[21]

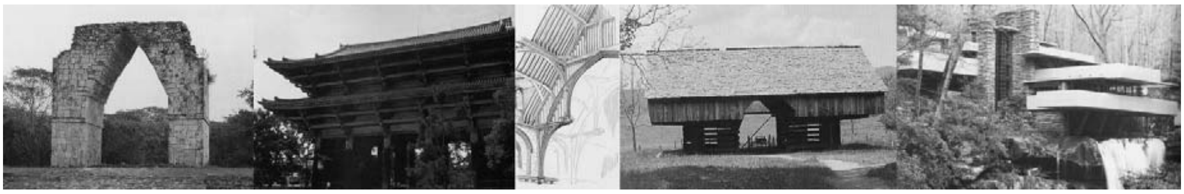

Fig. 30: Cantilever evolutions
From left to right; corbelled arch, Kabah, Mexico, 850-900; the cantilever brackets of the Great South Gate, Todaiji, Nara, Japan, ca. 1200; Hammerbeam truss, Westminster Hall, London, England, 1394-1402; Cantilever Barn, Tennessee, U.S.A., 19th century; and the Cantilever balconies at the Fallingwater House (1935-1937), Pennsylvania, designed by the American architect, Frank Lloyd Wright (Moffett 2003, p.2, 3, 101, 254 & 524)

[19] Serpentine shapes appear widely in the decoration of traditional Thai temples because they signify a benevolent divinity in according to Buddhist mythology.

[20] Cantilever is a beam firmly anchored on one end and unsupported at the other end. (Moffett 2003, p.568)

[21] Corbel is masonry that projects slightly from a wall and serves as a structural support. (Moffett 2003, p.569)

From 1920 to 1960, a group of European designers started incorporating floating qualities in furniture through a less obvious support.

In 1926 the Dutch architect, Mart Stam (1899-1986) introduced a design using tubular steel. Two years later, it was refined by the German-American architect, Mies van der Rohe (1886-1969) and later, the Hungarian-American architect, Marcel Breuer (1902-1981).

Fig. 31: The progressive development of tubular steel cantilever chairs
From left to right; Mart Stam's Side Chair , c. 1926; Mies van der Rohe's Cantilever Chair, c. 1927; and Marcel Breuer's Cesca Chair 3, c. 1928 (Stuhlmuseum 1998, p.127) and (Fiell 1991, p.10)

In 1960 the iconic plastic cantilever chair was designed by the Scandinavian designer, Verner Panton (1926-1998). In actuality, it was developed from an earlier design by the Danish designer, Gunnar Aagaard Andersen (1919-1982) in 1953.

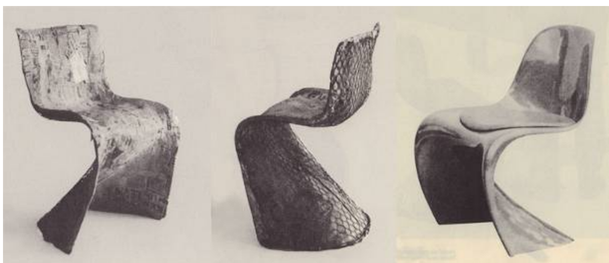

Fig. 32: The progressive development of moulding plastic cantilever chairs
From left to right; the front and back views of Gunnar Aagaard Andersen's prototype (made of chicken-wire and newspaper); and Verner Panton's Stacking Chair (made of fibreglass-reinforced polyester) manufactured by Herman Miller Company in 1960 (Stuhlmuseum 1998, p.16, 19 & 20)

However, due to my interest in combining regional material with the cantilever structure, I have focused on wooden cantilevered chairs. In 1924, German architect, Heinz Rasch quietly set a ball rolling through the new direction of wooden cantilever seats. He introduced the first prototype of his Cantilever Chair which was made of plywood. Seven years later, the Finnish architect, Alvar Aalto incorporated laminated Scandinavian birch and plywood to create a light weight armchair called the Pamio. The final outcome conquers both the irregular property of wood and the inhumane appeal of steel and plastic cantilever chairs. Aalto's Armchair continues to be manufactured by Artek, the Finnish furniture company which Aalto established in Helsinki since 1935.[22]

Fig. 33: The progressive development of wooden cantilever chairs
From left to right; the prototype of Heinz Rasch's Cantilever Chair, c.1924 (Stuhlmuseum 1998, p.71); Alvar Aalto's Paimio Armchair, c. 1931 (Ostergard 1989, p.79); Charlotte Perriand's Cantilever Bamboo Chair, c.1941 (Mcleod 2003, p.205); and George Nakashima's Conoid Chair, c.1960 (Nakashima 2003, p.175)

Cantilever design in Japan

Between 1940 and 1955, French designer Charlotte Perriand (1903-1999) was commissioned by the Japanese government to develop exportable goods made with Japan's low-cost native material and craft techniques. She combined Japanese bamboo with the well-known frame of Aalto's Armchair to create a cantilever seat.

[22] Laminated bentwood was firstly developed for industrial furniture since the nineteenth-century by the German-Austrian cabinet maker, Michael Thonet (1796-1871).

Japanese people did not accept her design and criticisms concluded that the design failed due to her limited use of bamboo. I think the criticism came partly from Perriand's lack of understanding of the customary sitting style of the Japanese who are more accustomed with sitting on tatami-mats on the floor. Subsequently, the Aalto chair/Japanese bamboo design has not been developed for industrial production.[23] (Mcleod 2003, p.106)

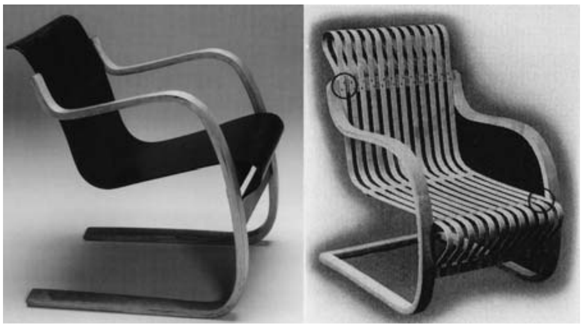

Fig. 34: The comparison between Perriand's Cantilever Bamboo Armchair (right); and its predecessor (Meleod 2003, p.205) and (Gura 2007, p.22)

Windsor chair and the cantilever influence in Japan

George Nakashima, the Pennsylvania-based Japanese-American architect, reiterated the prototype of Heinz Rasch's Cantilever Chair by relying on solid wood and conventional joinery. Although laminated wood makes a chair's frame stronger than solid timber, Nakashima uncompromisingly designed a chair out of traditional materials, cutting the sections for seat rails to take advantage of the natural strength of rosewood's grain. A robust dado joint was used at the junction of the stile and the seat

[23] According to Japanese etiquette, there is a traditional way of sitting called 'seiza'. This convention involves sitting down on the floor. In traditional Japanese architecture, floors in various rooms designed for comfort have *tatami* floors. Seiza is thus closely connected with *tatami* flooring. (http://en.wikipedia.org/wiki/Seiza)

rail, notched where the rail was thickest to provide the strength at this crucial junction.[24]

Although Nakashima's Conoid Chair is heavier than other models the spindles at the backrest appear~~s~~ lighter and more ventilated. This 'comb-like' structure echoes the original character of the Windsor chair's backrest.

Fig. 35: The evolution of Nakashima's Conoid Chair
From left to right; the prototype of Heinz Rasch's Cantilever Chair, c.1924 (Stuhlmuseum 1998, p.71); American Windsor Chair, c.1775-1800 (Ostergard 1989, p.154); and George Nakashima's Conoid Chair, c.1960 (Nakashima 2003, p.175)

The benefits of an eclectic approach

In 1961, the Coniod Chair was included in the catalogue of *Knoll Associates* in America. This commercial contract allowed Nakashima to control the manufacturing process by incorporating machinery and hands-on woodworking in his workshop. As a result, Nakashima's rapidly growing enterprise provided income for local woodworkers who took part in the chair-making process.

[24] A dado joint is a joint in which the end of one piece of wood fits into a groove cut across the width of another piece of wood. (Ostergard 1989, p.180)

Fig. 36: A woodworker in Nakashima's workshop fitting hickory spindles into a chair seat (Nakashima 2003, p.134)

A decade later, Nakashima was contacted by Masayuki Nagare (1923-present), the founder of *Minguren* 'People's Tool Guild', an association of designer-craftsmen in Japan, to reproduce the Coniod Chair. One positive outcome from this collaborative project can be seen in figure 37.[25]

Fig. 37: From left to right; Cantilever Conoid Chair, made in America in 1960 (Stone 1986, p.29); and a legless Coniod Cushion Chair II, made in Japan in 1973 (Nakashima 2003, p.197)

The original height of the Coniod Chair's seat was adapted to the Japanese physique and lifestyle. A legless Conoid Cushion Chair II was produced at Sakura Seisakusho's workshop under the supervision of Shinichi Nagami, a core member of the Minguren group. (Ostergard 1989, p.79 & 80) and (Nakashima 2003, p.190-197)

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[25] The Minguren's aim was to revive traditional Japanese crafts by getting permission from Western designers to reproduce their designs in Japan. This collaboration allowed local craftsmen to adapt their conventional skills to modern technique and design.

Conclusion

Both the Bank of China building and traditional Thai architecture demonstrate how Pei and early Thai craftsmen employed geometric segmentation as an integral design tool to harness the interplay between functionality, aesthetics and auspicious metaphor in accordance with environment, culture and milieus. The multi-faceted triangles of Pei's design simultaneously provide structural strength, dynamic suggestion and metaphorical expression through the skin of his building. Similarly, the volumetric fraction of triangular Thai roofs successfully integrates ventilation, a sense of lightness and Buddhist symbolism.

However, floating character, elaborate embellishment and Buddhist symbolism were exclusive to religious and palatial architectures, whereas the form and decoration of average early day Thai houses were reserved and austere. In addition, Buddhist chapels and royal palaces tend to diminish in vertical direction whereas most vernacular Thai houses tend to grow in horizontal direction. The reason for these differences will be revealed when I discuss cultural influences on architecture.

Although traditional Thai houses and temples share a lightening of architectonic volume through tapering, they are still encapsulated in static form and symmetry. This uniformity challenges me to push the boundary of orthodox aesthetics without abandoning the formal and orderly characteristics of conventional Thai architecture.

Of particular note is the combination of the vernacular Windsor Chair and cantilever design with the customary relaxed style of Japanese people. Nakashima's Conoid Chair from figure 37 reveals that design innovation does not need to be dependent on innovative materials and technologies. If designers utilise the advantageous properties of natural material in accordance with utilitarian form, function and cultural lifestyle, they can promote the distinctiveness of indigenous resources, technical advances and customary ways of living and provide an industry and income stream for local artisans. Furthermore, a harmonious relationship between native materials, local craftsmanship and cultural reference has a spiritual power to evoke memories associated with place.

Cross-Cultural influences

This section examines how traditional and contemporary craftsmen from Western and Thai cultures harness anthropometry and utility in accordance with customary lifestyle, considering the different sitting style of Westerners and Thais. Initially, I intend to let readers gain a broad understanding by discussing the comparison between Western and Eastern cultures toward sitting, eating and dressing styles. Then, I will lead readers more deeply into Thai furniture design's construction. Both convivial and dressing habits will be discussed in comparative case studies to illustrate the apparent incompatibility between the European and Oriental lifestyle.

This section consists of three main parts. These include:

- The comparison between Western and Eastern culture toward sitting, eating and dressing styles;
- Buddhist influences upon Oriental sitting style; and
- The antecedents and evolution of Thai furniture.

Western and Eastern sitting, eating and dressing styles

Fig. 38: Some Asians prefer sitting cross-legged on a rigid surface of modern chairs. (Kongsuwan 2008)

Quite often Asians draw up their feet while using Western chairs. This paradox stimulated me to investigate the incompatibility between the two conventions for possible connections and contradictions.

The comparison between Chinese and Windsor settees

Looking figure 38, it is noticeable that a Western seat's height does not seem comfortable for keeping legs and feet up on the seat's surface area. The seating surface of the Chinese settee called 'Ta' is nearly three times greater than the American-Windsor settee, even though Americans are generally larger than Chinese people. In contrast, the seat height of the Windsor settee is much greater than the Oriental one. What are the undertones of this difference?

Fig. 39: The Windsor Settee with high-back, England, 1740-55, Dim: H 1092 x W 1174.5 x D 438 mm. (Evans 1996, p.48)

Fig. 40: The Chinese settee 'ta' *(luohanchuang)*, Dim: H 838.5 x W 2092 x D 1054.5 mm. (Berliner 1996, p.119)

In ancient times, most Asian nations were accustomed to the mat-level mode of living. However, the American historian, Nancy Berliner, an expert in the history of Chinese furniture, writes in *Beyond the Screen*:

> *China was the only Asian nation to have adopted the chair-level mode of living. In about the tenth century, it had become common in China to sit on elevated seats at high table. (Berliner 1996, p.37)*

Fig. 41: Detail of a twelfth-century copy of a painting attributed to Gu Hongzhong. *The Night Revels of Han Xizai*, Five Dynasties period, tenth century, Handscroll, ink and colors on silk; H 29 cm, W 338.3 cm. Palace Museum, Beijing, Photo courtesy of Wango Weng. (Berliner 1996, p.37)

The first model of living on a raised platform in China was 'kang' (See fig. 40). Because of the harsh winter in northern China, a kang or brick bed oven platform was built into many homes to generate warmth. Consequently, most activities took place on this warm platform during winter months. Although southern homes in China did not have kang due to a warmer climate, the heated brick bed was adapted to the mat-level mode of living. Its height was adjusted and it provided sufficient length and width, which could be used in many ways. As time went on, kang became multi-functional, blurring the distinction between recliners, beds, seats and tables. (Berliner 1996, p.40, 122, 140 &141)

Fig. 42: The evolution of kang
From left to right; a kang or warm brick bed and kang’s drawings (Knapp 2005, p.115); kang appears in Chinese wood print; and kang Table called ‘kangzhuo’ Dim: W 629 x L 975 x H 313 mm. (Berliner 1996, p.141 &148)

Unlike kang, the seating surface of Western furniture seems to serve sitters for a specific purpose. For example, the depth of the Windsor’s seat does not provide enough room for the legs to be crossed or folded comfortably. The hollowed surface of the Windsor’s seat can fit the sitter’s buttocks, encouraging sitting in one position. (See fig. 39) The anthropometric dimensions of the Windsor’s seat are tailored for a rigid sitting posture whereas the flat large surface of the Chinese settee lets users change their body posture freely.

Was there any furniture tradition in Western countries associated with a flexible lifestyle on floor seating? Can we conclude that most of Western products are designed for an explicit function?

The comparison between Western and Asian cutlery

This question reminds me of the specific role of Western cutlery which tends to offer a singular functionality for users. For instance, forks are designed to hold, knives are designed to cut, spoons are designed to scoop; whereas Oriental chopsticks can be used to hold, cut and scoop food by relying one hand, and plates are designed to contain food while bowls can serve the diner as a food and liquid container.

Fig. 43: A convivial etiquette in Western and Eastern styles (Ferreri 1997, front page and p.55) and (Bornoff 2002, p.29)

In traditional European conviviality, the habit of eating by fingers was considered uncivilised. The King Rama IV of Siam (1851-1868) sent a set of luxurious cutlery alongside his official photograph (himself dressed in Western uniform, wearing Western regalia and seated on a Western chair) as an insinuating message to let Emperor Napoleon III know that the custom of the Siamese was not inferior to the French, even though dining with fingers was the convivial etiquette of royal Thai court at that time. This diplomatic approach was an astute strategy to evade colonial control.[26] (Moss 2007, p.82-115)

Fig. 44: The image of the King Rama IV, Mongkut (1851-1868) (http://topicstock.pantip.com/library/topicstock/2009/08/K8196859/K8196859.html)

[26] Siam was the former name of Thailand until the 24th of July 1939. Thailand literally means ‘free land’.

Later the embrace of Western culture was more conspicuous in the new custom of seating on European chair in the presence of the Siamese King. This change was recorded in the diary of the Belgian legal advisor to the King Rama V, Chulalongkorn (1868-1910), Emile Jottrand:

> *We noticed in the three pavilions a large number of Thonet chairs, this infallible indication of approaching civilisation, as there was no such thing as Siamese chairs. (Moss 2007, p.93)*

Fig. 45: A great number of Thonet chairs were initially imported to the royal Siamese court during the reign of the King Rama V, Chulalongkorn (1868-1910)
From left to right; the presence of Thonet bentwood chairs in the royal pavilion; Thonet bentwood armchair (Castle & Edman 1980, p.63); and Thonet No. 4 bentwood chair, 1848 (Fiell 1991 & 2001, p.11)

Although the introduction to Siamese court of things European encouraged Occidental formality, with consequential abolishment of some archaic customs, the adoption of Western etiquette was reserved exclusively for ceremonial purposes.[27] Significantly, the practice of floor seating and barehanded eating still remains common within Thai society. Clear evidence is apparent in fig. 46 & 47.

[27] Sir Robert Hermann Schomburgh, the first British Consul directly appointed by London, arrived in Siam in 1857 and recorded that the King Mongkut summoned his two brothers who, like the rest of the entourage, approached the King in a crawling posture, 'The King motioned them however to rise up and be seated in his presence on chairs'. (Moss 2007, p.92)

Fig. 46: The King Rama IX, Bhumibol Adulyadej (1946-present) sat on the floor in his private office while being interviewed by the English interviewer, David Lomax from the British Broadcasting Corporation in the late 1970s. Significantly, it can be noticed that the King Bhumibol tucks his legs and feet behind whereas Lomax keeps his legs and feet facing forward causing the bend of his back. According to Thai etiquette, keeping the back straight and tucking legs and feet behind demonstrate respect.[28]

Fig. 47: Most Thais still eat barehanded, particularly those who live in the northern and north-eastern region where glutinous rice is their staple. This habit suits Buddhist etiquette as well since there is no sound of metallic tang during a meal. (Chaichongrak 2002, p.183)

Different Western and Eastern craftsmen harnessed the interplay between human ergonomics and functionality in accordance with their habitual norm and ritualistic culture. Therefore, just because anthropometrical standards are widely accepted by industrial designers to provide a universal comfort for all cultures, it does not guarantee that the precise measurements of Western ergonomics conform with the

[28] This informal interview is a part of documentary film which was entitled ‘Soul of a Nation’. It was broadcasted through the BBC Channel in 1980. The excerpted version can be viewed via *http://youtu.be/jwMCHLAXGu8*

flexible lifestyle of Orientals or other races that are accustomed to using the floor quite differently.[29]

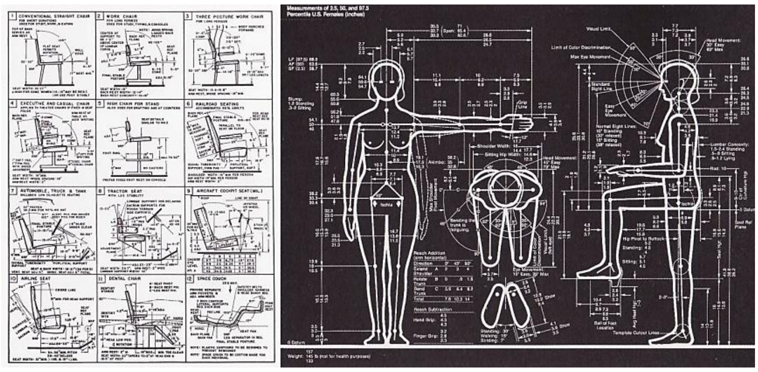

Fig. 48: From left to right; the Evolution of the Measure of Man: Human Factors in Design, in 1960 (Raizman 2010, p.261); and a diagram with percentile measurements of U.S. females in 1974 (Hiesinger 1993, p.253). Both came from Henry Dreyfuss Associates.

Is there any furniture that bridges the gap between a rigid Western anthropometry and less constrained living?

East meets West

Two examples bridge Western constrained functionality and Eastern relaxed living. The first example is a flexible stool called Sacco, designed by the three Italian designers; Piero Gatti (1940-present), Cesare Paolini (1937-present) and Franco Teodoro (1939-present). Sacco can be used as a chair or chaise lounge, shaping itself through the action of user. Its versatility breaks the tradition of European furniture and its flexible form blurs the boundary between the constrained dimension of Western seating and the lack of constraint of Oriental floor level mats. Since its production in 1968, Sacco quickly found its way to middle-class houses around the

[29] The statistical survey of human ergonomics was standardised by Henry Dreyfuss Associates in 1960. Later versions (*Humanscale 1/2/3*) were launched in 1974.

world. Due to its hybrid functionality and simple construction, a large number of Sacco and various imitations are still being produced.

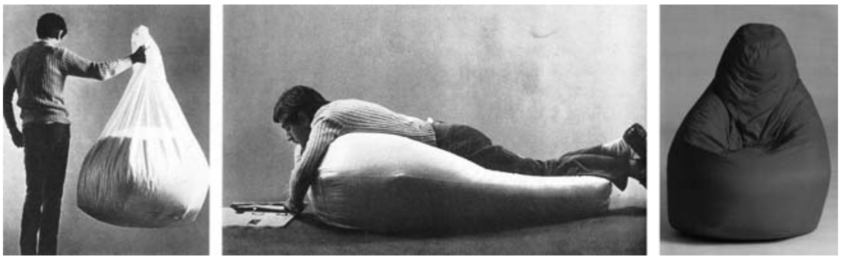

Fig. 49: The prototype of Sacco

From left to right; Sacco as a chaise and Sacco as a seat, designed by Piero Gatti, Cesare Paolini & Franco Teodoro, manufactured by Zanotta s.p.a., Nova, Milan in 1968. Its removable cover is made of lancio, its filling is polystyrene. Dim: 680 x 800 x 800 mm. (Vegesack 1996, p.126 & 127)

The second example is the Stacking Floor Chair, designed by the Japanese designer, Kenji Fujimori (1919-1993). This legless chair was designed for use at floor level on a tatami mat. While leaning on the backrest, sitters can comfortably stretch their legs out. This variation on seating design prevents the poor blood circulation that can occur when sitting in the traditional Japanese style for long hours. The structure and material of Fujimori’s chair are inspired by moulded plywood shells that can be mass-produced and stored economically. This chair is recognised as a precursor of intercultural design, and has been continuously manufactured and imitated since 1961.

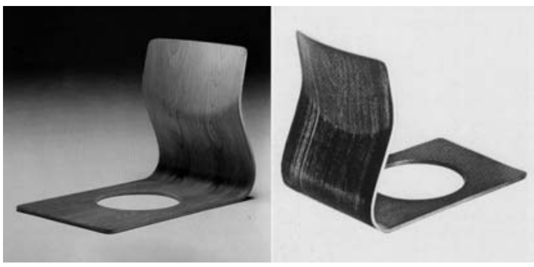

Fig. 50: From left to right; the front and the back view of Stacking Floor Chair, made of Rosewood plywood, designed by the Japanese designer, Kenji Fujimori, produced by Tendo Mokko in 1961. It was awarded MITI’s Long-Life Design Award in 1982. Dim: 400 x 330 x 490 mm. (Hiesinger & Fischer 1994, p.82) and (Hiesinger & Marcus, 1993, p.224)

While Fujimori’s Floor Chair successfully offers comfort for multi-cultural users, it requires one to point the feet forward thereby presenting some etiquette problems. Traditionally, pointing the feet to older people, monks or Buddha’s image is taboo in Eastern culture. As a result, kneeling or folding one’s legs remains common in Asian etiquette. This is why most Buddhists prefer sitting with folded legs on a high chair or bench.

Fig. 51: The traditional Japanese sitting style called ‘seiza’. Notably, it can be seen that traditional Japanese costume is conducive to sitting with folded legs. (Anawatt 2007, p.201)

Buddhist influences upon Oriental sitting style

Buddha sat crossed legged while he was reaching the stage of enlightenment. As a result, it has become the norm of Buddhist manner, and is commonly seen in images of Buddha and Buddhist monks in Asia.

Fig. 52: The Buddhist influence upon Asian sitting posture (Dansilp & Freeman 2002, p.58) and (Mertens & McLeod 2007, p.8)

According to the observation of ergonomics experts such as Dr Galen Cranz, the author of *The Chair: Rethinking Culture, Body and Design*:

> *Floor seating allows better alignment of the spine than Western-style furniture. Sitting on the floor, you can adjust your posture freely and position cushions for support. (Mertens & McLeod 2007, p.177)*

Comfort

However, it is indisputable that sitting crossed-legged for long periods of time causes serious illnesses for many meditators. While I was participating in monkhood, I occasionally made pilgrimages to practice meditation in remote and tranquil temples. One night, a noble master led all of his disciples to sit crossed-legged and meditate from dusk until midnight without moving.[30] During the second hour, I had to change my posture as I suffered tremendous pain. This painful experience let me know quite directly that sitting in any one position for too long is uncomfortable. Real comfort comes from a regularly moving of our bodies.

Buddha compared body movement to four types of wheels that rotate steadily. These include standing, walking, sitting and sleeping. Have you ever noticed how many times you change your body posture while travelling on a long-haul flight?

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[30] Master Chanrean (the abbot of Thumsahigh Channimit temple) is one of the most respectable monks in Thailand. During the Buddhist lent (between July and October), he usually leads his disciples to sit crossed-legged and meditate from dusk until dawn without moving.

Fig. 53: I was photographed in front of a boundary marker, which designates the sacred compound of religious ceremonies. This marker is installed into a wall of the main ordination hall of the royal monastery ‘Wat Bawornniwe Viharn’, Bangkok where I stayed for one and a half years. (Kongsuwan 2001)

The antecedents and evolution of Thai furniture

To let the reader trace the development of Thai furniture, I raised seven significant topics to examine. These include:

- High elevation as social status in Thailand;
- The absence of legged furniture in traditional Thai houses;
- The presence of woven mats in vernacular Thai houses;
- The implication of the mat’s popularity;
- A hierarchical social order upon Thai architectures and belief;
- Foreign influence upon Thai furniture; and
- Cross-cultural adaptation.

Differences in the height of buildings, furniture and other domestic objects, as well as body placement, all signify the social status of people in Thai communities. Due to honorific connotation and the infusion of Buddhist cosmology, palaces and temples were elevated. Common houses were built low, so as not to overlook the edifices of royal families and monks. It was said that the basic height of commoners’ homes should not be greater than the height of the king when seated within the covered seat on an elephant.

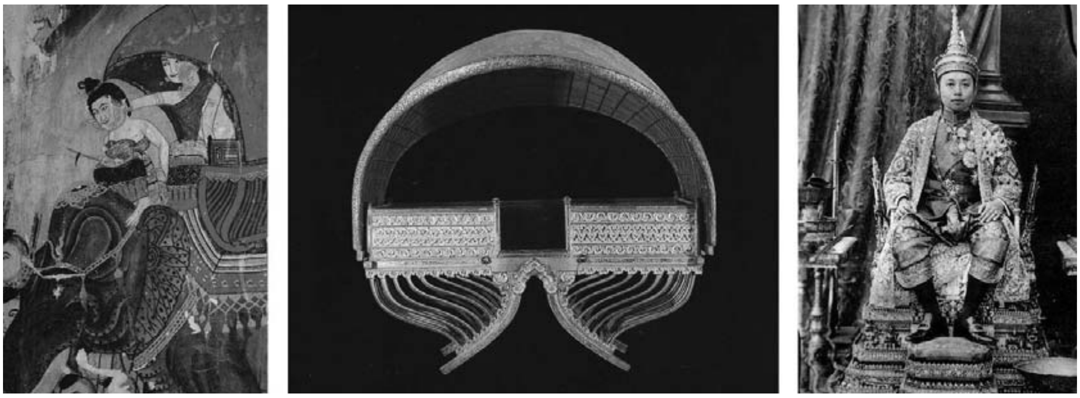


Fig. 54: From left to right; elephant with howdah and mahout from mural painting; the feature of howdah; and the King Rama VI, Vajiravudh (1910-1925) on his throne. (Dansilp & Freeman 2002, p.40 & 41) and (Warren 1994, p.8)

In terms of ecclesiastic furniture, there were two distinguishing types of high raised furniture (without protruding legs) – scripture cabinets and pulpits – built exclusively for religious purposes. These privileges demonstrate that Buddhism and the monarchy are raised as the highest position in Thai society.

Fig. 55: The evolution of Ecclesiastic furniture without legs
From left to right; four styles of scripture cabinet and two early models of legless pulpits (Dansilp & Freeman 2002, p.79 & 82) and (Warren 1994, p.58)

If high elevation and furniture were only reserved for religious and royal purposes, how did Thais live within such limited conditions in earlier times?

Pitya Bunnag, the Thai designer and expert in the history of Thai furniture writes in *Asian Furniture*:

> *There are two main reasons why Thais had limited home furniture in their culture, at least before approximately the mid-19th century. They considered furniture with pointed legs firstly as unsuitable and secondly as unnecessary. On the one hand, the point of unsuitability is accounted for by the fact that the floor of average houses was made of split bamboo tied to bamboo joists; thus any furniture with protruding legs would simply penetrate the frail floor. This is the main reason why we find that most Thai household utensils were constructed legless, as well as being light in weight, small in configuration and easy to move. Among the legless furnishings that most ancient Thais used were elevated trays with circular base called 'kan-toke', cloth storages and mat. (See fig. 56 - 58) On the other hand, the point of being deemed unnecessary resulted from the floor structure and arrangement of Thai houses, which in themselves provided and served as furniture. (Moss 2007, p.86 & 88)*

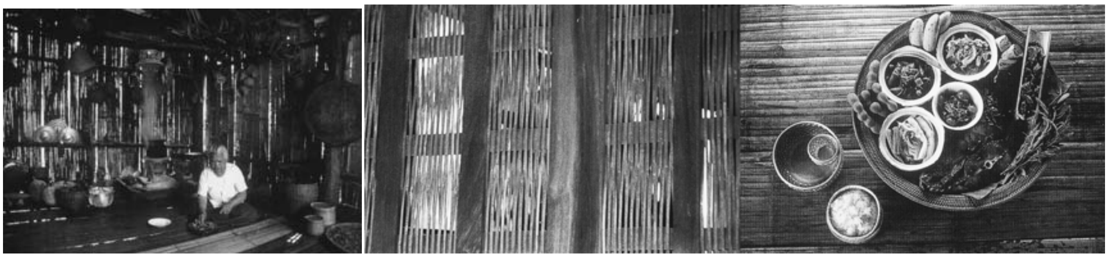


Fig. 56: Features of bamboo houses

From left to right; interior ambience; bamboo panel; and floor's detail while sustaining elevated tray, sticky-rice container and water bowls. (Chaichongrak 2002, p.84 & 171)

Fig. 57: Various styles of elevated trays with circular bases (Danslip & Freeman 2002, p.106) and (Warren 1989, p.89)

Fig. 58: Various styles of clothing chest

From left to right; royal clothing chest with black and gold lacquer (Moss 2007, p.111); clothes container in northern style; and a common style clothing chest called Smook, made of bamboo (Kanokpongchai 1991, p.124)

Traditional Thai houses were either constructed by joining solid timber, which is costly but more durable, or simply built by binding locally available materials such as bamboo, palm leaf, straw or grass thatch, which are inexpensive but perishable. Binding split bamboo results in an uneven surface and in bamboo houses mats become essential equipment for reclining and sleeping on rough floors.

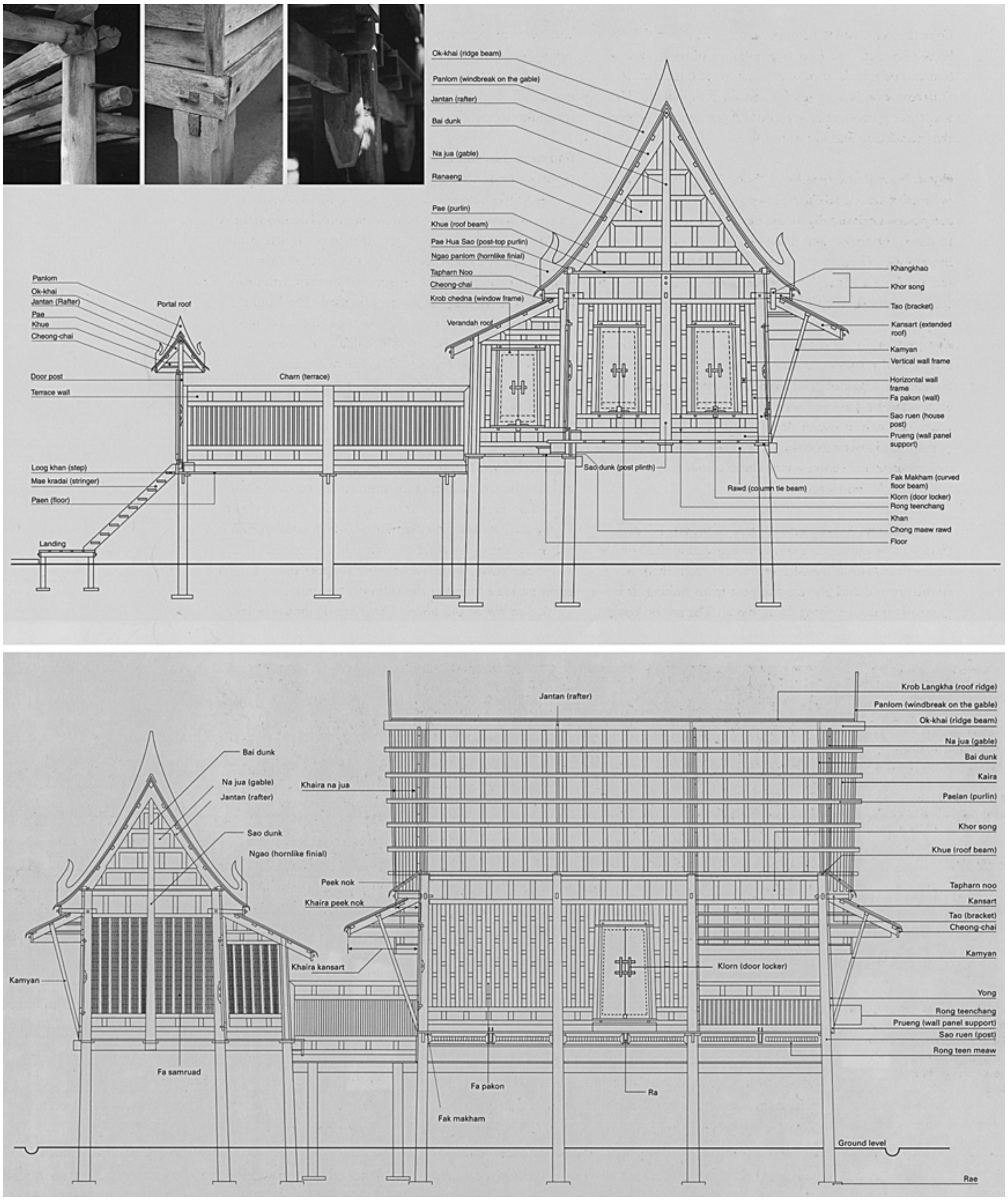


Fig. 59: From top to bottom; the details of joinery and the two end elevations of wooden Thai houses called ‘Ruen Krueng Sab’ (Chaichongrak 2002, p.61 & 81) and (Sthapitanonda 2006, p.71)

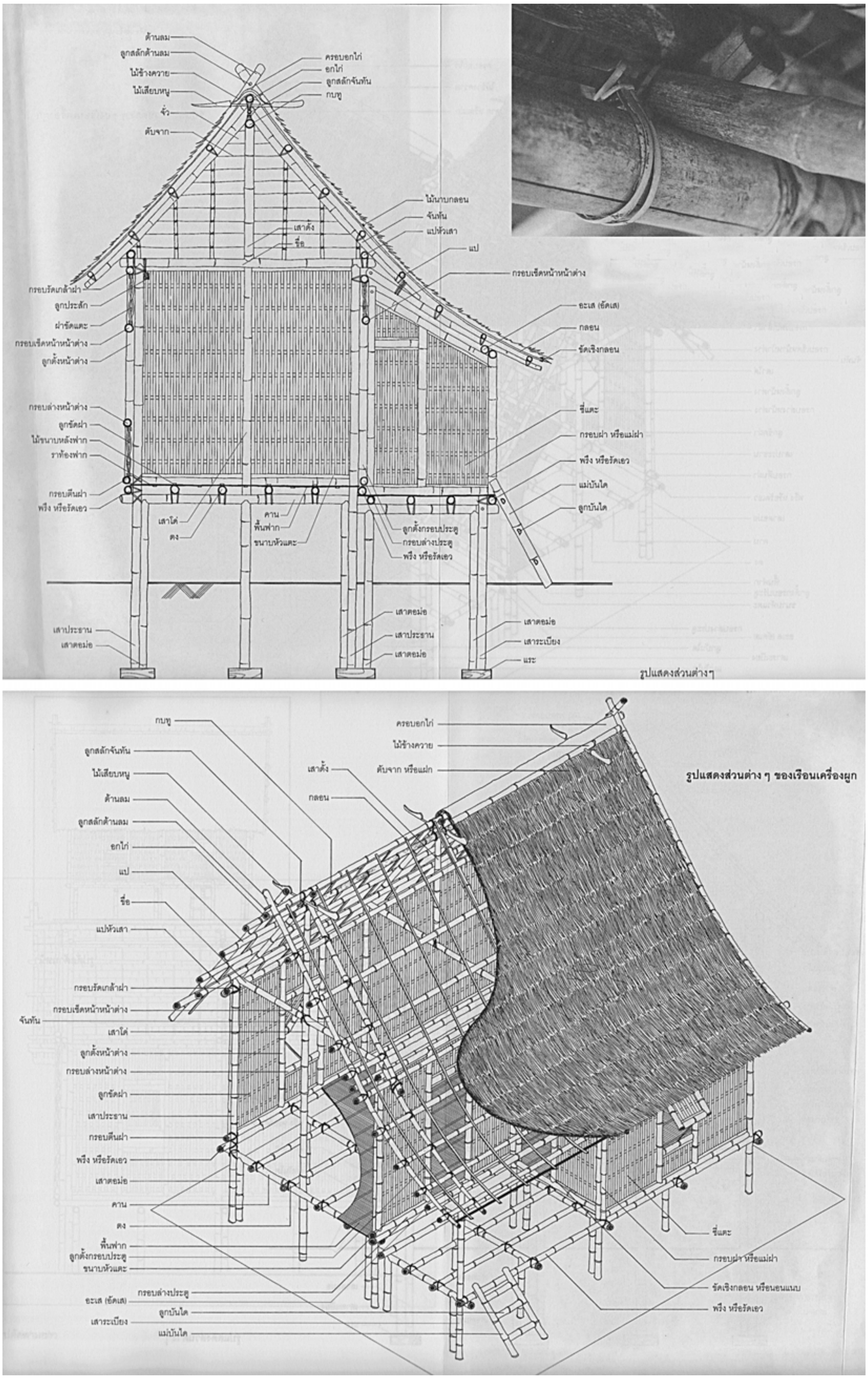


Fig. 60: From top to bottom; the binding detail, the end elevation, and the isometric view of thatched Thai house called ‘Ruen Krueng Pook’ (Nilladaj 2004, p.43, 45 & 58)

In Thailand, reeds, straw, cane and bamboo are readily available materials that can be easily employed for making mats. Mats can be plain or intricately made in various patterns, techniques and materials. As they can be coiled and stored, mats are useful in small rooms and mobile furnishings such as cushion or mattresses can also be placed on the floor. The versatility of woven matting has made it an ubiquitous household component in all Thai regions.

Fig. 61: Various rites of Thais normally take place on the floor. (Mertens & MeLeod 2007, p.177)

However, why was not a more durable material such as stone and brick employed for constructing commoners' houses?

Fig. 62: Three major types of traditional Thai house
From left to right; wooden houses called 'Ruen Krueng Sab'; thatched house called 'Ruen Krueng Pook'; and raft houses called 'Ruen Pair'. The wooden one relied on joining method whereas the rest two relied on binding method. (Chaichongrak 2002, p.12 & 67)

In early Thai history, the hierarchy of Buddhist architectures, sculptures and objects was implied through the value of materials, the delicacy of embellishment, and the infusion of Buddhist metaphor. These crafts belonged to the community and were offered as an act of pious devotion for the virtue of the 'Triple Gems of Buddhism': The Buddha, the teaching of Buddha and Buddhist monks. According to Buddhist philosophy, everything follows the 'Three Common Characteristics'; impermanence 'Aniccata', being oppressed 'Dukkhata' and soullessness 'Anattata'.

In regard to this thought, vernacular Thai houses are humble, with primitive use of available materials and austerity of decoration whereas religious and royal architecture often reflects a sense of longevity and beauty through long-standing materials, glittery ornamentation and colour. Consequently, the use of durable materials, colour, glass mosaic and glazed roof tiles were exclusive in the early days.

Fig. 63: Sri Sawai temple (13^{th} century); three towers were made of laterite. (Sthapitanonda 2006, p.15)

The end elevation of wooden Thai house in figure 59 & 64 represents three multi-levelled floors of terrace, verandah and bedroom. The spacing between each floor allows sitters to drop their legs comfortably without the benefit of chairs. The gaps also let the wind flow through the house and when guests of honour such as monks and nobility are invited to the house these multi-levelled platforms serve as an honorific offering, allowing honourable guest to sit above others.

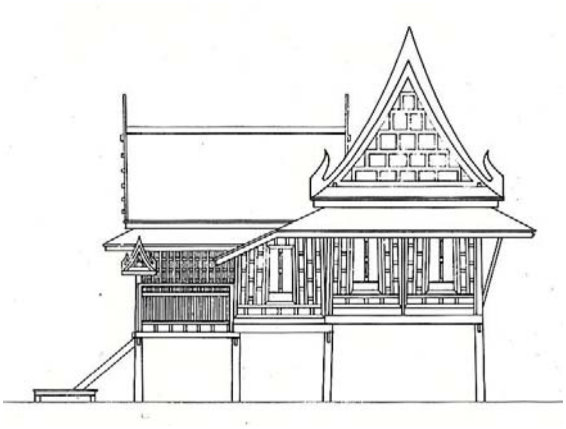


Fig. 64: The end elevation of this central plains small family house shows three multi-levelled floors. (Warren 1989, p.200)

Fig. 65: The versatile functions of multi-levelled floors allow Thais to sit either with legs hanging or in the customary mat posture, with legs and feet up on the floor. (Chaichongrak 2002, p.132)

While the built-in function of multi-levelled platforms and the flimsy structure of bamboo floor led to the absence of furniture in traditional Thai houses, this does not mean there was no tradition of legged furniture in Thailand.

As with many Asian countries, Thai tradition and culture has adapted in response to various outside influences. Before the arrival of colonies, cultural diffusion had begun owing to trading with neighbouring countries during the fourteenth century. Chinese culture played a significant role in Thai architecture, arts and crafts. As a result, most conventional Thai domestic furniture is indebted to Chinese influences. One of the most recognised Chinese furniture adapted for Thai styles use with floor seating is a low raised table called ‘tang’. This multi-functional table might have been the descendant of kang (the warm brick bed).

Fig. 66: Two types of warm brick bed ‘kang’
From left to right; while Chinese women were sitting on kang a warm brick bed during the late nineteenth-century; and kang occupies a great deal of space in Wang family manor’s living room, Shanxi, China. (Knapp 2005, p.71 & 77)

Tang was adapted by Thai craftsmen to various scales, proportions, functions and auspicious ornamentations. Symbols of powerful animals, especially lion and dragon’s paws, were often emulated through a tang’s legs, signifying the social status of the owner. However, the presence of auspicious symbols tended to be reserved for Buddhist and royal purposes. (Moss 2007, p.91)

Fig. 67: From left to right; two sizes of low raised tang (Warren 1994, p.57); the leg ends depicts dragon’s five-clawed foot and ball, a sign of royal patronage (Warren 1989, p.32); and a mitre joined leg reveals the strong influence of Chinese joinery. (Moss 2007, p.107)

Fig. 68: The evolution of preaching chair

From left to right; a splendid preaching podium, built during late 17th century (Warren 1994, p.58); a preaching podium is placed on tang to increase its height. (Danslip & Freeman 2002, p.78); the back view of a preaching chair shows elaborate carved work. (Warren 1989, p.33); and a preaching chair is adapted for contemporary usage. (Danslip & Freeman 2002, p.79)

By observing figure 68 from left to right, it can be noted that the predecessor of preaching podium with multi-tiered roofs and legless structure was replaced by the cabriole legs of a kang that are often re-curved and elevated low in order to represent a mythical animal's paws. Notably, three descendent models were further developed by adding a back rest, two arm rests and cushions, as well as increasing the seat's depth in order for a monk to sit cross-legged comfortably.

Similar to the evolution of preaching chairs, the legless feature of a traditional scripture cabinet was superseded by cabriole legs, revealing its Chinese influence.

Fig. 69: The evolution of traditional Thai cabinet

From left to right; legless scripture cabinet, built during the Ayutthaya period 14th -18th centuries (Danslip & Freeman 2002, p.83); and tapered scripture cabinet with cabriole legs, made in the early of Rattanakosin period, 1820s (Moss 2007, p.99)

Different heights also imply the hierarchical order of religious objects. When a group of miniature tangs of various heights are stacked like a pyramid, they form multi-elevated tables. The highest platform is reserved for the holiest or oldest image of Buddha, and then arranged in descending height according to sacredness or age. Significantly, placement of Thai altars resembles the multi-levelled floors of wooden Thai houses. This resemblance illustrates an embrace of foreign influence without discarding customary culture.

Fig. 70: The traditional installation of Thai altars (Chaichongrak 2002, p.34 & 35)

Another example of cross-cultural adaptation is the combination of tang and Thai furnishings. Tangs of sufficient length can be employed as multi-functional platforms including beds, seats or low tables. Similarly, small tangs can be variously used as seats, stools or the pedestal of a dressing table. The marriage of tangs with triangular cushions creates a flexible recliner with additional functions: it can be leant against to support the lower back or leant upon sideways to rest the arm. The triangular cushions are densely stuffed with kapok and then upholstered in a fabric with a traditional pattern, typically brocaded silk or cotton.

However, the use of triangular cushions on tang was restricted to nobility and aristocrats and it is more common to see laymen use triangular cushions on mat floor level. In this case, tangs can serve as a low table. Combining tang and triangular cushions near multi-levered floors generates a stair-like platform, allowing sitters to drop, draw up their feet or take ease on cushions freely.

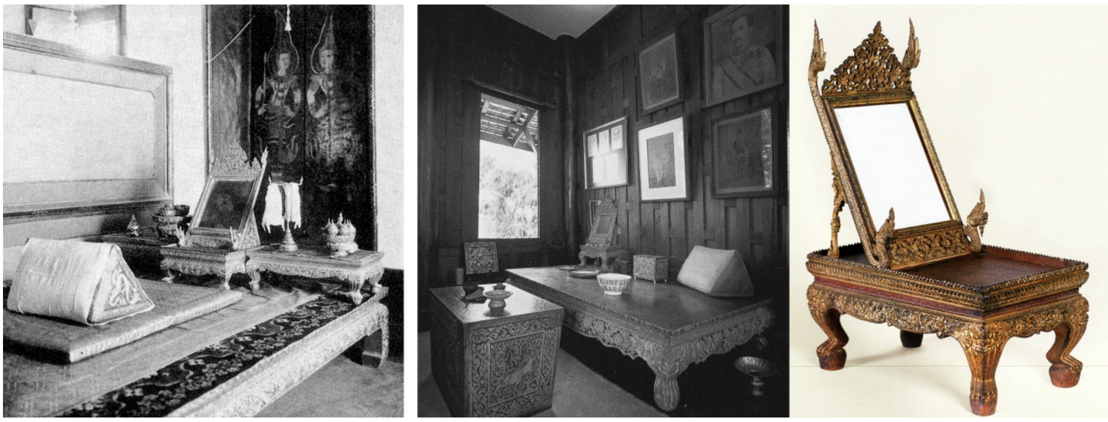


Fig. 71: The combination of tangs, triangular cushions and vanity tables
From left to right; both black and white images show how small scaled tangs are adapted as vanity tables. (Warren 1994, p.20) and (Sthapitanonda 2006, p.62); and the coloured image depicts the detail of a vanity table. (Moss 2007, p.110)

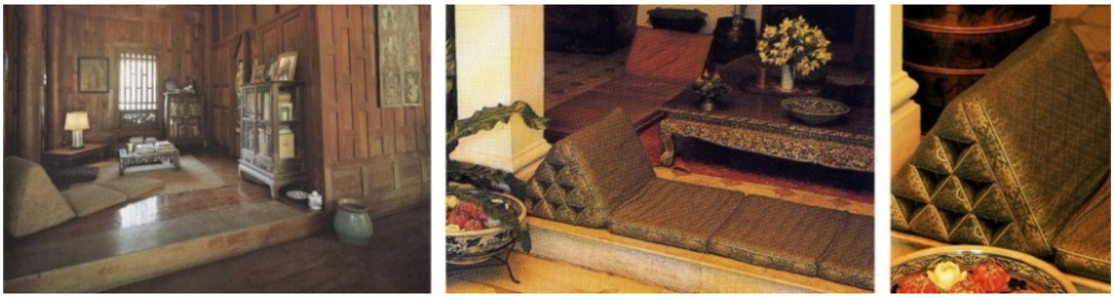


Fig. 72: The combined functions of Tang, triangular cushions and multi-levelled floors are common in Thai homes. (Chaichongrak 2002, p.31) and (Danslip & Freeman 2002, p.133)

Recently, the versatility of multi-levelled platforms has been also adopted more widely in Western countries. (See fig. 73 & 74)

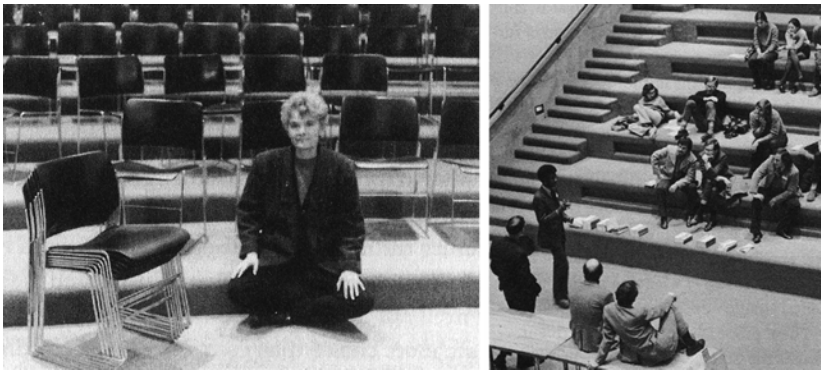


Fig. 73: The adoption of multi-levelled platforms in American Universities
From left to right; the auditorium at Berkelely's College of Environmental Design is equipped with modern stacking chairs whereas at Harvard's Graduate School of Design adopts multi-levelled platforms to provide more room and freedom. (Cranz 1988, p.200)

According to the research of the college of Environmental Design's lecturer at Berkeley, California, Dr Galen Cranz, the choices students make when given 'the option of sitting on chairs' or 'on auditorium's multi-levelled floors':

> *The class divided 50-50. Practical factors justified their decisions: chair sitters cited note taking, the desire to stay awake, or the need for back support. Those who chose the floor said they had more room and freedom. Neither my teaching assistants nor I observed any obvious sex difference, probably because female architecture students are just as likely to wear pants as the males. The most interesting difference was a personality issue, having to do with the symbolism of students' choice between chair and floor. There was a radical-conservative split. The conservatives thought sitting on the floor was unseemly and the radicals thought it was cool to do so. The choice doesn't seem to have anything to do with 'comfort' or body health. Rather, it shows where they stand socially-status once again. […] Some of the floor sitters did lie down to listen to lectures and explicitly appreciated having the option to do so. This experiment led me to conclude that more auditoriums should provide the option of sitting or reclining without the benefit of chairs. However, the culture pressure is so strong…In some years the professors who use the auditorium after my class have complained to the dean's office about the chairs not being in place. I have contacted them to explain and suggest that some of their students might like the option of sitting on the floor. I found*

resistance, particularly from one professor who felt that students couldn't master serious material while sitting or lying on the floor. Even though I told her about research on study habits showing no difference between those who studied on their beds and those who sat at desks, she would not be dissuaded [from her preference for traditional seating]. Social constructs are many times just too hard to break. (Cranz 1998, p.199-201)

Fig. 74: The freedom of sitting or reclining on multi-levelled platforms is coincidentally evident in Thailand and Tasmania.
From left to right; Thais still prefer sitting or eating on multi-levelled platforms near Ampawa canal, Sumut Songkhram province. Similarly, Hobartians are keen on sitting or reclining on multi-levelled platforms near the harbour-side dock area of Hobart. (Kongsuwan 2010 & 2012)

Conclusion

By observing cultural differences in sitting, eating and dressing, it can be seen that Western furniture, cutlery and costume are often assigned single constrained function while Thai furnishings, utensils and apparel have flexible functions, which allow for constant change and with the human body.

Thai household components more readily suit communal purposes rather than private usability. Thai furniture implies and imposes a hierarchical social order through its elevation, material usage and symbolic expression.

Spiritual influences

One busy day during winter in Tasmania I went out with a thin jacket. I felt very cold while I was walking under the shadow of tall buildings in downtown Hobart. After passing through the shade I felt better because of the warmth of sunlight. This experience reminds me of the two polar forces that govern the universe called Yin (dark) and Yang (light). If the complementary opposites of nature such as warm and cool, heavy and light, opaque and transparency, positive and negative could truly generate natural balance, the benefit of these dual aspects could be used for harmonious design.

This section investigates six major works of designers and sculptors inspired by the interplay of opposition. These works are differentiated by three elemental composites: line, plane and volume. I will describe the two-dimensional and then three-dimensional works.

Sand Garden fabric, designed by the Japanese designer, Hiroshi Awatsuji (1929-present)

Fig. 75: Sand Garden fabric designed and made by Hiroshi Awatsuji studio in Tokyo in 1967, made of Screen printed cotton, dimension: width 110 cm, owned by the artist (Hiesinger & Felice 1994, p.101)

The linear pattern of Awatsuji's fabric was inspired by the raked sand gardens of Japanese Zen Buddhist temples. The fabric's focal points are ovals in concentric patterns accentuated by horizontal lines. The objective of a Zen garden is for a visitor to approach a calm stage of mind while staring at the concentric pattern of raked sand. The opposition between curves and straight lines as well as vertical and horizontal directions is reminiscent of the dual aspects of nature (male/female, day/night, etc.).

Japanese dry gardens, created with rocks and raked gravel, are miniature abstract representations of the natural landscape (groups of islands rising out of the sea). The dry garden originated in China and was brought to Japan by the priests of Shingon Buddhism who had travelled and studied there.[31]

Fig. 76: Zen garden at Ryoanji temple at north-western Kyoto Japan, built around 1488 (McArther 2002, p.202)

[31] The Shingon School of esoteric Buddhism was established in Japan by Kobo Daishi (733-835 BC), the most celebrated priest in Japanese history. He studied in the esoteric Buddhist school in China under Hui Guo from 746 until 805 BC.

The first Peace Altar, designed by the Japanese-American architect, George Nakashima (1905-1990)

Fig. 77: The first Peace Altar designed and made by George Nakashima in America in 1986, made of book-matched walnut boards, dimension: 10.5 x 10.5 feet, owned by the Cathedral of St. John the Divine in New York City (Ostergard 1989, p.87)

The second work was designed and made by George Nakashima. Nakashima planned to make monolithic altars; one for each continent. Unfortunately, only one was accomplished during his lifetime.

The gigantic top of the first altar was made of book-matched walnut boards.[32] These separate boards were joined by five butterfly keys. The base was specially engineered to cope with the lateral expansion and contraction of wood. The book-matched pattern and the shape of the butterfly keys create a sense of duality towards the mirror image of wooden pattern and trapezoidal inlay. There is also a play of opposites between the free edge of the altar's top and the edgy geometry of the butterfly key motif. There are contrary forces between the movement of organic material and the firmness of architectonic structure. As it was made for community use, the wooden surface was finished with polyurethane to withstand hard usage. Since 1986, the first Altar for Peace has been housed in the Cathedral of St. John the Divine in New York City.

[32] Book-matching is a traditional technique in which a piece of wood is split tangentially, opened like the page of a book, and joined together to form two adjoining surfaces, so that they almost reflect the exact correspondence of size and shape between opposite side of a structure.

IN-50 Coffee Table, designed by the Japanese sculptor, Isamu Noguchi (1904-1988)

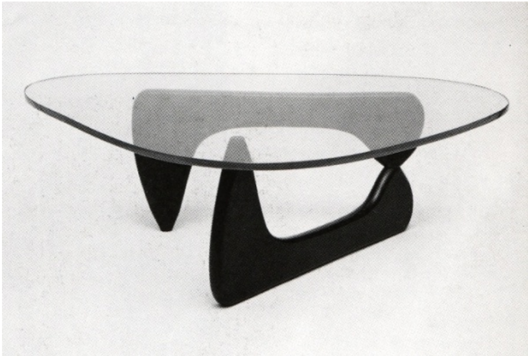


Fig. 78: IN-50 Coffee Table, designed by Isamu Noguchi in 1944, manufactured by the Herman Miller Furniture Company in America in 1947, made of two identical pieces of solid walnut and a clear glass plate (Hiesinger & Marcus 1993, p.159)

The third piece is IN-50 Coffee Table, designed by the Japanese sculptor, Isamu Noguchi. The three planar components of this coffee table demonstrate a simple way of achieving the integration between sculptural qualities, aesthetic contrast and kinetic expression. This achievement relates to Noguchi's view:

> *Sculpture was the art which can only be appreciated in the raw, relative to man's motion, to time's passage, and to its constantly changing situation. (Noguchi 1987, p.12)*

The polarised character of this piece is obvious in the play between the transparent top and solid legs. Although the legs are identical in shape, they have been rotated and reversed. They are locked together simply with a single pin and socket coupling.

As its components are symmetrical, the table is conducive for mass production. Additionally, every element can be dismantled and flat packed. Its economical logistics and simple manufacture make this coffee table very popular among buyers (and imitators). The IN-50 Coffee Table has been produced by the Herman Miller Furniture Company in America since 1947.

Dik Dak No.2, designed by the Hong Kong-base Chinese designer**,** Freeman Lau (1958-present)

Fig. 79: Dik Dak No.2 from the Chairplay series, designed by Freeman Lau made in 2007 (Fischer 2010, p.72)

Most of Lau's works blatantly reflect the play of opposition. Although Lau's Dik Dak No.2 is made up of two identical modules of solid trapezoidal form, it is rich in contrasting effects featuring dark with light colour, inward and outward slants, and positive pin and negative recess.

This modular furniture illustrates how seemingly polar elements are interconnected and interdependent in arrangement, and how they give rise to each other in turn. This complementary opposite references the creative interplay of yin and yang. Significantly, there is a trapezoidal connection between the diminished size of dovetail pin and the contour of furniture.

Butterfly Stool, designed by the Japanese designer, Sori Yanagi (1915-2011)

Fig. 80: Butterfly Stool, designed By Sori Yanagi in 1956, produced by Tendo Company, Ltd., made of plywood and brass, dim: 39 x 42 x 31 cm. (Hiesinger & Marcus 1993, p.202)

Yanagi’s stool harmoniously blends the traditional attributes of Japanese architectural form with modern material and manufacturing processes.

The Butterfly Stool is sparse in parts but rich in contrasts. It is made of two identical moulded plywood sections symmetrically connected by two screws underneath the seat and a single threaded brass rod; the stool can easily be disassembled and reassembled.

The play of opposites can be seen in the mirrored form and the book-matched pattern of the veneer. Although the height of the Butterfly Stool is not conducive to the customary lifestyle of Japanese people, Yanagi successfully assimilated the overhanging elements of the portal of Shinto shrines with the floating appeal of the cantilevered seat. Moreover, the fluid outline of the stool echoes the flowing lines of the Japanese calligraphy symbol for sky. This eclectic approach demonstrates how vernacular Japanese heritage, Occidentalism and industrialisation are integrated in contemporary furniture.

The Butterfly Stool became well known after being exhibited at the XI Triennial in Milan in 1957, where Yanagi won a gold medal award for his piece. The Butterfly Stool has been produced by the Japanese furniture company Tendo Mokko since 1957.

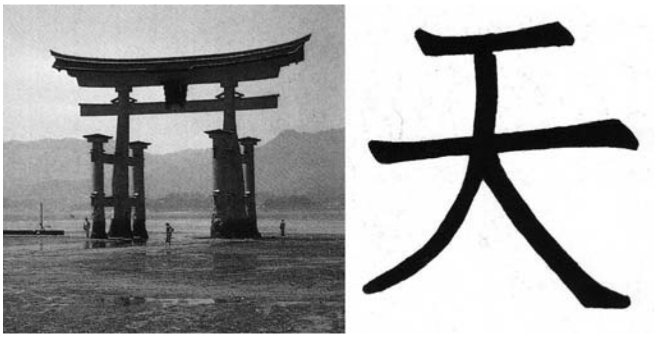


Fig. 81: From left to right; The torii (portals) of Itsuhushima shrine on Miya-jima, Japan; and Japanese character for sky (Vegesack 1996, p.160)

Iron Bookends, designed by the Japanese craftsman, Rikucho Ogasawara (1929-present)

Fig. 82: Iron Bookends
From left to right; Bookend K (W9.7 x D6.5 x H13.5 cm) and Bookend F (W9 x D8.8 x H17cm), designed and made by the Japanese craftsman, Rikucho Ogasawara (Koyama 2005, p.26)

The design of these bookends was based on Ogosawara’s ordinary observations. The horn-shaped bookend was inspired by a cow chewing its cud whereas the flat symbol-like shape of Bookend F reflects Ogasawara’s interest in Chopin and Mozart.

Both bookends elicit a sense of symmetry and opposition through the reverse posture of an identical forged form. Although the heaviness of iron is necessary for the utility of a bookend, their shape is not subjugated by the physical weight of material. These polarisations powerfully suggested both ambiguous and contrasting effects such as: stability with instability, immutability with movability, hard material with gentle contour and solid form with empty space.

Conclusion

The commonality of these six exemplary works is the arrangement of two symmetrical patterns and forms in interdependent compositions. Although all six designers employed the play of opposition as a means of relieving the boredom of unity, the two major components of each work remain inseparable; these selected works demonstrate how the polarised characters of pattern, colour and form are interconnected in linear, planar and volumetric modes. All works also demonstrate ways of saving manufacturing and transportation costs by using the same component repeatedly. The complementary opposites of the works have a synergetic power that evokes the dual aspects of Buddhism associated with the spirit of natural harmony.

Chapter Three: methodology

A thematic design tool of this project lies in the combination of trapezoidal shapes, geometric abstractions, re-compositions and play of opposites. These elements were utilised as a mechanism to generate new organisations of decorative pattern and functional form in volumetric, planar and linear experiments. The main objective was to explore basic ways of assimilating the aristocratic attributes of Thai architectural elements with the pared down aesthetics of functional furniture. These attributes were:

- The floating quality of boat-shaped structure;
- The trapezoidal geometries of traditional Thai walls;
- The contrasting colours of ornamental inlay;
- The dynamic effect of coloured glazed roof tiles; and
- Overlapping geometric roof planes.

As the first stage of the research and development process, I made numerous drawings of objects that addressed and reflected some or all of the attributes mentioned above. Designs evolved from drawings and a selection of the designs was made up as miniature models and full-scale prototypes. Following processes of reflection, discussion and consideration, I resolved to focus the balance of the project around three experiments which form the core of this chapter.

Drawing from Thai folk crafts, I combined the linear elements of a fish trap with the techniques of Kinetic and Op Art to apply the moiré effect of the trap’s wickerwork weave and fringe within a large utilitarian object.

The project resulted in four groups of realised design works: Cantilever Benches, Diagonal Benches, Dowel Bench Seats and Shelving Units. Each object's vertical and horizontal elements revealed the interplay between geometric form, cross-cultural function and overhanging structure. The design/making process included sketched designs, computer-aided design (CAD), computer modelling, miniature models, full-scale prototypes and final fabrication.

Chapter Three is made up of four sections. The first three consider volumetric, planar and linear experiments. The last section describes the concept for the layout of the final exhibition.

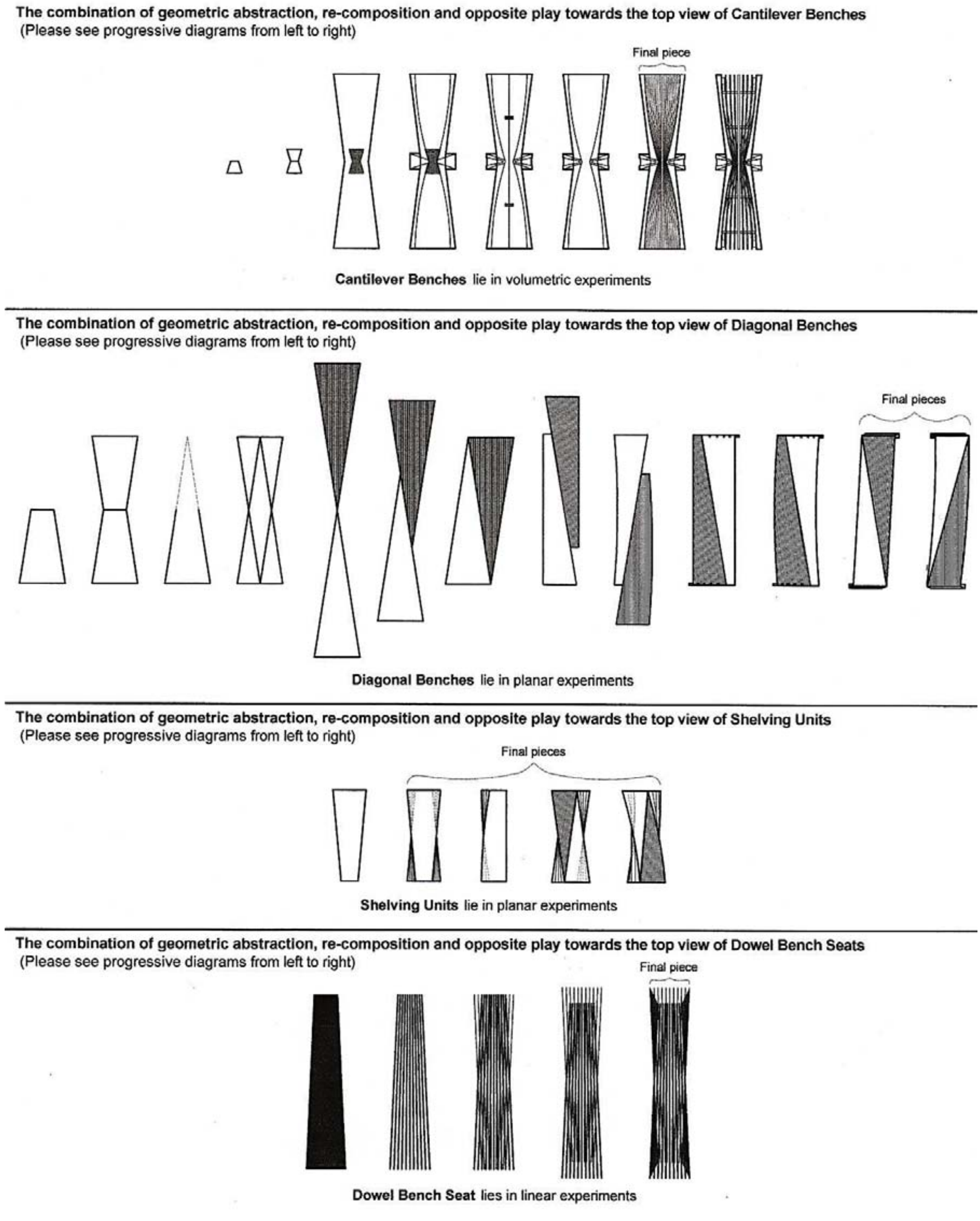


Diagram 1: The four groups of design works were separated by three modes of experimentation (Kongsuwan 2011)

The First section of Chapter Three: volumetric experiment

Product: Cantilever Benches #6M & #6F (2012)

Medium: Solid and laminated Huon pine

Finish: hand-oiled

Dimension: Width 575 x Length 2200 x Height 450 mm.

Fig. 1: A pair of Cantilever Benches #6
From left to right: Cantilever Benches #6M and #6F (Whyte 2012)

The designs within the volumetric experiment comprised six versions of a cantilever bench. These were ranged from Cantilever Bench #2 to Cantilever Bench #7. The design of Cantilever Benches #6M and #6F was selected for the final fabrication due to its simpler design which was conducive to both handmade and mechanical production.

Design aim

The main objectives of the volumetric experiments were:

- To use venerated motifs of revealed joints (dovetail pin and butterfly key) as a thematic design key of the Cantilever Benches;
- To shift the two-dimensional plane of the traditional inlaid motif to the three-dimensional form of a bench's contour; and
- To incorporate dualistic metaphor and the floating, fluid qualities of a Thai boat with the modern influence of cantilever design.

The geometric elements within the process of designing the Cantilever Benches included:

- The solid plane of trapezoid;
- The solid plane of double trapezoids (two elements were joined at their narrow tops);
- The solid plane of rectangle;
- The truncated pyramid with rectangular base; and
- Concave and convex lines. (See diagram 2)

These geometric elements were abstracted and recomposed in ten major steps including:

- **Mirroring** the trapezoidal motif vertically along its narrow top to resemble the butterfly key motif;
- **Juxtaposing** two different scales of butterfly key motif;
- **Differentiating** two different scales by using opposite colours;
- **Introducing** cruciform layout for unity. This aimed to signify the centre of universe in reference to Buddhist cosmology;
- **Subduing** the stiffness of rectilinear contours by juxtaposing curvilinear lines;
- **Replacing** the central motif of the dark butterfly key using two smaller motifs along the longitudinal glued line;
- **Scooping** flat surfaces to suggest visual lightness and a sense of invitation;
- **Removing** two smaller motifs and the longitudinal glued line;
- **Rendering** curvilinear patterns longitudinally to manipulate the apparent width of an enlarged motif; and
- **Breaking** the massive plane of the butterfly key motif by constituting curvilinear members, supported by longitudinal and transverse elements. (See diagram 2)

The play of opposites in the processes of designing and making Cantilever Benches consisted of:

- Large versus small scale;
- Dark versus light coloured;
- Rectilinear versus curvilinear lines;
- Vertical versus horizontal axes;
- Left versus right side;
- Longitudinal versus transverse beams;
- Positive versus negative curve members;
- Concave and convex profiles;
- Floating top versus earthbound base;
- Flat versus scooped surface;
- End grain versus normal grain direction; and
- Ventilative versus solid top. (See diagram 2)

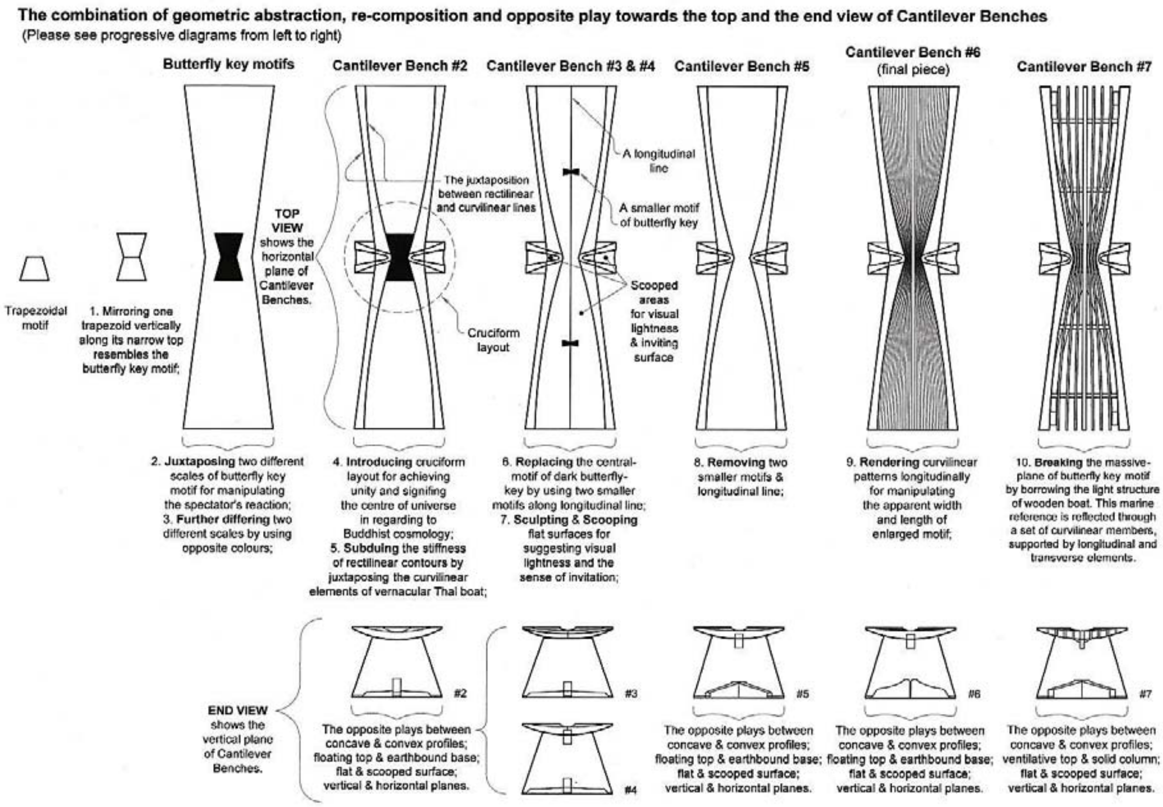
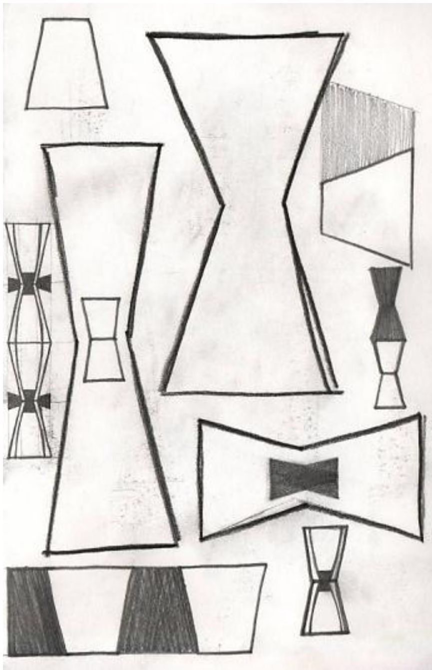


Diagram 2: from left to right; the sequence of stages in abstracting and recomposing the horizontal and vertical elements of the Cantilever Benches (Kongsuwan 2011)

The process of designing the Cantilever Benches

With the above points in mind, I began the design and making process by reflecting one trapezoidal plane vertically along its narrow top to form the mirror image of the trapezoid. The result resembled the butterfly key motif. Then, two different sizes of butterfly key were juxtaposed to manipulate the viewer's reaction. The smaller motif differed further by being filled in with dark colour whereas the large motif remained unfilled. The use of opposite tones aimed to preserve the original character of the butterfly joint.



Drawing 1: The combination of mirror image, different scale and opposite colours (Kongsuwan 2008)

The addition of cruciform layout and curvature

I placed an additional plane of butterfly key across the mid length of the two previous motifs to make reference to the cruciform layout of Buddhist and royal architectures in Thailand. In-Buddhist cosmology the cruciform structure symbolises the centre of universe.

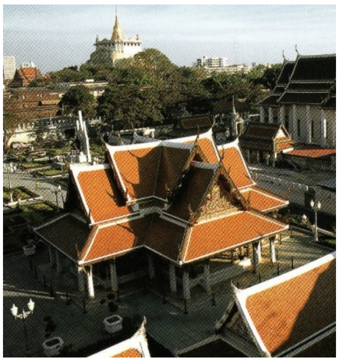
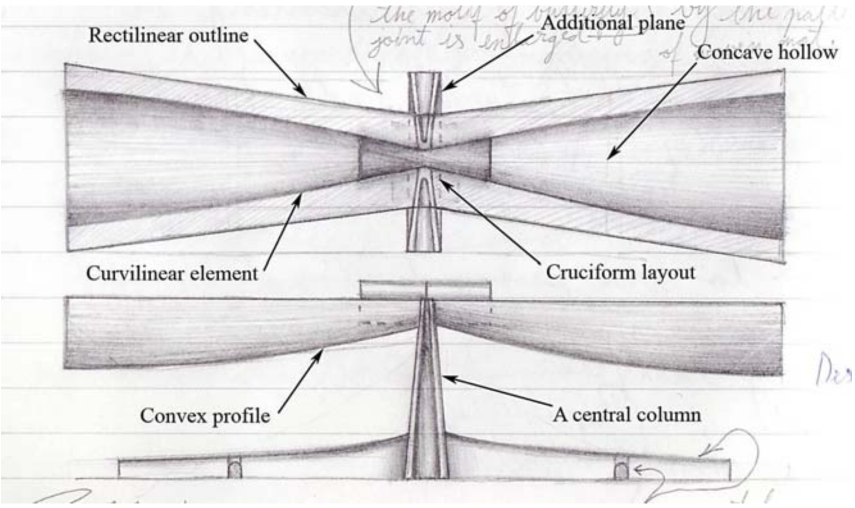


Fig. 2: The cruciform roof of the ceremonial pavilion of Bangkok near Ratchanatdaram temple (Sthapitanonda 2006, p.136)

The cruciform element also achieved unity. Notably, the mirror image of trapezoid represents duality. These components were united by the addition of a central column. (See drawing 2)



Drawing 2: The top and the front elevation of initial design (Kongsuwan 2008)

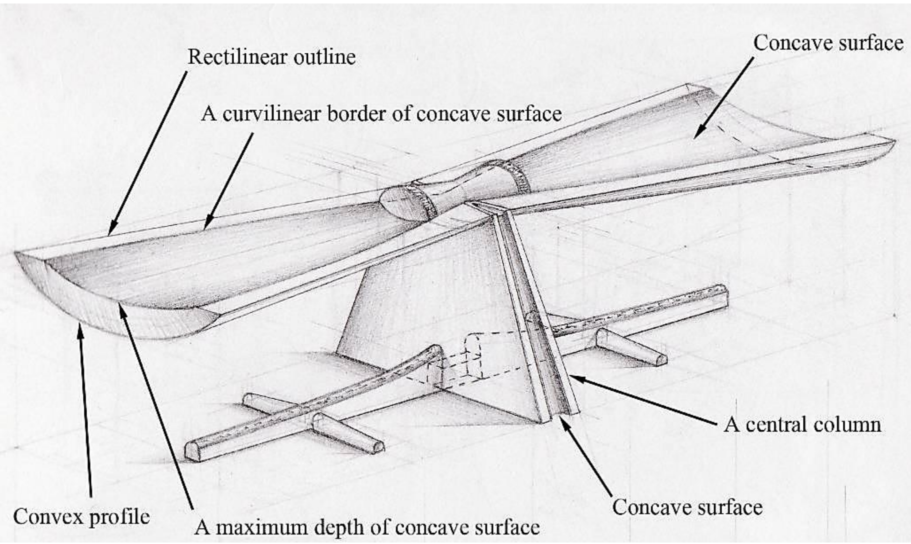
To subdue the stiff look of rectilinear contour, I ran a gentle curve along the trapezoidal outline of the butterfly key motif. These curves borrowed from the aerial contour of vernacular Thai boats, reminiscent of riparian areas of Thailand as well as being a metaphor for the Buddhist vessel of enlightenment.

The presence of concavity and convexity

The curved element and the boat metaphor stimulated me to convey floating and inviting qualities in the bench seat. I began incorporating concave and convex elements to incorporate a sense of volume to planar elements.

The convex profile underneath the seating platform implies visual lightness whereas the concave hollow at the top of sitting platform softens the rigidity of a flat surface. This inviting feature echoes the scooped surface of the Windsor shaped seat. The seat's centre has a maximum concave depth, which gradually gets shallower until reaching a curvilinear border.

I then began making perspective drawings to further explore the correlation between vertical and horizontal elements.



Drawing 3: One early design (Kongsuwan 2008)

The significance of dualistic display

Due to the identical shape of the opposite sides of the bench, I was interested in the repetitive use of symmetric form. When two benches were lined up together, they reflected a boat train of Thai merchants through elliptic curves that run continuously between two modules. Similar to the top elevation, the continuity of ellipsoidal lines were also reflected through the front elevation of two modules. This is another marine reference that evokes nostalgic memories associated with the water route of Thais in early days.

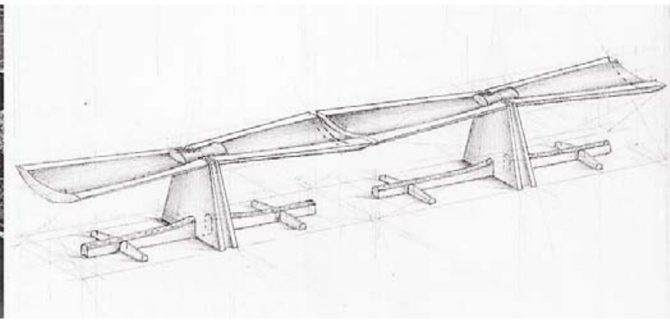
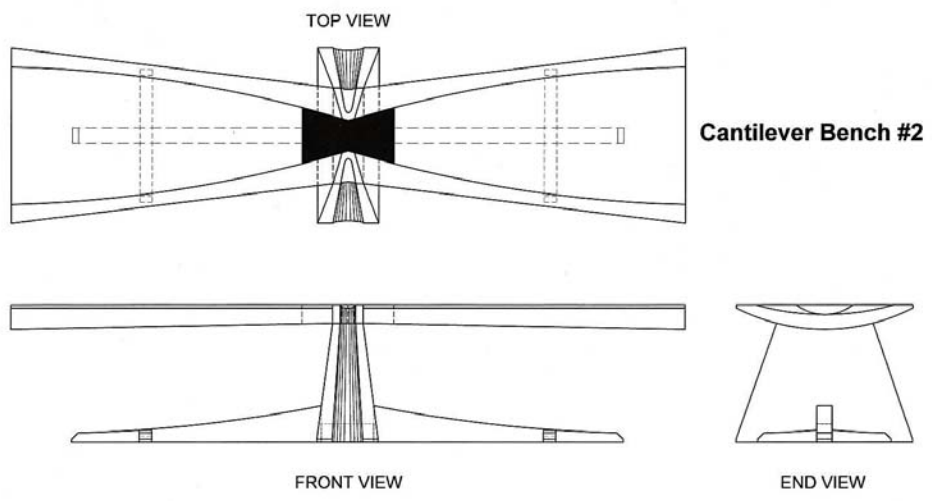



Fig. 3 & drawing 4: from left to right; an aerial view of local Thai boats lining up in a canal (Chaichongrak 2002, p.45); and the sketch of my early design which was influenced by a boat train of Thai merchants. (Kongsuwan 2008)

Miniature models

The study of models was used to investigate harmonious relationships between proportion, appearance and stability. The scale of the miniature models is 1:7.5. The model-making process consisted of three main steps:

- Breaking all the elements apart (Cantilever Bench #2 consisted of three major components including cantilever platform; trapezoid column; and cruciform foot base);
- Executing all components according to specified drawing and actual material (Huon pine); and
- Joining and gluing each part together.



Mechanical drawing 1: The three elevations of Cantilever Bench #2 (Kongsuwan 2008)

Cantilever platform

The butterfly shaped platform of miniature models of Cantilever Bench #2 was made up of two identical trapezoid boards. These separate components were joined together at their narrow ends by a single butterfly key.

Fig. 4: A pair of cantilever platforms on the scale of 1:7.5 (Kongsuwan 2008)

When the butterfly shape was used as a seating platform, it generated the varied dimensions of buttock-popliteal lengths.[33] Measuring the butterfly shaped platform, the width of the seat varies from 57.5 centimetres to 31.5 cm.

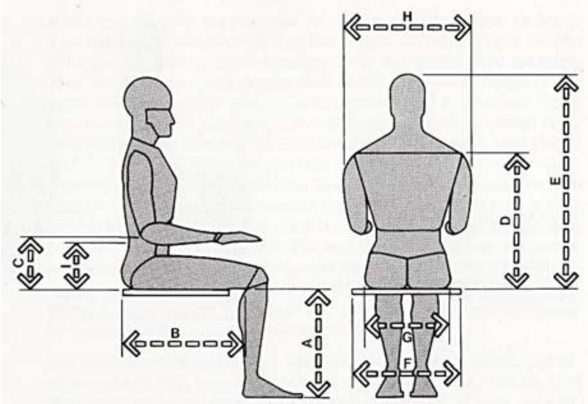


Figure 4–4. Key anthropometric dimensions required for chair design.

	MEN				WOMEN			
	Percentile				Percentile			
	5		95		5		95	
MEASUREMENT	in	cm	in	cm	in	cm	in	cm
A Popliteal Height	15.5	39.4	19.3	49.0	14.0	35.6	17.5	44.5
B Buttock-Popliteal Length	17.3	43.9	21.6	54.9	17.0	43.2	21.0	53.3
C Elbow Rest Height	7.4	18.8	11.6	29.5	7.1	18.0	11.0	27.9
D Shoulder Height	21.0	53.3	25.0	63.5	18.0	45.7	25.0	63.5
E Sitting Height Normal	31.6	80.3	36.6	93.0	29.6	75.2	34.7	88.1
F Elbow-to-Elbow Breadth	13.7	34.8	19.9	50.5	12.3	31.2	19.3	49.0
G Hip Breadth	12.2	31.0	15.9	40.4	12.3	31.2	17.1	43.4
H Shoulder Breadth	17.0	43.2	19.0	48.3	13.0	33.0	19.0	48.3
I Lumbar Height	See Note.							

Fig. 5: The key anthropometric dimensions required for chair design (Panero & Zelnik 1979, p.61)

Although the various seat depths did not correspond to the buttock popliteal length of Western standards, it was my intention to offer a multi-cultural comfort. The height of the seating platform was elevated at 43 to 45 centimetres in order for Westerners to sit comfortably with legs hanging, yet I elongated the seating platform by lining up two modules to let Easterners relax in the more flexible mat posture with their legs and feet up.

[33] Buttock popliteal length is the horizontal distance from the rearmost surface of the buttocks to the back of the lower leg. (Panero & Zelnik 1979, p.79 & 95)

Trapezoidal column

This column is a crucial component that connects the cantilever platform and the cruciform foot base together. In order for these composite parts to be joined in place, a decapitated pyramidal column was trenched at both its narrow top and wide rectangular base. Another important function of this column is to elevate the seating platform above the ground at about 45 centimetres. The ergonomic intention was to avoid discomfort that occurs when users with a smaller popliteal height feel pressured thighs when sitting on a bench that is too high.

Fig. 6: Trapezoid column (Kongsuwan 2008)

In order to manipulate the visual weight of this component, four vertical sides of this rectangular solid were tapered inwardly like a truncated pyramid. Two narrow sides of trapezoid column were hollowed to further reduce its visual heaviness.

The cruciform foot base

My combination of the cruciform foot base and the cantilever platform was inspired by the progressive development of wooden cantilever furniture from 1920 to 1970. The bridge between the design of Cantilever Bench #2 and those cantilever predecessors is obvious in *Minguren I Coffee Table*, designed by George Nakashima.

Fig. 7: Minguren I Coffee Table, made of English oak burl, produced in 1968, Dim: H 403 x W 1778 x D 755.5 mm (Ostergard 1989, p.133)

The cruciform base of Cantilever Bench #2 consisted of two main parts; a pair of transverse foot bases and a longitudinal base. Both the transverse and longitudinal bases were relatively trenched at the same depth. Then, each transverse base was joined across the length of longitudinal base. In order for a cross halving joint to work efficiently, the trench of longitudinal and transverse base must be set out on the opposite side. In this case, a longitudinal base was trenched from the square edge, which attaches the floor. In contrast, a pair of transverse foot bases was trenched from the reverse side.

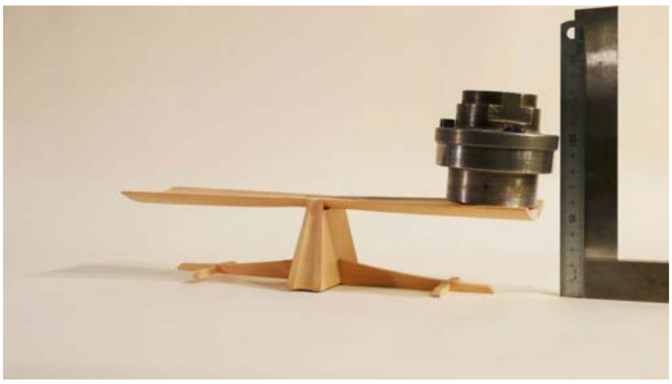


Fig. 8: A structural test of Cantilever Bench #2's scaled model was done by placing a piece of metal (about 1.2 kilograms) at one end of cantilever platform. (Kongsuwan 2009)

After testing the scaled model of Cantilever Bench #2, I found two major problems: the instability of the foot base and the weakness of a singular butterfly joint. The instability occurred because the distance between two transverse foot bases was too close.

Fig. 9: Various views of Cantilever Bench #2's model (Kongsuwan 2009)

After investigating the weakness of the butterfly joint, I found that the grain direction of the singular butterfly key runs along the same direction of two major trapezoidal pieces. This led to being joined from end grain to end grain, which did not reinforce joint's structure. Moreover, as time goes on, the different percentage of wood shrinkage and expansion are likely to cause fissures at the glued lines of the joint. For a butterfly joint to work effectively despite fluctuations of temperature, the grain direction of the butterfly key must always run against that of the primary wood of the piece.

Sourcing material (part 1)

The four significant reasons that I preferred using Huon pine for executing Cantilever Bench Seat were due to;

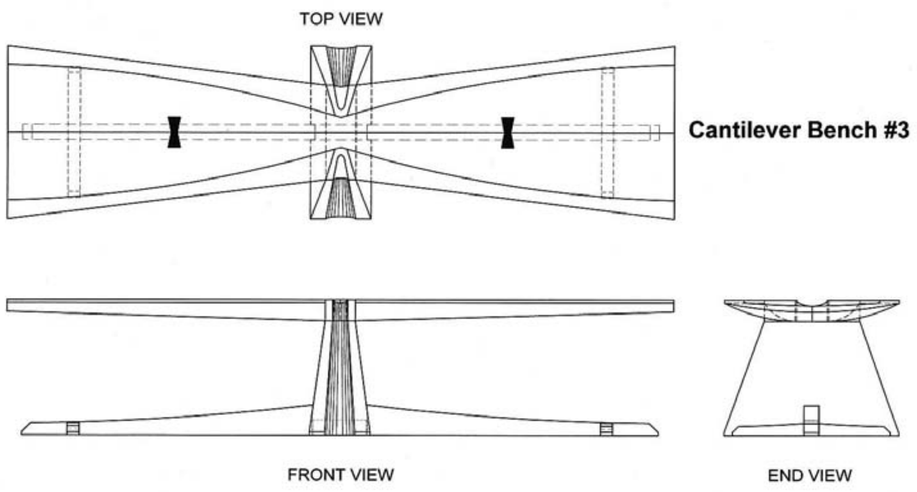
- Its historical and endemic values related to the spirit of place in Tasmania;
- Its properties of being carve-able by hand-tools and machine;
- Its ability to withstand water; and
- Its buttery bright colour that lets light and shadow accentuate the depth of concave surface.

The dimension of cantilever platform requires a single wide board (60 centimetres) with an extra thickness (8 centimetres). With this concern, I visited local sawmills around the northwest of Tasmania, to Queenstown and Strahan where Huon pine grows effectively in nearby rainforest areas.

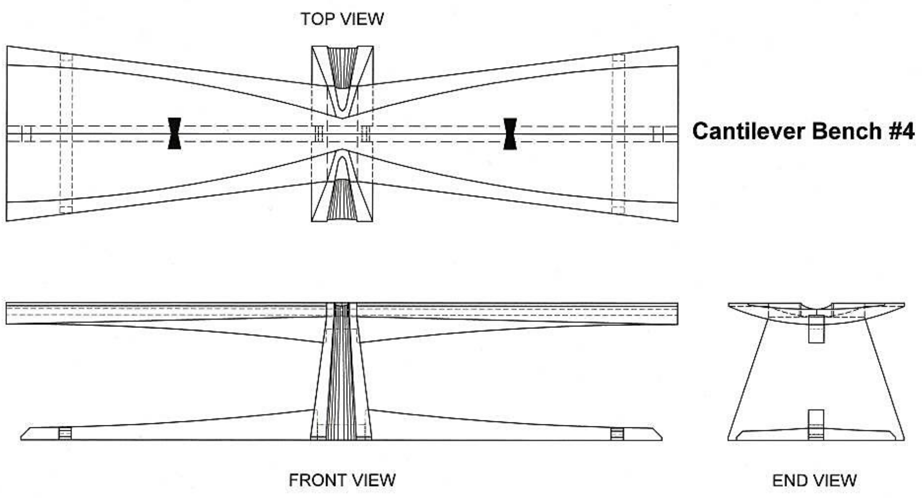
Fig. 10: A local sawmill in Queenstown, Tasmania (Kongsuwan 2009)

Although the extra width and thickness of the primary board of my bench seat did not match the available sizes of air-dried Huon pine slabs, I was offered green wood which needed to be dried by artificial seasoning. Kiln-dried timber is a lot cheaper than air-dried timbers; however, wood can be damaged through lack of care and the over-accelerated method of kiln drying. In the case of not being able to source a single wide board of Huon pine, the function of butterfly key would be utilised to join two narrower slabs of air-dried Huon pine.

After a trip to north-western Tasmania, I began revising the design of Cantilever Bench #2 in response to the concept of using joined boards instead of a single board of kiln dried timber. Then I started developing a new series of scaled models in order to resolve the problems of an unstable foot base and weak joined structure.



Mechanical drawing 2: The three elevations of Cantilever Bench #3 (Kongsuwan 2009)



Mechanical drawing 3: The three elevations of Cantilever Bench #4 (Kongsuwan 2009)

The revision of scaled models

Fig. 11: From top to bottom; each horizontal row illustrates the progressive development of Cantilever Bench #2, #3 and #4 respectively. (Kongsuwan 2009)

The five distinctions of these three scaled models are:

- The distance between the two cruciform structures at the foot base of each model;
- The length of both longitudinal and transverse bases;
- The thickness of cantilever platform;
- The convex profile underneath cantilever platform; and
- The relocation of butterfly keys.

In comparison with the scaled model of Cantilever Bench #2, the distance between the cruciform structures at the foot base of Cantilever Bench #3 and #4's models were extended. This wider and longer adjustment aimed to maintain the base's contact with the ground. Similarly, by observing the end and front view of Cantilever Bench #3 and #4's models, it can be seen that the longitudinal and transverse bases appear longer. This elongation aimed to improve stability. (See fig. 11)

By looking at the end elevation of every model, it is noticeable that each cantilever wing shows the differences of concave and convex profiles. By looking at the front elevation, the profile beneath the seating platform of Cantilever Bench #2 is distinguished by its elliptic curve. This ellipsoidal profile appears thinnest at the centre and gradually gets thicker to both ends. (See fig. 11)

In contrast, looking at the front elevation of the model of Cantilever Bench #3, the profile underneath the seating platform imitates the figure of a tree branch. This appears thickest at the centre and gradually gets thinner to both ends. (See fig. 11)

Unlike Cantilever Bench #2 and #3, the model of Cantilever #4 has a single beam to reinforce projecting platforms. This beam was fitted in a longitudinal trench that runs beneath seated platforms. By watching at the front view, the widest part of the beam is at the centre of its length. This extra width was kept for a cross halving joint. (See fig. 11)

The single butterfly joint that appears in the model of Cantilever Bench #2 was replaced by two small butterfly keys. These were inlaid across the glued line between two separate boards. This change can be seen from the top elevation of Cantilever Bench #3 and #4's models. (See fig. 11)

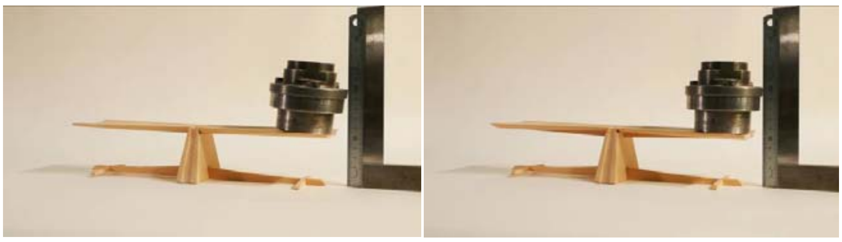


Fig. 12: From left to right; the stable test of Cantilever Bench #3 and #4's scaled models (Kongsuwan 2009)

I tested the stability of Cantilever Bench #3 and #4's scaled models by weighting a piece of metal (1.2 kilograms) at one end of cantilevering wing. The result of the test revealed that the structure of the cruciform foot base could not resist an overloaded pressure. This can be seen from the high flex of the longitudinal foot base.

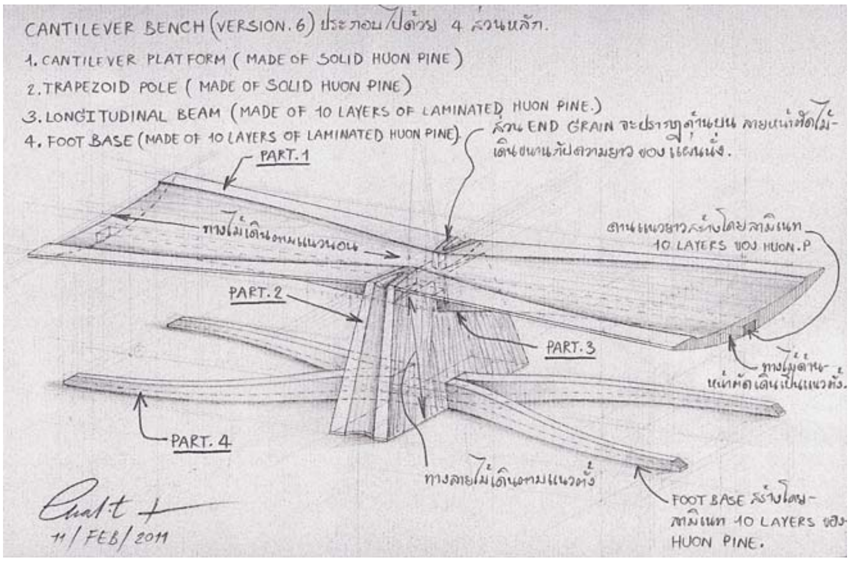
Sourcing material (part 2)

After I tested two new scaled models, my research consultant recommended I visit the southern part of Tasmania to see Huon pine slabs that were logged thirty years ago before a dam was constructed in north-west Tasmania. Because they had desiccated naturally for more than three decades, these slabs are ready to be used.

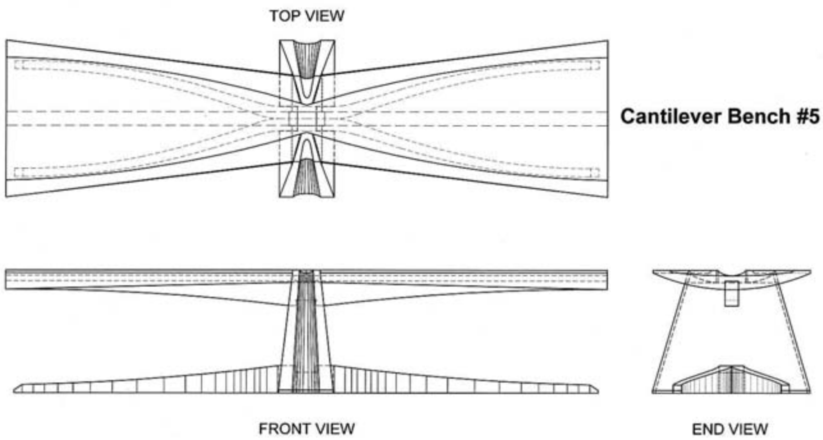
Fig. 13: Huon pine slabs had been air-dried under shade for more than three decades in Huon valley. (Kongsuwan 2009)

Fortunately, the width and thickness of these slabs coincided with the dimensions of my design. As a result, there was no need to employ butterfly keys for joining two separate boards of wood.

Then, I adapted the design of Cantilever Bench #4, excluding the two butterfly joints. The cruciform foot base was replaced by the X-shaped structure. This change aimed to resemble the butterfly-shaped contour of a cantilever platform and to resolve the problem of instability. This adaptation later became the design of Cantilever Bench #5.



Drawing 5 shows the hand drawing of Cantilever Bench #5 (Kongsuwan 2011)



Mechanical drawing 4: The three elevations of Cantilever Bench #5 (Kongsuwan 2011)

Computer modelling

With the instability of the cruciform foot base, I proceeded to experiment with the new structure of Cantilever Bench #5 using computer modelling. The objective of this experiment was to let the Solid Works' software calculate the maximum load of both the overhanging platforms and the X-shaped foot base. Due to the irregular density of natural timber, the software did not allow me to test the strength of Cantilever Bench #5's construction. Consequently, I had to make a full-scale mock-up.

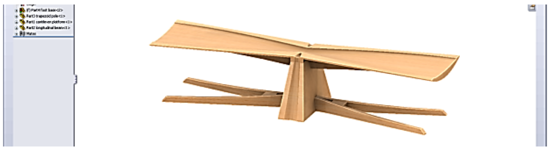


Fig. 14: Cantilever Bench #5 was rendered by Solid Works' software. (Visalvate 2011)

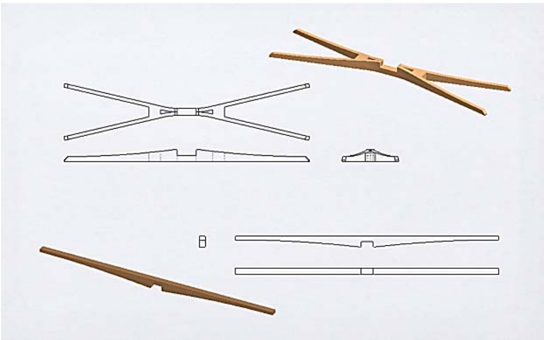


Fig. 15: From top to bottom; The X-shaped foot base and the longitudinal beam of Cantilever Bench #5, rendered by Solid Works' software (Visalvate 2011)

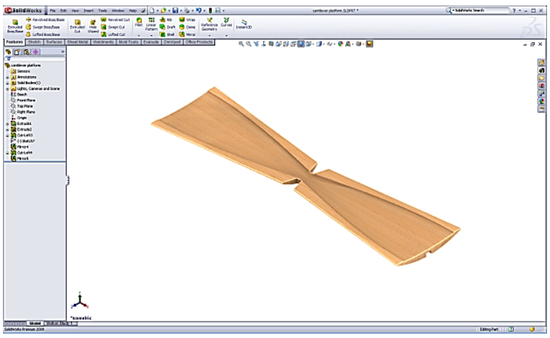


Fig. 16: The butterfly-shaped platform of Cantilever Bench #5, rendered by Solid Works' software (Visalvate 2011)

Fig. 17: The trapezoidal column of Cantilever Bench #5, rendered by Solid Works' software (Visalvate 2011)

Full-scale prototypes

I experimented with three versions of Cantilever Benches on an actual scale. These included Cantilever Bench #5, #6 and #7. Cantilever Bench #5 and #6 share the same structural component. However, the sides of the projecting wings differed in texture: as the Cantilever Bench #6 had a fluted texture. Unlike version #5 and #6, Cantilever Bench #7 differed by its ventilative seating platform and the contour of the foot base.

Fig. 18: The processes of making the full-scale prototype of the Cantilever Benches #5 and #6 (Kongsuwan 2011)

Cantilever Benches #5 (non-fluting pattern) **& #6** (fluting pattern)

The full-scale prototype of the Cantilever Benches #5 and #6 consisted of four main components. These were:

- A butterfly-shaped platform (made of low density fibreboard ‘LDF’);
- A trapezoidal column (made of low density fibreboard ‘LDF’);
- A longitudinal beam (made of medium density fibreboard ‘MDF’); and
- An X-shaped foot base (made of medium density fibreboard ‘MDF’)

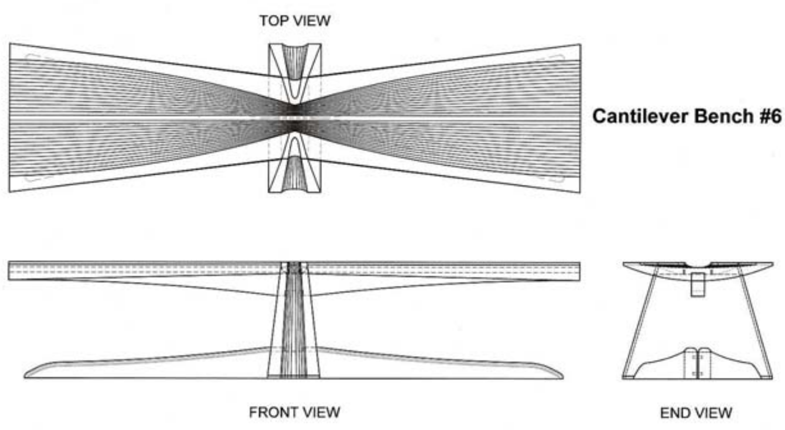
All components (except an X-shaped foot base) were mainly cut and shaped by computer numerical control (CNC). An X-shaped base was made up of two identical parts. Each part was built by laminated MDF. Both were glued and bent in accordance with a specific curve of a mould. Notably, I found that the thickness of the laminated components was uncontrollable. Consequently, the X-shaped foot base should be made first. After getting an actual thickness of laminated parts, the dimension of the trenches and notches of trapezoidal column can then be specified. This order is important to achieve neatness of the joint between the foot base and the column.

The aesthetic revision of Cantilever Benches #5 & #6

Fig. 19: The various perspective views of Cantilever Benches #5 & #6’s prototype, made of solid LDF and laminated MDF (Kongsuwan 2011)

A butterfly-shaped platform: The fluted texture was made by the round tip of a router bit. In comparison with a non-fluted texture, a fluted texture is more seductive to look and touch. While fluting texture casted light and shadow, it suggested the sense of volume. I observed that most people were immediately drawn to take tactile pleasure. In addition, the convex profile underneath the seating platform led people's eyes to explore the honesty of a post-and-beam construction. Furthermore, although the repetition of curved lines (made by multiple paths of a router bit) outnumbers a rectilinear outline of a butterfly-shaped platform, this curvilinear pattern is encompassed by edgy trapezoid.

Looking from the end view, the wide end of the butterfly-shaped platform appears in the foreground and the narrow end recedes into the distance. This perspective illusion makes the actual length of the projecting wing appear longer. I also noticed that the repetition of curvilinear patterns causes a visual decrease in width as well as giving an effect of an increase in the length of the seating platform. Because of its ability to generate tactile stimulus, volumetric quality and an illusory effect, a fluted texture will be used in final fabrication. (See fig. 19)



Mechanical drawing 5: The three elevations of the Cantilever Bench #6 with fluting pattern (Kongsuwan 2011)

A trapezoidal column: Although the concave surfaces that appear from the decapitated top and the two narrow facets of the truncated pyramid were criticised by my research consultant as an unnecessary addition, I insisted on keeping these scoops in order to reduce the large plane of trapezoidal facets. Moreover, these hollowing scoops can be married with the concave surface of the seating platform.

An X-shaped foot base: Although there was an obvious harmony between the curved contour of foot base and the curvilinear pattern of the seating platform, this visual harmony can only be observed from the end view. By walking around object, I found that there was a conflict between the rectilinear outline of the seating platform and the curvature of the laminated foot base. This incongruence stimulated me to make a rectilinear version of the foot base.

The structural test of Cantilever Benches #5 and #6

In order to test the strength of the cantilever structure, I made a specific gauge to indicate the flex of the seating platform and the foot base. Letting one man (weighing 120 kilograms) sit on one end of cantilever platform, it could be seen that the level of the other end stayed above a neutral line by about 20 centimetres. This flexibility was mainly caused by the foot base's inadequate thickness. As a result, the new version of the foot base must be two times thicker. Inevitably, a thicker foot base will lead to a more bulky structure. In order to make a thicker foot base appear slender, its edge profile would need to be rounded.

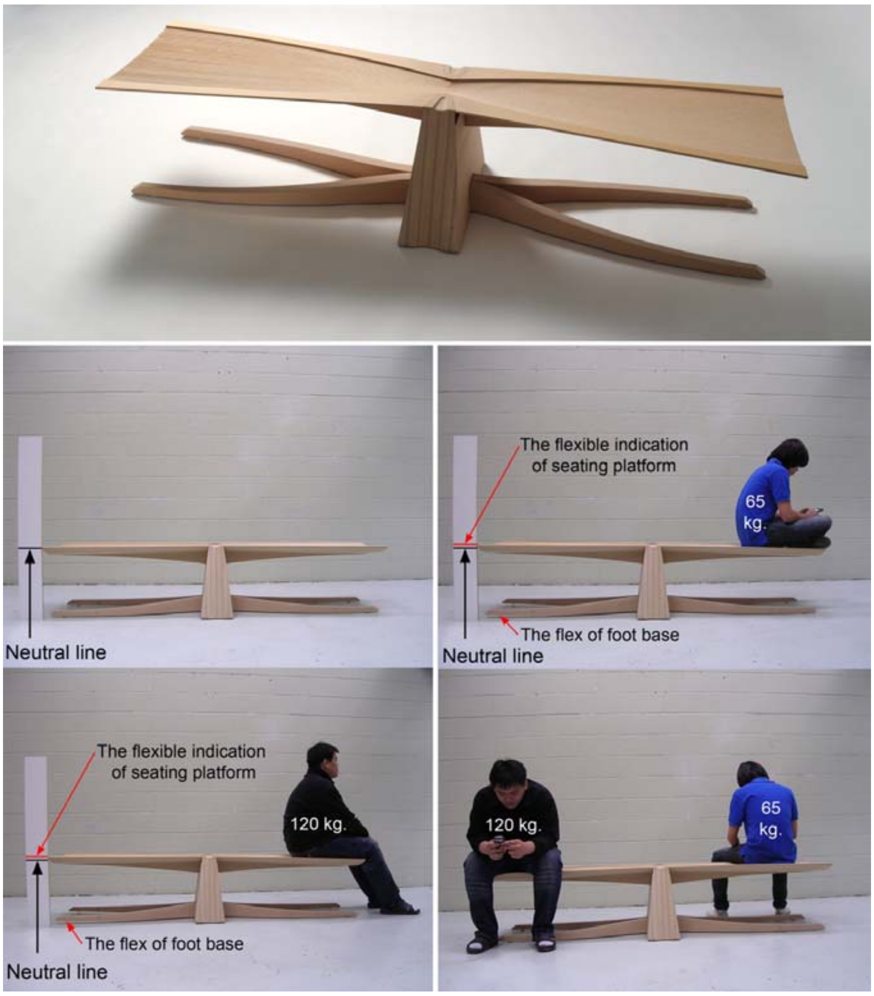
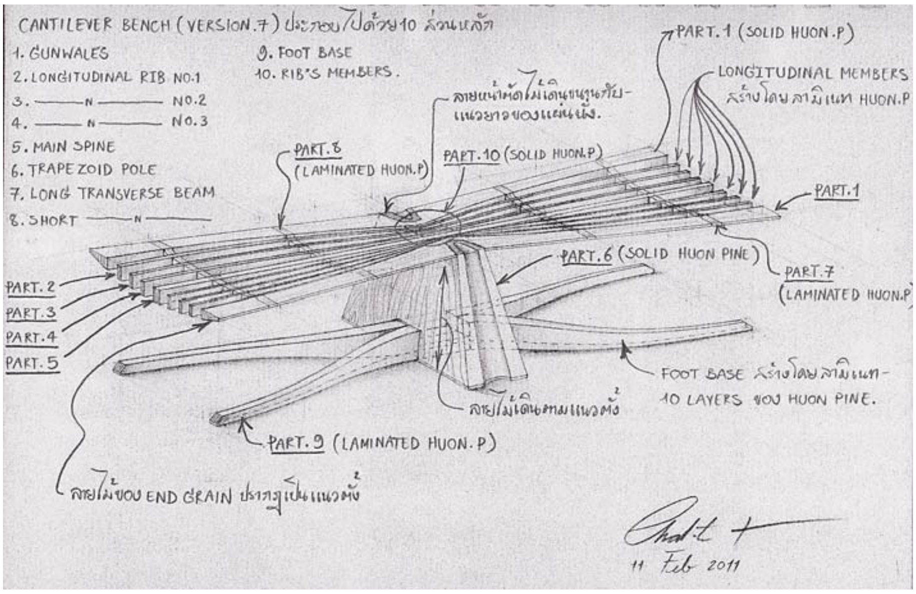


Fig. 20: The structural test of Cantilever Benches #5 and #6 (Kongsuwan 2011) and (Whyte 2012)

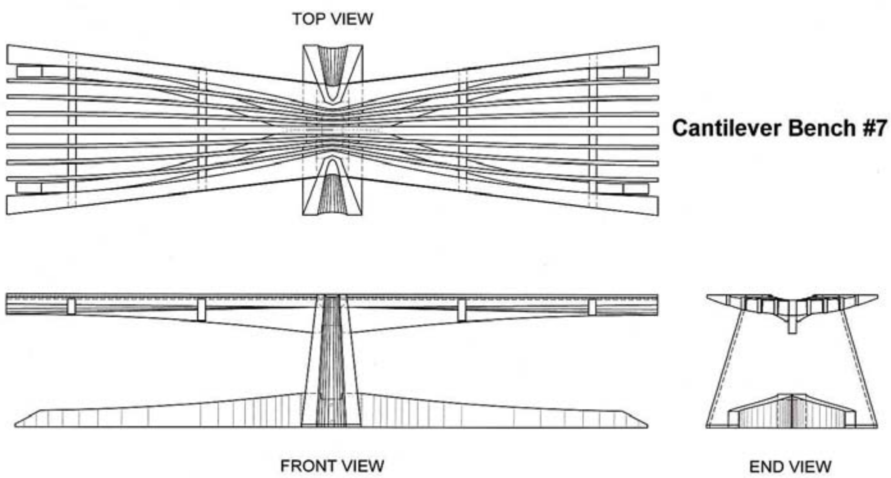
Cantilever Bench #7

Because of the solidity of the seating platform, I was keen to reduce the apparent weight of the object. Both visual and physical heaviness stimulated me to look into the construction of wooden boats. I sought ways of incorporating their light structure and bending technique in the design of Cantilever Bench #7.

As a result of its marine influences, the description of Cantilever Bench #7 will use some of the technical language used in boat-building. The construction of Cantilever Bench #7 differed from Cantilever Bench #5 and #6 in two main ways; the ventilative structure of cantilever platform and the rectilinear contour of X-shaped foot base.



Drawing 6 shows the hand drawing of Cantilever Bench #7(Kongsuwan 2011)



Mechanical drawing 6: The three elevations of Cantilever Bench #7 (Kongsuwan 2011)

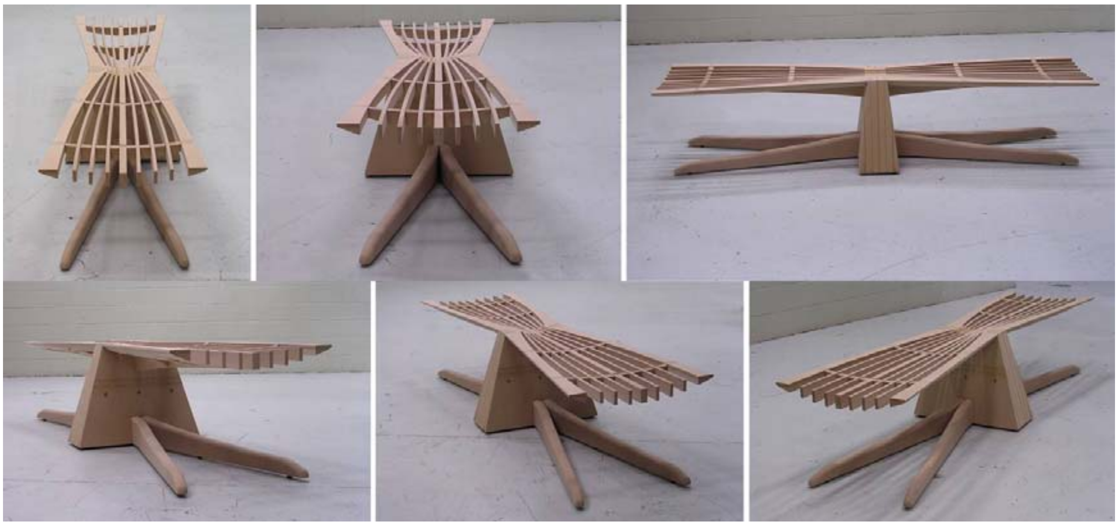


Fig. 21: The various perspective views of Cantilever Bench #7's prototype, made of solid LDF and laminated MDF (Kongsuwan 2011)

Ventilative structure

The solidity of the seating platform of Cantilever Benches #5 and #6 was broken by the use of the curvilinear skeleton. The ventilative structure of Cantilever Bench #7 consisted of a pair of identical gunwales, three pairs of identical keels on and a single main spine. These curvilinear members were supported transversely by two pairs of identical ribs. In order for all curved members and transverse ribs to be fitted together in place, they were relatively trenched for cross halving joints. In order to reinforce the structure of cantilever platform throughout its length and width, I designed both the major spine and four transverse ribs with extra thickness. The fork-like platform was fixed in the trench of a solid trapezoidal column.

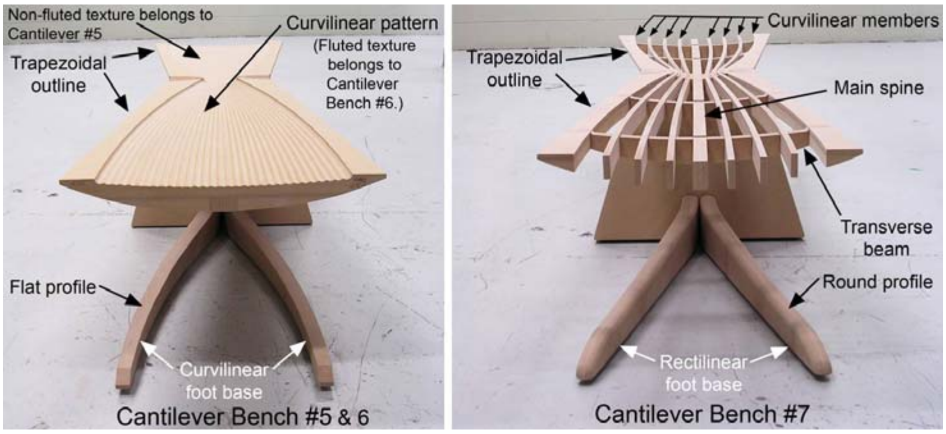


Fig. 22: The comparison between Cantilever Bench #5, #6 and #7 shows two distinctions: the difference between a curvilinear pattern and curved members and the difference between a curvilinear and rectilinear foot base. (Kongsuwan 2011)

New foot base

Although the foot base of Cantilever Bench #7 remains indebted to the X-shaped layout of Cantilever Bench #5 and #6, its curvilinear outline was replaced by a rectilinear contour. This was done to create a visual harmony between an X-shaped foot base, a butterfly-shaped platform and a trapezoidal column. However, this change did not achieve harmony because the outline of the trapezoidal platform was subjugated by a set of curvilinear members.

The perspective view of Cantilever Benches #5, #6 and #7 reveals the interaction between a butterfly-shaped platform, a trapezoidal column and an X-shaped foot base. Although the curved contour of the foot base of Cantilever Benches #5 and #6 echoes the curvilinear elements of fluted texture, it does not correspond with the edgy contour of the seating platform and central column. In contrast, the rectilinear contour of the foot base of Cantilever Bench #7 harmoniously echoes the straight edges of a trapezoidal platform and column. However, this linear interplay does not work with the curvilinear members of the seating platform.

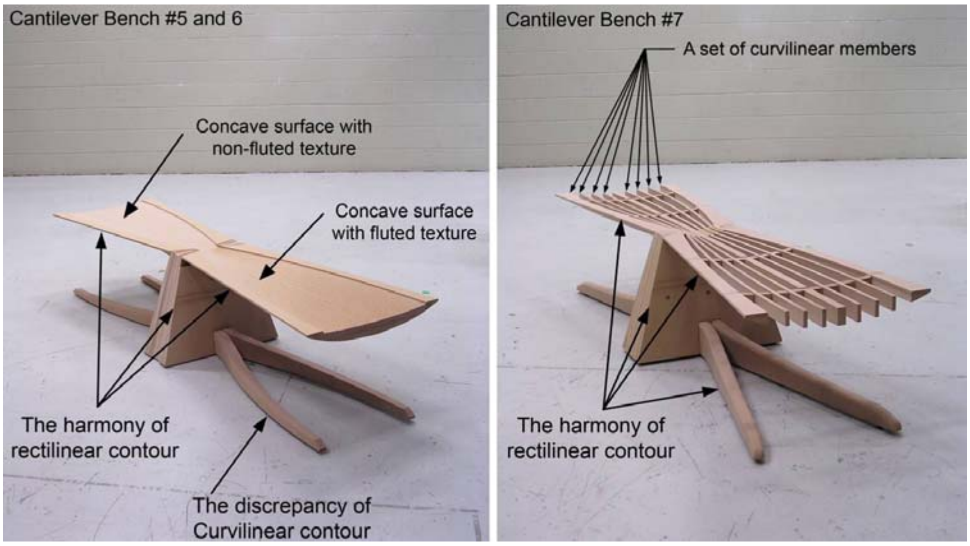


Fig. 23: From left to right; the perspective view of Cantilever Bench #5 & #6 show the disharmony between rectilinear and curvilinear contours whereas Cantilever Bench #7 illustrates the rectilinear harmony between trapezoidal platform, column and foot base. (Kongsuwan 2011)

In order to find harmony between overhanging and earthbound elements, I had to match the curvilinear foot base of Cantilever Bench #5 & #6 with the curved members of Cantilever Bench #7, while the rectilinear foot base of Cantilever Bench #7 was matched with the solid trapezoidal platform of Cantilever Bench #5 and #6.

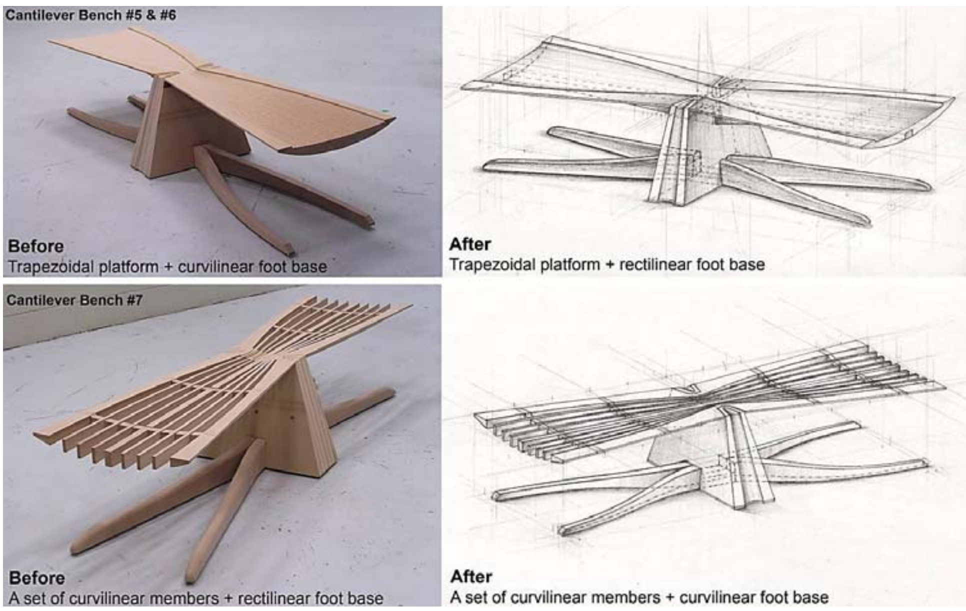


Fig. 24: From left to right; the revision of the foot base of Cantilever Benches #5, #6 and #7 (Kongsuwan 2011)

Looking at the front elevation of Cantilever Bench #7, it can be noted that a single main spine appears widest at its mid length, becoming narrower toward the left and the right ends. Similarly, an X-shaped foot base looks widest at its centre and gradually gets narrower toward both ends. This mimicry aimed to suggest a mirror image between the upper the lower components. Moreover, these extra widths were provided for joined purposes.

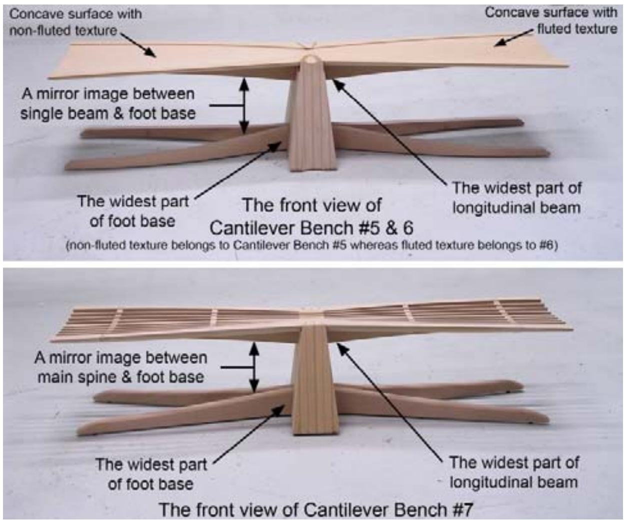


Fig. 25: The front elevation of Cantilever Benches #5, #6 and #7 (Kongsuwan 2011)

The structural test of Cantilever Bench #7

A structural test using the gauge indicated that the flexibility of the ventilative structure of Cantilever Bench #7's platforms was greater than the solid structure of Cantilever Bench #5 and #6's platforms. However, this was successfully amended through an increase in the dimension (both thickness and width) of foot base. Although the physical and visual weight of Cantilever Bench #7 is much lighter, the number of composite parts is two times greater than the former version. A greater number of components resulted in complexity of joints and assembly would become a time-consuming process. Subsequently, I chose to make Cantilever Bench #6 for the final fabrication.

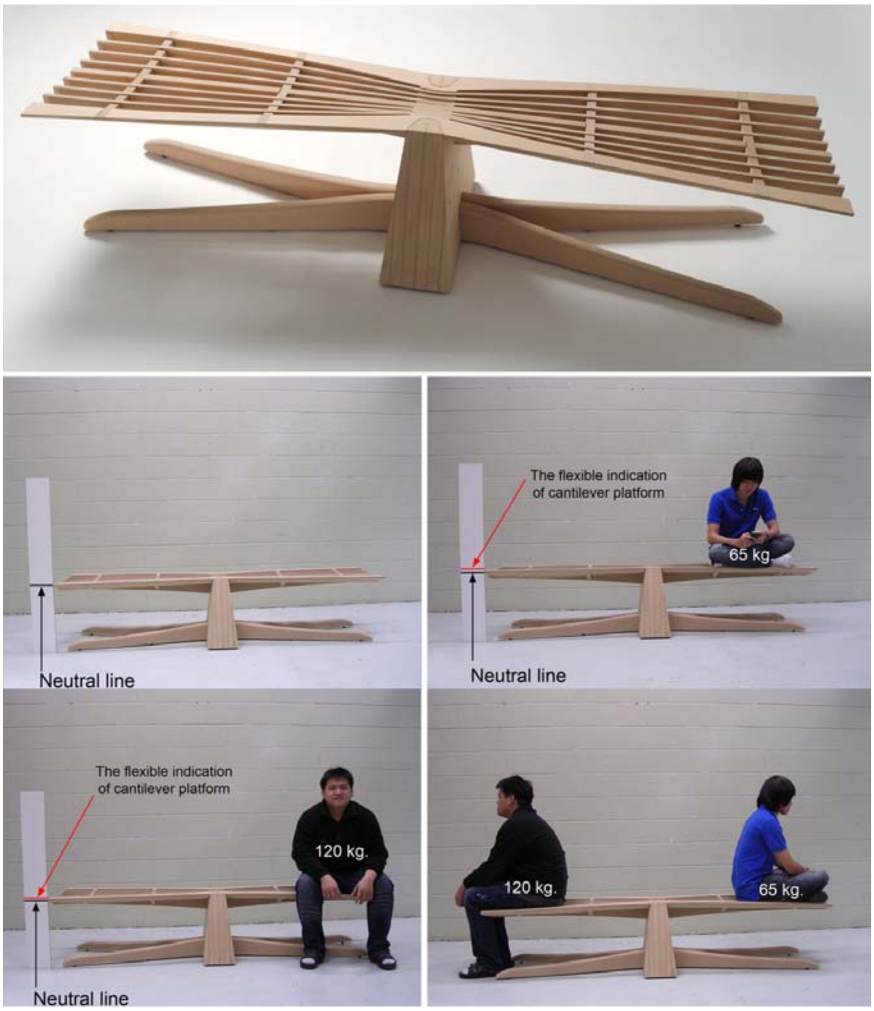


Fig. 26: The structural test of Cantilever Bench #7 (Kongsuwan 2011) and (Whyte 2012)

The final fabrication of a pair of Cantilever Benches (version #6M & #6F)

The detail of making a pair of Cantilever Benches can be seen in Appendix 1.

Fig. 27: From left to right; Cantilever Benches #6M & #6F (Whyte 2012)

In final fabrication, I decided to make two objects to infuse the complementary opposites between male and female. This dual aspect was represented through the different profile of trapezoidal columns. I used convexity and concavity metaphorically to imply the genital shape of men and women respectively. The dualistic metaphor also made reference to seedling regeneration of Huon pine, which occurs when male and female cones mix after falling from separate trees.

Fig. 28: From left to right; the convex and concave profile of Cantilever Benches #6M and #6F (Whyte 2012)

Although nearly all edgy elements were rounded for safety and due to aesthetic consideration, the profile of the underneath beam remains square. This is to let the two ends of the beam seamlessly converge the convex profile underneath seating platform, illustrating the unity of two separate components.

Fig. 29: The harmonious ensemble between the convex profile of the underneath of the seating platform and the curvilinear ends of the beam (Kongsuwan 2012)

Lining up a pair of benches nostalgically echoes the floating volume of a Thai boat train along a limpid canal. This dualistic installation lengthens the functional surface, allowing for hybrid functions. The continuity of the fluting pattern resembles the ripple marks left by the gentle flow of a wooden ship. Both floating and fluid qualities evoke a sense of nostalgia for the riparian traditions of Bangkok and Hobart.

Fig. 30: From left to right; a Thai boat train along a canal (Van Beek 2004, p.9); and the continuity of the fluting pattern can be seen from the top of Cantilever Benches #6M & #6F's seating platform. (Whyte 2012)

Although the fluting pattern was precisely cut by machine, the visual outcome did not lose the vitality of handwork. This paradigm clearly illustrated how digital technology and handmade spirit were coexisted. It is noticeable that the fluting pattern appears bold at projecting ends and gradually fades out to the centre. This fluid quality was achieved by sloping the flat surface of seating platform slightly. Initially, this slight slope was made by machine and then smoothened by the use of hand-plane.

Fig. 31: From top to bottom row; the combination of digital technology and hands-on execution
The first row; from left to right shows the processes of fluting and sloping the top surface of the seating platform. **The second row;** from left to right shows the sequence of stages in routing the bottom surface of the seating platform. **The third row**; from left to right depicts the processes of using hand-tools to enhance the sense of fluidity and the quality of the wooden surface. (Kongsuwan 2011)

The Design Outcomes of a pair of Cantilever Benches (#6M & #6F)

The outcomes of this volumetric experiment demonstrated a basic way to turn the planar representation of utilitarian and decorative inlay into the sculptural form of functional furniture. The shift of the butterfly key inlay was combined with the play of opposites within scale and colour; it encouraged viewers to engage in a small familiar motif within an unusual massive form. Manipulating the visual impact by using the opposite scale and colour of butterfly key motifs pushed the conventional boundaries of the use of revealed joinery.

I thought that, a pair of Cantilever Benches (#6M & #6F) successfully assimilated the traditional and religious aspects of Thai design with the modern influence of cantilever structure. This assimilation was expressed through visual balance, a floating quality as well as a sense of duality. The symmetrical quality is apparent in the cruciform layout of object, creating a unity that represents the centre of universe in Buddhist cosmology. The sense of lightness, space and dualism are apparent in the concave and convex elements of the overhanging platform.

The objects also illustrated a simple way to combine the gentle curve of a vernacular Thai boat with the edgy character of trapezoidal contour. This juxtaposition created a synergy between rectilinear and curvilinear elements.

A changing visual effect in line which is conspicuous in the fluid quality of fluting pattern clearly demonstrated how the rigidity of mechanical execution and the spirit of handcraftsmanship are integrated.

The apparent size of a large scaled trapezoid was changed through an optical illusion that came from the repetitive curves of fluting pattern. Various conditions of light and shadow upon the fluted pattern enhanced a sense of volume and encourage tactile stimulus. The simultaneous illusory effect, volumetric quality and tactility were shown to be a practical method for manipulating the apparent weight of a three-dimensional object.

The Second Section of Chapter Three: planar experiment

Design aim

The main objectives of planar experiments were:

- To find ways of reintroducing the trapezoidal geometry of traditional Thai walls in the contemporary design of multi-functional and demountable furniture;
- To utilise the overlap of trapezoidal identical planes to represent the venerated motifs of dovetail pins and butterfly keys in the contour of furniture;
- To apply traditional techniques used to break the volume of the Thai roof form to furniture components; and
- To reflect the flexible nature of Thai houses through a modular system of furniture.

This section describes two separate experiments. The final output of these two planar experiments is a collection of ten pieces of shelving units and benches.

The final pieces of the first planar experiment are a pair of Diagonal Benches (Diagonal Bench 1 and 2) made of solid Myrtle and Celery top pine.

Fig. 32: From left to right; Diagonal Bench 2 (Dimension: Width 526 x Length 1950 x Height 450 mm.); and Diagonal Bench 1 (Dimension: W 630 x L 1950 x H 450 mm.) (Whyte 2012)

The final pieces of the second planar experiment consist of four pairs of shelving units, comprised of:

- Trapezoidal Shelves 1 & 1B (made of 18 mm plywood, covered by veneered Huon pine and Myrtle);
- Curvilinear Shelves 2 & 2B (made of 18 mm plywood, covered by veneered Huon pine and Myrtle);
- Diagonal Shelves 1 & 1B (made of 18 mm plywood, covered by veneered Leatherwood and Celery top pine); and
- Diagonal Shelves 2 & 2B (made of 18 mm plywood, covered by veneered Leatherwood and Celery top pine).

Fig. 33: From left to right; Curvilinear Shelves 2 & 2B (Dim: W 315 x L 1192 x H 2092 mm.); Trapezoidal Shelves 1 & 1B (Dim: W 420 x L 1192 x H 2092 mm.); Diagonal Shelves 2 & 2B (Dim: W 542 x L 1192 x H 2092 mm.); and Diagonal Shelves 1 & 1B (Dim: W 480 x L 1192 x H 2092 mm.) (Whyte 2012)

Diagonal Benches

Similar to the volumetric experiments, the design of the first planar experiment also combined themes of geometric abstraction, re-composition and the play of opposites. These design elements led me to find new ways of arranging trapezoidal geometries in planar modes.

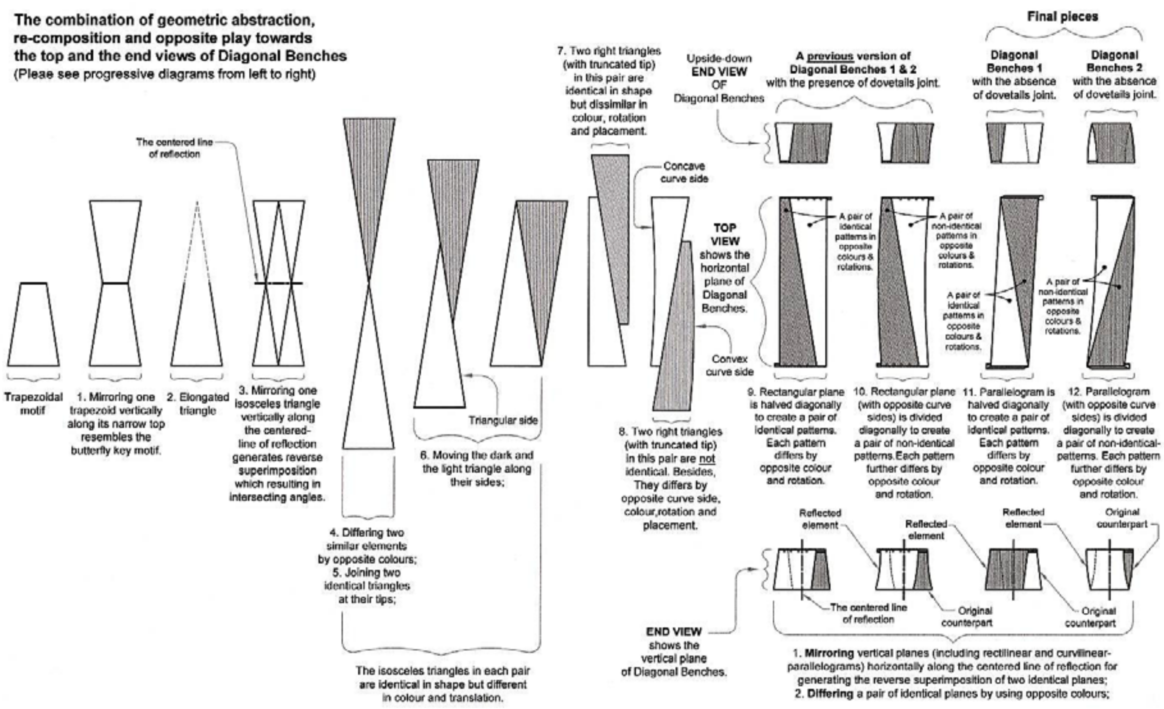


Diagram 3: From left to right; the sequence of stages in abstracting and re-composing the horizontal and vertical elements of Diagonal Benches (Kongsuwan 2011)

The geometric elements in the design of the Diagonal Benches consisted of:

- Solid trapezoidal plane;
- Solid double trapezoidal (one mirrors the other at its truncated top);
- Solid isosceles triangular plane;
- Solid right triangular plane with truncated tip;
- Solid right triangular plane with truncated tip and opposite curved sides;
- Solid rectangular plane;
- Solid parallelograms plane;
- Solid parallelograms plane with opposite curve sides;
- Reverse identical triangular patterns;
- Reverse identical triangular patterns with truncated tip;
- Reverse non-identical triangular patterns with truncated tips and curved sides;
- Reverse non-identical triangular patterns with curved sides;
- Diagonal lines; and
- Curve lines (concave and convex). (See diagram 3)

These geometric elements were sequentially abstracted and re-composed to create the horizontal and vertical elements of the Diagonal Benches. Abstracting and re-composing the <u>horizontal elements</u> was done in twelve major steps:

- **Mirroring** the trapezoidal motif vertically along its narrow top;
- **Elongating** the truncated top of trapezoid to form an isosceles triangle;
- **Mirroring** the isosceles triangle vertically along the centre line of reflection to generate reverse superimposition;
- **Differentiating** two similar elements with the use of opposite colours;
- **Joining** two identical triangles at their tips;
- **Moving** the dark and the light triangle along their sides;
- **Moving** two identical right triangles (with truncated tip) along their hypotenuses and **differentiating** them through the use of opposite colours;
- **Moving** two non-identical right triangles (with truncated tip and opposite curved sides) along their hypotenuses and **differentiating** them through the use of opposite colours;
- **Halving** a rectangular plane diagonally to create a pair of identical patterns in opposing colours;
- **Dividing** a rectangular plane (with opposite curved sides) diagonally to create a pair of non-identical patterns in opposing colours;
- **Halving** a parallelogram diagonally to create a pair of identical patterns in opposing colours; and
- **Dividing** a parallelogram (with opposite curved sides) diagonally to create a pair of non-identical patterns in opposing colours. (See diagram 3)

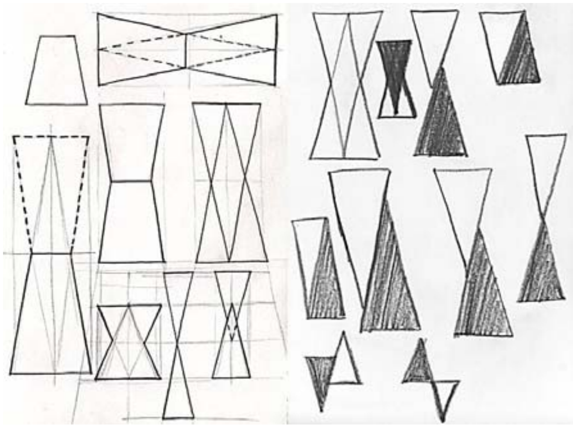
Abstracting and re-composing the <u>vertical elements</u> was done in two major steps:

- **Mirroring** vertical planes (including rectilinear and curvilinear parallelograms) horizontally along the centre line of reflection to generate the reverse-superimposition of two identical planes; and
- **Differentiating** a pair of identical elements by using opposing colours. (See diagram 3)

The play of opposites in the design process of the Diagonal Benches consisted of:

- Vertical versus horizontal reflection;
- Dark versus light colours;
- Symmetrical versus asymmetrical compositions;
- Identical versus non-identical patterns;
- Rectilinear versus curvilinear contours;
- Concave versus convex contours;
- Parallel versus diagonal line; and
- Upward versus downward translations such as: rotation and placement. (See diagram 3)

The design process for the Diagonal Benches



Drawing 7: The first step of rearranging the binary motifs of trapezoid and triangle (Kongsuwan 2008)

Firstly, I set the ball rolling by rearranging the binary motifs of trapezoid and triangle in various ways, experimenting with reflection, elongation, translation and breaking. Initially, I designed motifs in pairs that were identical in shape but different in colour and rotation. I aimed to use a combination of symmetrical forms, contrasting colours and reverse directions to balance the play of opposites within these symmetrical compositions. Then, I designed pairs of non-identical patterns with opposite colours and rotations in order to achieve simple aesthetics within non-symmetrical compositions.

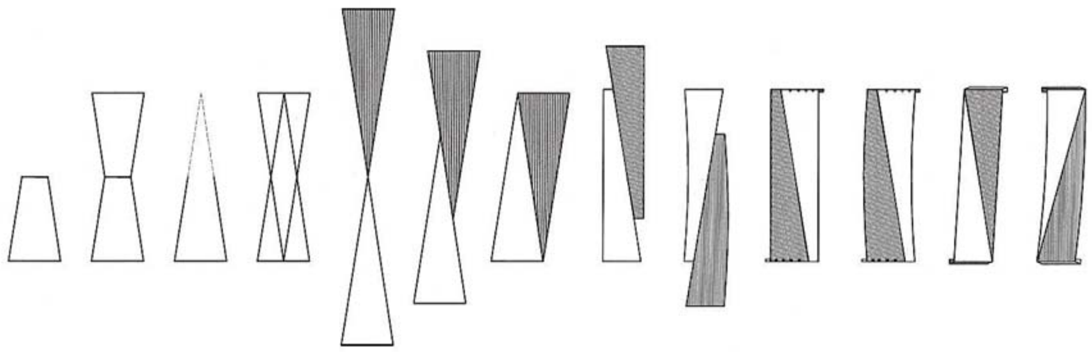
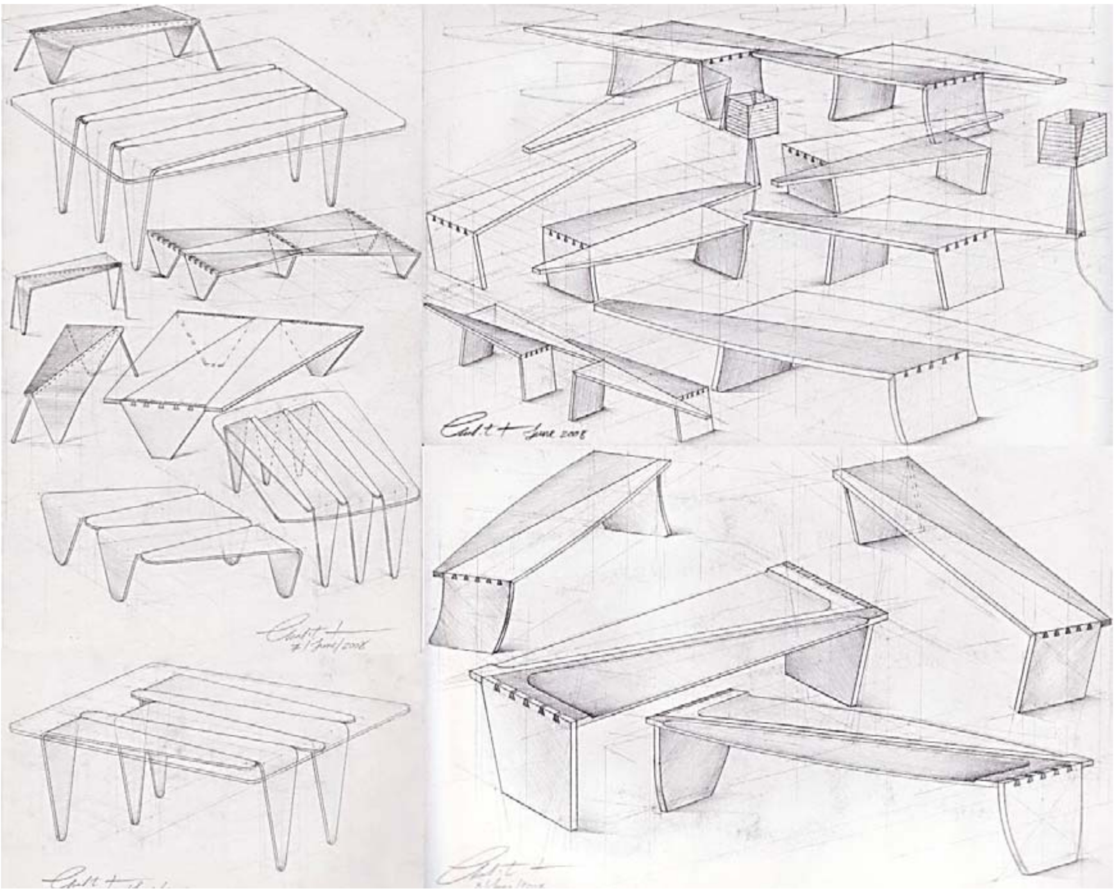
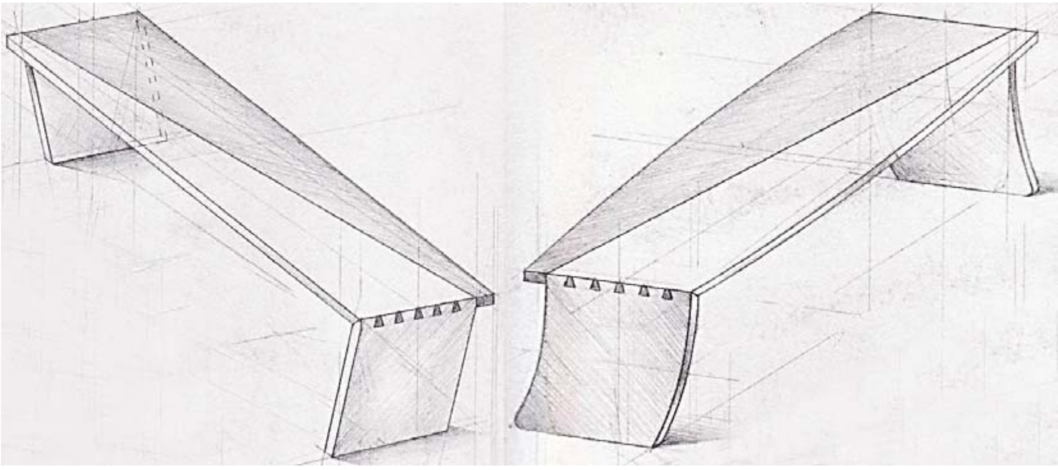


Diagram 4: The sequence of stages in clarifying the proportion of the binary motifs of trapezoid and triangle (Kongsuwan 2011)

I then used CAD to calculate a size for each pair to suit both aesthetic and utilitarian purpose. Later, these planar rearrangements became a dominant design key within a series of high and low-raised furniture including tables and bench seats.



Drawing 8: Perspective drawings of new tables and benches (Kongsuwan 2008)

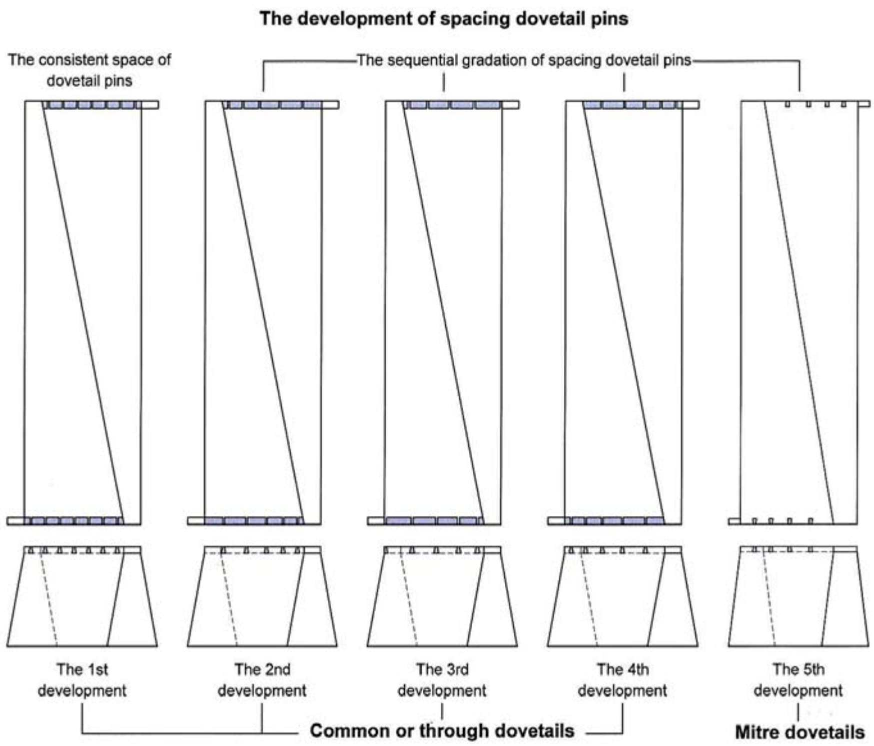


Drawing 9: From left to right; the perspective drawing of Diagonal Bench 1 shows its rectilinear contour whereas Diagonal Bench 2 has a curvilinear outline. (Kongsuwan 2008)

In Drawing 9 it can be seen that the seating platform and vertical panels form the two major parts in this design. Although two pairs of identical boards were used for the platform and vertical panel components, I arranged them in reverse direction to relieve the boredom of uniformity. In industrial furniture making, utilising the same components over and over again in different combination minimises production costs and maximises time efficiency.

With the aim of combining symmetrical components to design a dynamic composition, I made miniature models of a pair of diagonal benches. Although both designs used the same repeated components, they differed in colour and contour.

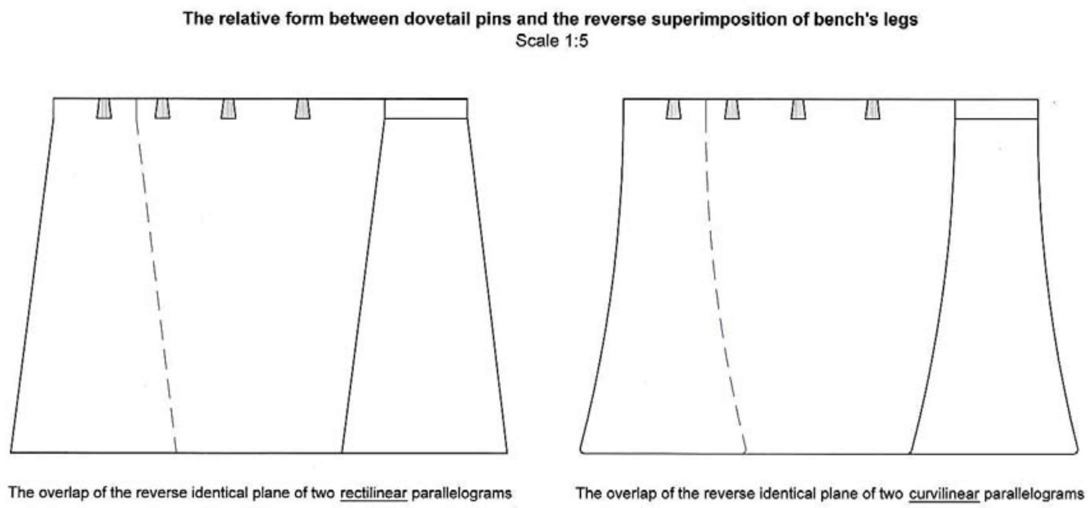
After selecting two designs, I used CAD software to specify their dimensions. I also concentrated on creating an interactive rhythm using progressive spacing of dovetail pins and the positive figure of the cantilever end. The result of varying gaps in progression aimed to produce a rhythmic effect that distinguishes the design from the orthodox aesthetics of a regular spacing.



Mechanical drawing 7: The development of spacing the pins of the common dovetails
The far left diagram shows that I began spacing each pin in a stark manner whereas the second and third diagrams show how the space between each pin becomes progressively narrower from left to right. Unlike the other diagrams, the sequential space of the dovetail pins in the fourth and the fifth diagrams becomes progressively wider in the same direction. (Kongsuwan 2008)

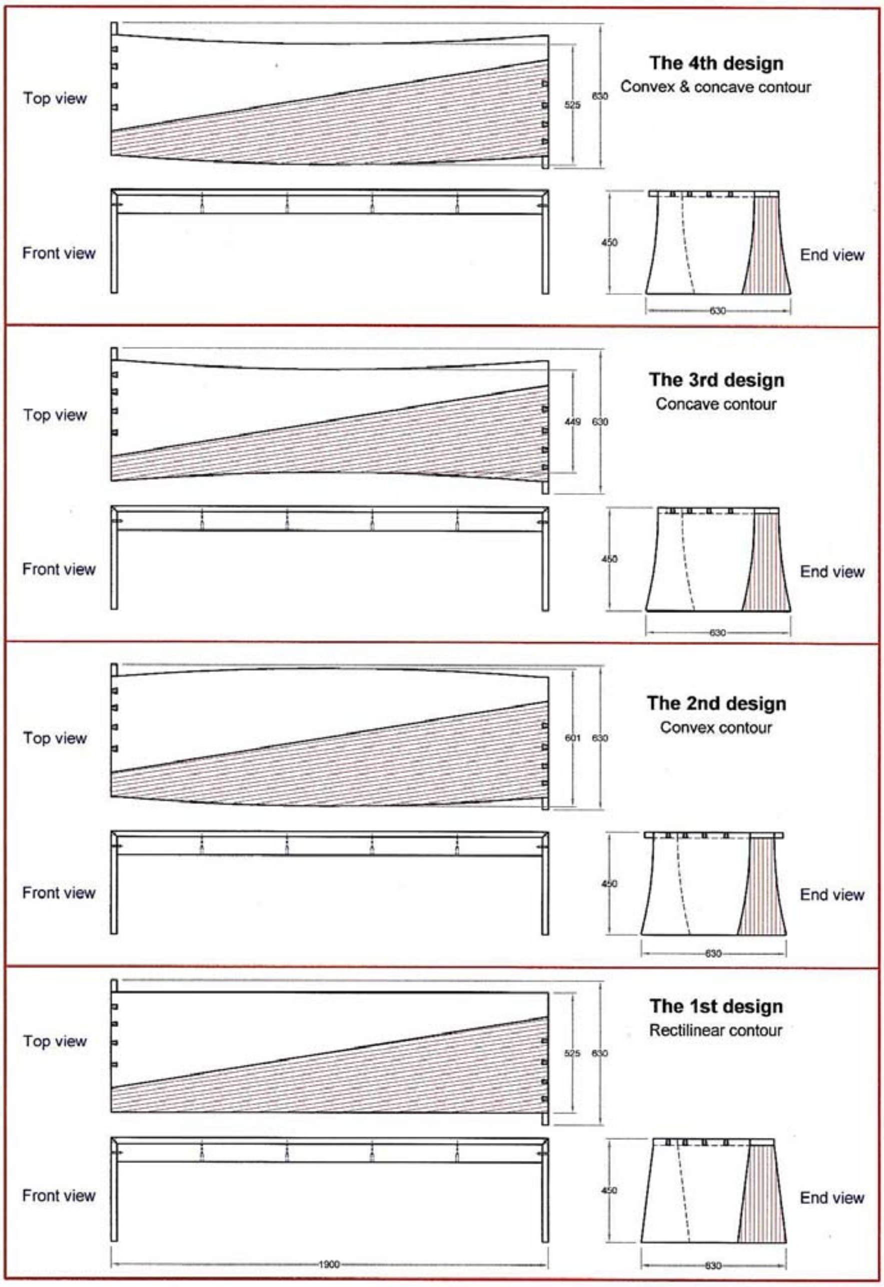
When observing each diagonal bench from the top elevation, it can be seen that the seating platform was designed with extra width. This offered extra space for those Asians who prefer sitting fold-legged on a Western standard height of bench seat.

The end elevation of the diagonal bench reveals the magnification of the dovetail pin motif through the reverse superimposition of the bench legs. Later, I softened the stark appearance of the rectilinear outline by incorporating curvilinear elements. I magnified and adapted the shape of the dovetail pin for the bench legs to incorporate another traditional motif of revealed joinery and echo the joinery motif within the vertical plane of the bench's leg.



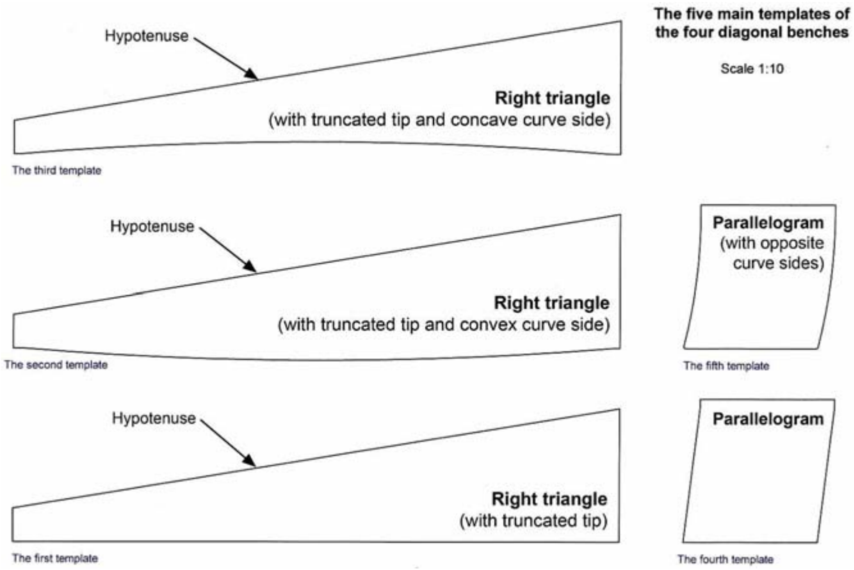
Mechanical drawing 8: The uniformity of the small motif of the dovetail pin and the dovetail-like shape of the larger bench legs, generated by the reverse superimposition of the bench legs (Kongsuwan 2008)

I then created two additional designs for the curvilinear version to decrease the large plane of the convex contour of the seating platform.



Mechanical drawing 9: From bottom to top; the configurative developments of four diagonal benches; the top view of the 3rd design illustrates a pair of reverse identical motifs with concave outline. The 4th design depicts a pair of reverse non-identical motifs. Each motif was differentiated by opposite colours and contours. (Kongsuwan 2008)

Each bench was constructed from two pairs of identical boards. The long pair was joined together along their hypotenuse to generate the seating platform. The short pair worked as legs.



Mechanical drawing 10: The five major templates used for the four different shapes of diagonal benches (Kongsuwan 2008)

Miniature models

To express the play of opposites, I matched the complementary colours of Blackwood and Celery top pine as these two species are native Tasmanian timbers with a similar percentage of contraction and expansion. I let the grain direction of the wood run against the diagonal glued line in order to create linear conflict.

Fig. 34: From left to right; the miniature models of Diagonal Benches 2 and 1 show the juxtaposition of Blackwood and Celery top pine. (Kongsuwan 2008)

Fig. 35: The lineate conflict between a longitudinal grain of wood and a diagonal glued line (Kongsuwan 2008)

Additional function

Initially, I slid two reversed identical boards along the diagonal lines to create the seating platform. But this resulted in an unstable structure. Later, the 'slide-able function' was replaced by clustering each single module together as a pair or group. The cluster of multiple modules echoed the expandable characteristic of traditional Thai houses and brought a larger surface of utilitarian platform, new geometric organisations and contrasting effects to the furniture.

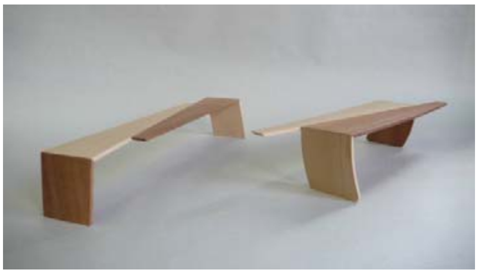


Fig. 36: Slide-able function (Kongsuwan 2008)

Fig. 37: The cluster of the multiple modules of bench seats (Kongsuwan 2008)

Optional joints

In sympathy with consumers who may have expectations of high quality but different budgets, I used two kinds of joints. The vertical and horizontal elements of miniature benches were joined by two methods: dovetails and mitre joints. Although the dovetail joint was more complicated and time-consuming than the mitre joint, this traditional joint can now be made by machine. Both joints prevent breakage at the joint's intersection.

Fig. 38: From left to right; Diagonal Bench 2 was joined by common dovetails; and Diagonal Bench 1 was joined by a mitre joint. (Kongsuwan 2008)

Unstable problem

I tested the stability of Diagonal Benches' scaled models by placing a piece of metal (1.2 kilograms) on the overhanging parts. Although the structure of both models could resist an overloaded pressure, the oblique angles of Diagonal Bench 1's legs and the round corner of Diagonal Bench 2's legs needed to be reduced for better stability.

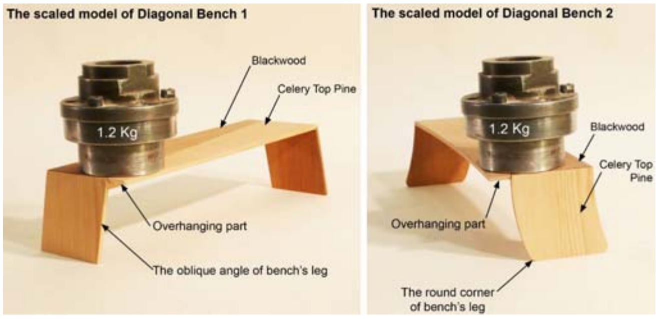
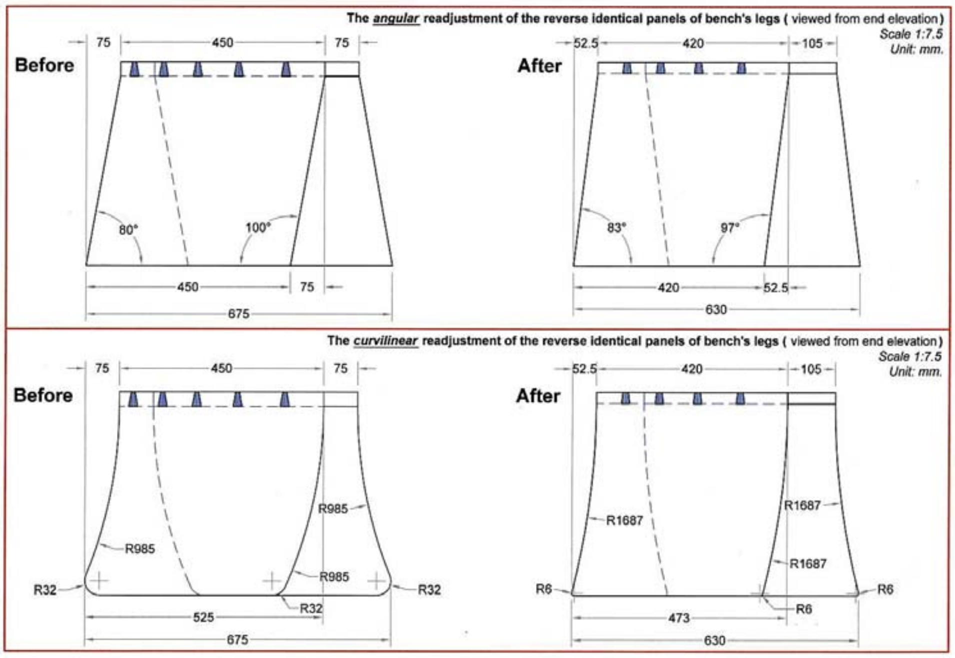


Fig. 39: From left to right; testing the stability of Diagonal Benches 1 and 2's scaled models (Kongsuwan 2008)



Mechanical drawing 11: The revision of the bench's legs (Kongsuwan 2009)

After this revision I had to readjust all mechanical drawings. Then, I transferred CAD files to computer numerical control (CNC) in order for the templates of both Diagonal Benches to be cut in actual size.

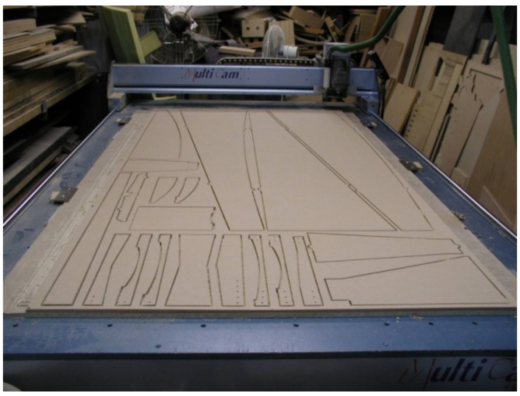


Fig. 40: The templates of Diagonal Benches while being cut by CNC router (Kongsuwan 2009)

Making actual pieces

The process of executing the Diagonal Benches was made up of thirteen major steps. These can be seen in Appendix 2.

Aesthetic revision

Although the colours of Blackwood and Celery top pine created a contrasting effect in the miniature models, I personally thought this combination was too strong and decided to match Celery top pine with Myrtle for a more subdued contrast. However, gluing and joining these two species may lead to structural problems because they have a different percentage of shrinkage and expansion. As a result of this risk, I had to test gluing and joining these two species in actual dimensions. (See table 1 & Appendix 2)

The shrinkage and expansion of Tasmanian timbers		
Type of timber	**Radial** shrinkage	**Tangential** shrinkage
Blackwood *(Acacia melanoxylon)*	1.5 %	4 %
Celery top pine *(Phyllocladus aspleniifolius)*	1.5 %	3.5 %
Horizontal *(Anodopetalum biglandulosum)*	3.5 %	8 %
Huon pine *(Lagarostrobos franklinii)*	2.5 %	3 %
King William Pine *(Athrotaxis selaginoides)*	1.5 %	4 %
Leatherwood *(Eucryphia lucida)*	5 %	9.5 %
Myrtle *(Nothofagus cunninghamii)*	3 %	6.5 %
Sassafras *(Atherosperma moschatum)*	2.5 %	6.5 %
Tasmanian Oak *(Eucalyptus regnans)*	6 %	12 %

Table 1: Timber shrinkage and expansion percentages (Excerpted from *Bootle Keith R., 1986*, ***Wood in Australia: Type, Properties and Uses***, *McGraw-Hill Book, NSW, Australia*)

After the assembly process I found that sitting on the overhanging parts of the horizontal platform caused instability and the knees of the user could be hurt by the sharp edge of the mitred end. Consequently, I had to change these projecting elements. The absence of cantilever components affected the progression of spacing the pin of the mitre dovetails. Finally, I also had to exclude dovetail joints in order to achieve the desired interplay between vertical and horizontal elements.

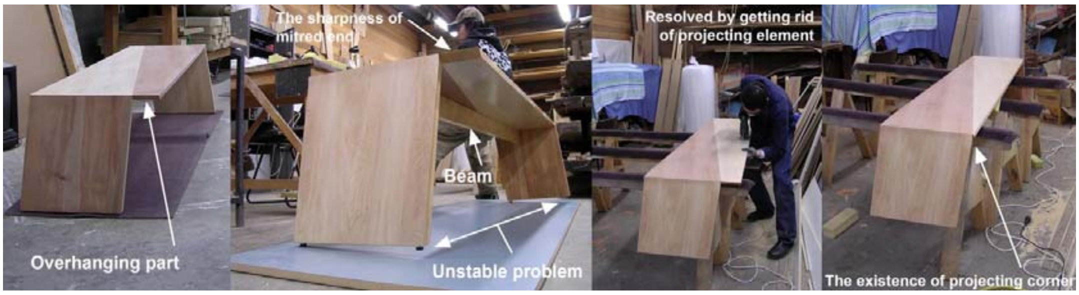


Fig. 41: The revision of Diagonal Bench 1 for greater stability (Kongsuwan 2010)

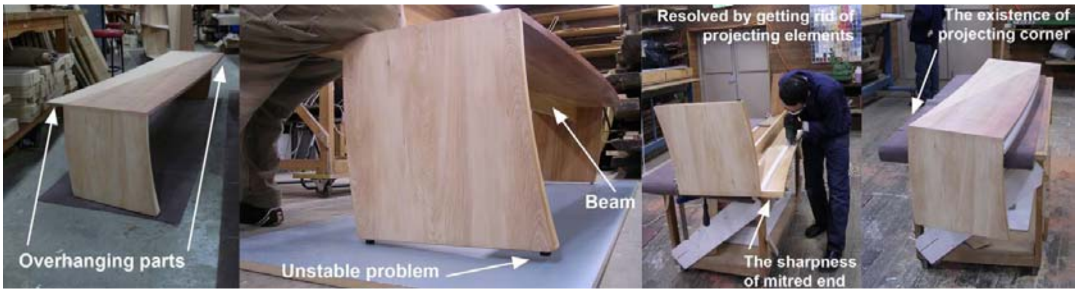


Fig. 42: The revision of Diagonal Bench 2 for greater stability (Kongsuwan 2010)

The Design Outcomes of Diagonal Benches 1 & 2

Fig. 43: From left to right; Diagonal Benches 2 & 1 (Whyte 2012)

The outcomes of the first planar experiment demonstrated a simple method of utilising the symmetrical shape of basic geometries for kinetic and synergetic expressions within bench seat. Both Diagonal Benches 1 and 2 successfully achieved balance within their asymmetrical composition.

The large horizontal planes of both Diagonal Benches were broken diagonally by juxtaposing complementary colours of wood in reverse identical and non-identical patterns. This reduced the visual mass of the seating platform. The play of opposites such as contrasting colours, reverse rotations and linear conflict enlivened the objects and manifested a sense of duality.

The objects successfully replicated the motif of the dovetail pin through the bench legs. By observing Diagonal Bench 1 & 2 from an end view, one can see that the overlaps of both rectilinear and curvilinear parallelograms aped the shape of the dovetail pin in larger scale.

Because of the object's instability, the module with sequential spacing of the dovetail pin and an overhanging end was not included in my final pieces. However, this exercise led me to explore ways of creating rhythmic effects to relieve the uniformity of geometric components. I lightened the visual weight of a large horizontal plane by overhanging two projecting corners from receding feet.

Diagonal Bench 2 represented ambiguous form through the oblique taper of vertical panels. Due to its curvilinear contour, the straight slope seemed concave when the piece was seen from specific viewpoints. The combination of curvilinear parallelogram and oblique taper provided an alternative method to hint at a concave surface without actually bending or scooping material.

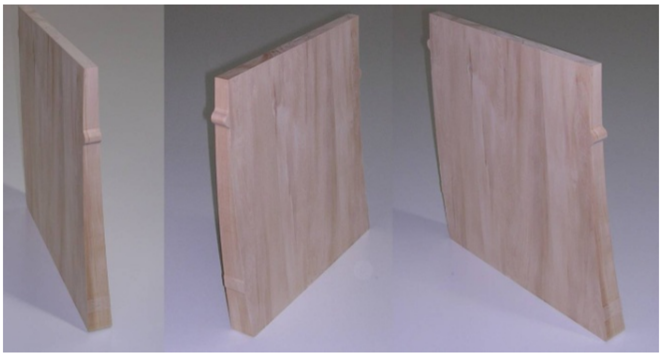


Fig. 44: An ambiguous form produced by the combination of oblique sloping panel and curved contour (Kongsuwan 2009)

The second planar experiment: a series of shelving units

The second planar experiment is explained in two parts. The first part will describe the processes and outcomes of Trapezoidal Shelves (1 & 1B) and Curvilinear Shelves (2 & 2B).

Fig. 45: From left to right; Curvilinear Shelves 2 & 2B (Dim: W 315 x L 1192 x H 2092 mm.); and Trapezoidal Shelves 1 & 1B (Dim: W 420 x L 1192 x H 2092 mm.) (Whyte 2012)

The second part will portray the processes and outcomes of Diagonal Shelves (1, 1B, 2 and 2B).

Fig. 46: From left to right; Diagonal Shelves 2 & 2B (Dim: W 542 x L 1192 x H 2092 mm.); and Diagonal Shelves 1 & 1B (Dim: W 480 x L 1192 x H 2092 mm.) (Whyte 2012)

Similar to Diagonal Benches 1 and 2, the combination of geometric abstraction, re-composition and play of opposites was also a thematic design thread of all the shelving units. The main objective of design was to explore ways of creating a kinetic interplay between vertical and horizontal planes of knock-down furniture for flat package.

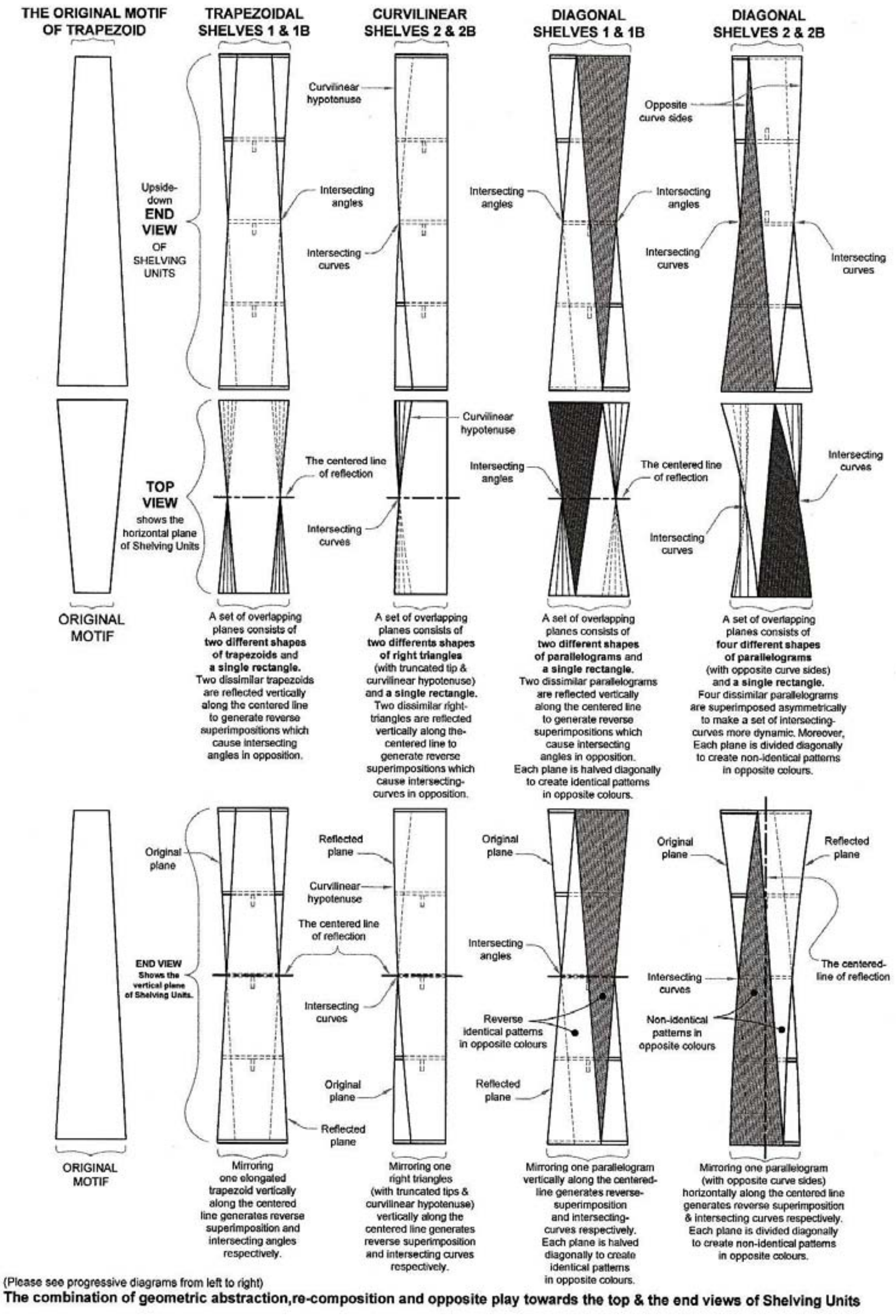


Diagram 5: The sequence of stages in abstracting and re-composing the horizontal and vertical elements of all shelving units (Kongsuwan 2011)

The geometric elements in the design of the shelving units consisted of:

- Solid trapezoidal plane;
- Solid right triangular plane (with truncated tip and curvilinear hypotenuse);
- Solid parallelogram plane;
- Solid parallelogram plane with opposite curved sides;
- Solid rectangular plane;
- Reverse identical isosceles triangular patterns;
- Reverse identical trapezoidal patterns;
- Reverse identical rectangular pattern;
- Reverse non-identical triangular patterns (with curved sides);
- Angular lines (acute, obtuse and perpendicular); and
- Curved lines (concave and convex).

These geometric elements were sequentially abstracted and re-composed to create the horizontal and vertical elements of the shelving units. There were four major stages in abstracting and re-composing horizontal elements:

- **Mirroring** a set of overlapping planes (including trapezoids, parallelograms and right triangles with truncated tip and curved hypotenuse) vertically along the centre line of reflection;
- The **reverse superimposition** of two sets of overlapping planes, creating intersecting angles and curves;
- **Halving** the solid plane of both rectilinear and curvilinear parallelograms diagonally to create identical and non-identical patterns in opposing colours (only for Diagonal Shelves); and
- **Superimposing** a single rectangular plane and four dissimilar parallelograms (with opposite curve sides) asymmetrically to create reverse superimposition and intersecting curves (only for Diagonal Shelves 2 & 2B).

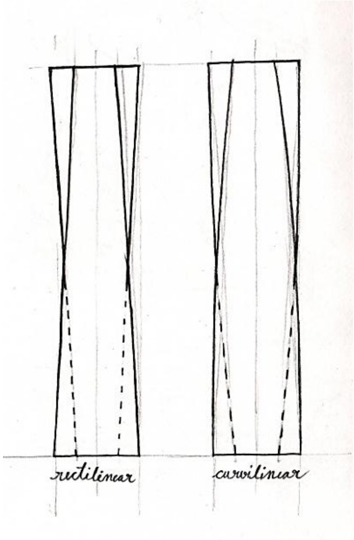
The four stages in abstracting and re-composing vertical elements were:

- **Mirroring** vertical elements (including trapezoids, parallelograms, right triangles with truncated tip and curved hypotenuse) vertically along the centre line of reflection;
- The **reverse superimposition** of the two vertical elements, creating intersecting angles and curves;
- **Halving** the solid plane of both rectilinear and curvilinear parallelograms diagonally to create identical and non-identical patterns in opposing colours (only for Diagonal Shelves); and
- **Reflecting** parallelogram (with opposite curved sides) horizontally along a specified centre line to create reverse superimposition and intersecting curves (only for Diagonal Shelves 2 & 2B).

The play of opposites in the design of the shelving units were:

- Vertical versus horizontal reflection;
- Dark versus light colours;
- Symmetrical versus asymmetrical superimpositions;
- Identical versus non-identical patterns;
- Rectilinear versus curvilinear intersections;
- Wide versus narrow ends;
- Concave versus convex contours;
- Geometric order versus organic wooden grain;
- Simple geometries versus complex superimpositions; and
- The in-determination of negative space versus the predetermination of positive space. (See diagram 5)

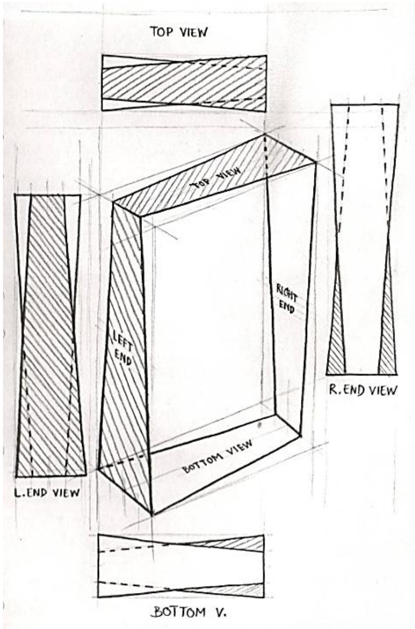
Trapezoidal and Curvilinear Shelves



Drawing 10: The reverse superimposition of rectilinear and curvilinear trapezoids (Kongsuwan 2008)

The process of designing the Trapezoidal and Curvilinear shelves began by abstracting and re-composing a single plane of trapezoidal geometries in various ways, including vertical reflection, single and multi-superimposition. The vertical reflection of trapezoids and right triangles (with truncated tip and curved hypotenuse) led me to reverse superimposition and then to the intersection of angles and curves. I initially concentrated on the trapezoid shape due to its visual resemblance to the joinery motifs and reminiscence of traditional Thai walls. In keeping with the concept of play of opposites, I incorporated curved elements to soften the stiffness of the trapezoidal contour. In comparison with the superimposition of rectilinear trapezoids, which are distinct and slender, the overlap of curvilinear trapezoid appears more imprecise and bulky.

In order to convey the transformable symbolic motif through both vertical and horizontal planes, I placed two pairs of reverse trapezoids into the four facets of a tall rectangular cube.

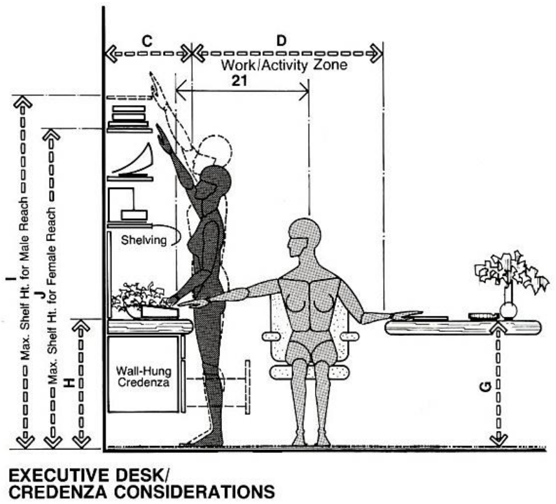


Drawing 11: Placing two pairs of reverse identical trapezoids on the four facets of a rectangular cube (Kongsuwan 2008)

On the vertical plane, I placed a tall trapezoid on the left end of rectangular cube by letting its wide base touch the ground. Another one was reversely placed on the right end by upturning its wide base to the top.

In order to create the interplay between vertical and horizontal planes, I placed two short identical trapezoids on the top and bottom facets of a rectangular cube in reverse direction. In this case, the narrow and wide ends of the two horizontal trapezoids were congruously attached to those vertical trapezoids.

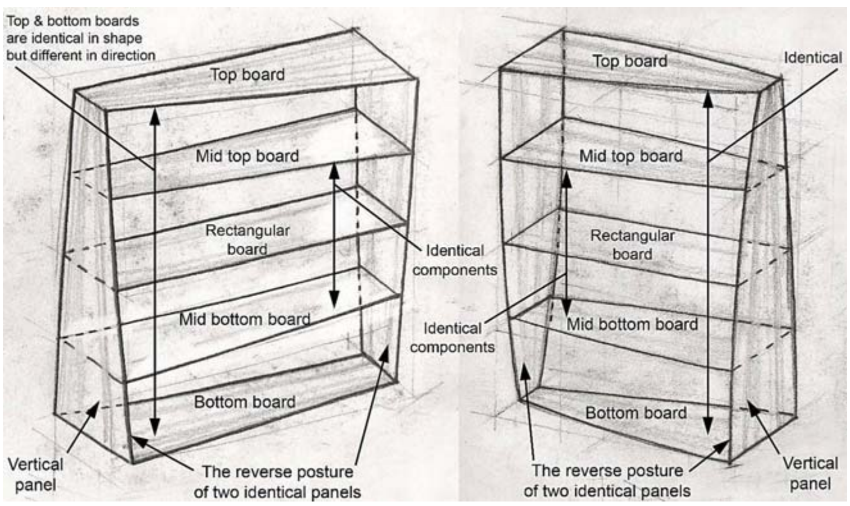
Drawing 11 shows two unplaced facets that appear from the front and the back elevation of the rectangular cube. As a result, I intended to utilise this solid void as the shelving storage. According to the anthropometric factors of human dimension, the maximum height of a shelf should not be greater than 182.9 and 175.3 cm for taller and shorter people respectively.



	in	cm
A	30–45	76.2–114.3
B	42 min.	106.7 min.
C	18–24	45.7–61.0
D	23–29	58.4–73.7
E	5–12	12.7–30.5
F	14–22	35.6–55.9
G	29–30	73.7–76.2
H	28–30	71.1–76.2
I	72 max.	182.9 max.
J	69 max.	175.3 max.

Fig. 47: The maximum shelf height for male and female reach (Panero and Zelnik 1979, p.173)

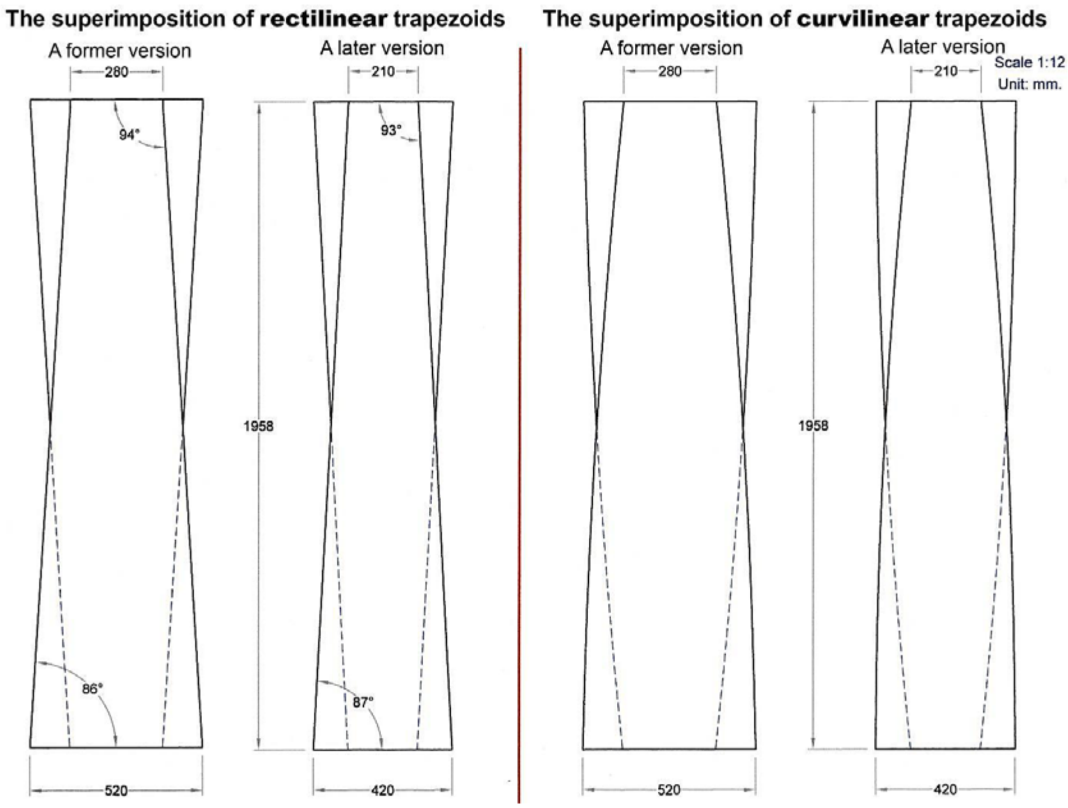
Consequently, the height of the rectangular cube was equally divided in four sections according comfortable adult reach. The contour of each horizontal board was dictated by the reverse posture of two vertical panels. As a result, each shelf cannot be adjusted. In this case, the middle board, situated at the intersecting angle of two reverse vertical panels, became rectangular. The other two horizontal boards were identical trapezoids, situated above and under the rectangular shelf in reverse direction.



Drawing 12: From left to right; the initial sketched design of Trapezoidal and Curvilinear Shelves (Kongsuwan 2008)

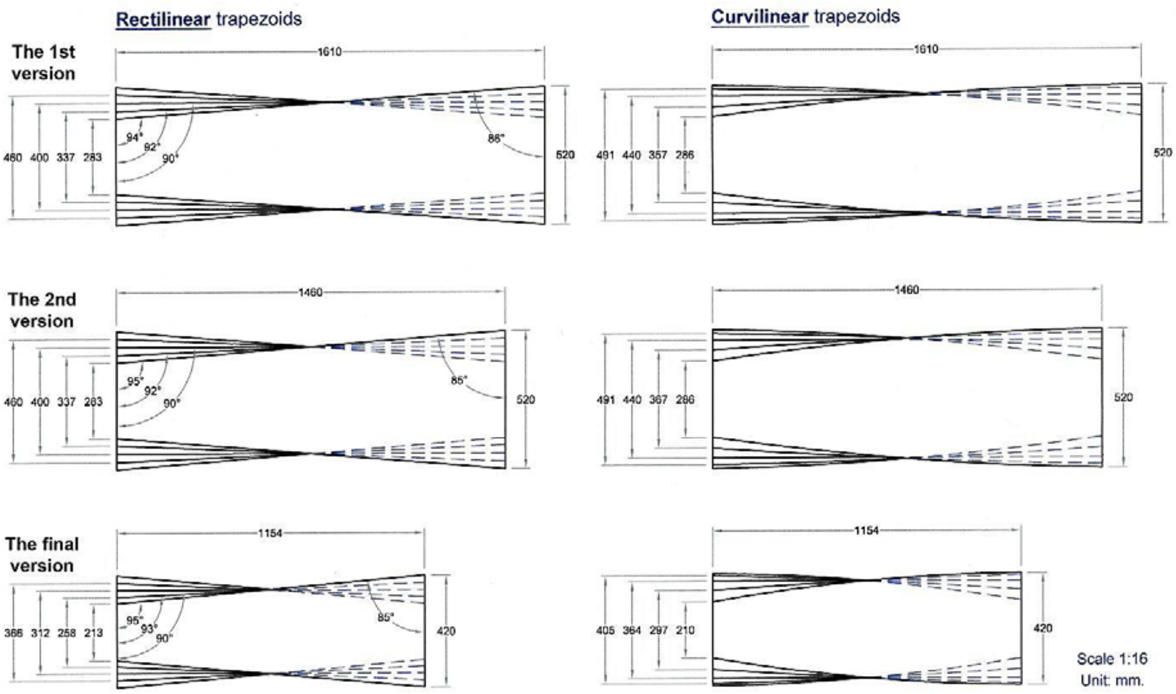
I employed CAD to develop the proportions of my initial design to suit the standard size of my preferred material. I selected ‘Gaboon’ plywood due to its availability, regular density, lightness and affordability. In comparison with marine grade plywood and MDF board, Gaboon plywood is much lighter. I also intended to match the multiple layers of the plywood edge with the overlapping elements of the shelf planes.

Mechanical drawing 12 illustrates the comparison between two versions of trapezoidal superimpositions. In the second version, the wide base of rectilinear and curvilinear trapezoids was decreased by 100 mm, while their narrow top was reduced by 70 mm. Although this modification caused a slight change in angle and curve, the second version turned out more in proportion.

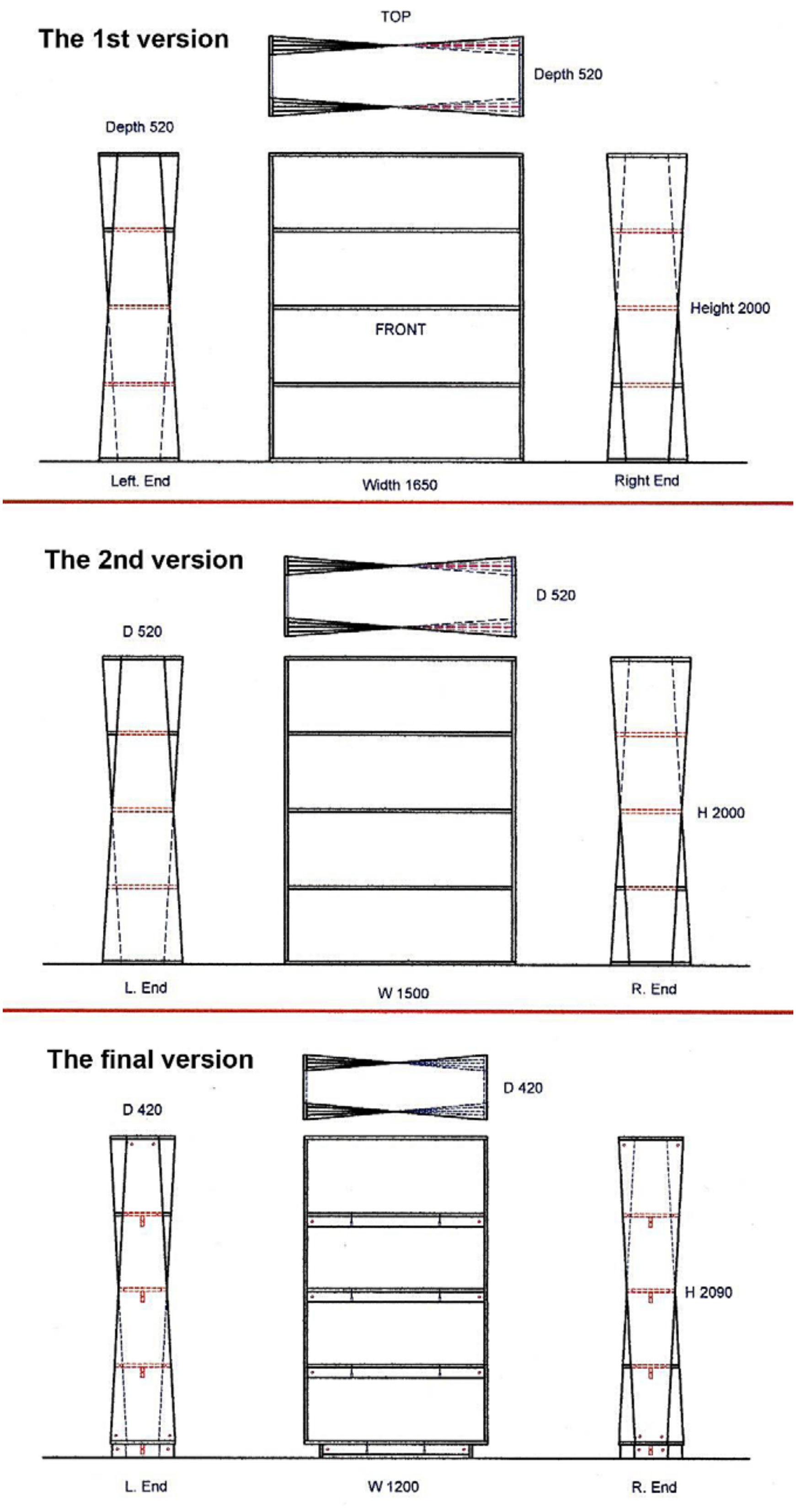


Mechanical drawing 12: The processes of proportioning the trapezoidal superimposition of vertical planes (Kongsuwan 2008)

Then, I began matching the horizontal boards with two vertical panels. As shown in Mechanical drawing 13**,** the length of each set of overlapping planes was gradually reduced from 1610 mm. to 1154 mm. Although viewing the five overlapping planes from aerial view shows the progressive motion of obtuse, right and acute angles, these angular lines share the same intersection, resulting in visual balance of the object. This was achieved through symmetrical superimposition. I then reassembled all components of Trapezoidal Shelves 1 to observe the interactive elevations of the object.



Mechanical drawing 13: From top to bottom; developing and clarifying the proportion and dimension of a set of overlapping planes (Kongsuwan 2008)



Mechanical drawing 14

From top to bottom; developing and clarifying the proportion and dimension of the Trapezoidal Shelves 1 (Kongsuwan 2009)

Scaled models

Fig. 48: From left to right; the comparison before and after developing the proportion of Curvilinear Shelves 2 (Kongsuwan 2008)

I began making a number of scaled models (1:7.5) to examine proportion, appearance, colour effect and stability. (See fig. 48) The right model appears slimmer than the left because of the reduction of the width and length of both vertical and horizontal boards.

Fig. 49: From left to right; the difference between Trapezoidal and Curvilinear Shelves (Kongsuwan 2008)

(See fig. 49) Compared with a pair of Trapezoidal Shelves, a pair of Curvilinear Shelves appears more suitable for domestic use because the presence of gentle curve makes the objects more reassuring. In contrast, the rectilinear outline of Trapezoidal Shelves suggests the sense of excitement, which is more suitable for public utility such as library or a shop.

A single module in each pair is identical in shape but different in colour. I intended to let the conflict of wooden tone accentuate the exact correspondence of size and shape between two similar modules. The combination of symmetrical form and opposite colour recalls the complementary opposites of yin and yang.

Functionally, in order to provide an additional function for users in library or bookshop, I elongated the length of the mid bottom board to provide a cantilevered seat. This additional function suits the habit of most Westerners who are accustomed to sit on seats built above the ground.

Fig. 50: From left to right; Trapezoidal Shelves without seat and with additional cantilevered seat (Kongsuwan 2008)

For more flexible use of living space, I examined the possibility of combining the separate functions of shelving storage and mobile screen. In doing so, I made three more scaled models to explore the sliding function when multiple modules of the shelving unit were clustered in a pair or group. While the concave, convex and oblique back of each scaled model means they can be attached together, they could not slide against one another horizontally. As a result, I had to flatten the back of all units in order to generate a right angle that allowed multiple models to slide against one another.

Fig. 51: The sequence of developing the sliding function of modular shelves (Kongsuwan 2009)

In order to increase the mobility and convenience of each module, I thought about installing two pairs of castors at the bottom board. However, I had to discontinue this idea because the distance between the four tangential points of each pair of castors was restricted by the narrow end of trapezoidal board, leading to a high risk of collapse.

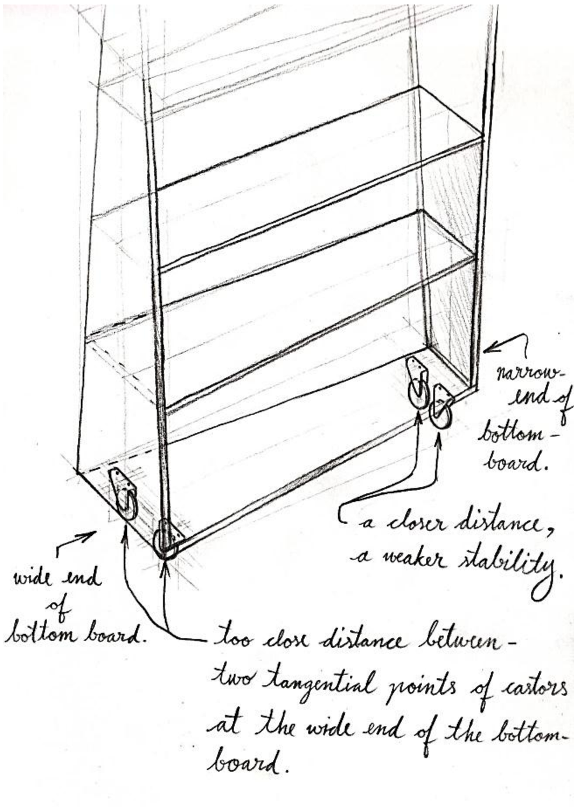


Fig. 52: The problem of using castors (Kongsuwan 2009)

Later, I came up with two choices of installation: placement near the wall against the module's single flat back, or installing in the middle of the room as a room divider.

Aesthetically, the oblique reversal of the Trapezoidal Shelves' scaled models stimulated the eye to explore visual movement more explicitly than the Curvilinear Shelves. When placed away from the wall, this central position allowed me to see its ambiguous effects, especially its stability and asymmetry from many directions. When in position against the wall, I chose a pair of Curvilinear Shelves with a single flat back to mitigate the rigid angle of perpendicular wall. (See fig. 53) I eventually selected a pair of Trapezoid Shelves and a pair of Curvilinear Shelves (with a single flat back) for the final fabrication of the first part of the second experiment.

Fig. 53: Two options of shelves’ installation
From left to right; the miniature models of the Curvilinear Shelves 2 & 2B (with a single flat back) and the Trapezoidal Shelves 1 & 1B (Kongsuwan 2008)

Final fabrication

There were five major steps in making the Trapezoidal and Curvilinear Shelves. These can be seen in Appendix 3.

Aesthetic revision

Before sanding, I assembled all shelves to examine their actual proportions, appearance and stability. The two main points that needed to be improved were rectangular beams and foot bases.

Fig. 54: From left to right; the first assembly of the Trapezoidal and Curvilinear Shelves (Kongsuwan 2009)

Firstly, all rectangular beams did not echo the trapezoidal outline of horizontal boards. As a result, I tapered one edge of each beam in respond to the trapezoidal shape. Similarly, all the rectangular beams of the Curvilinear Shelves were adjusted by curving one edge in order to mimic the curvaceous contour of shelving panels.

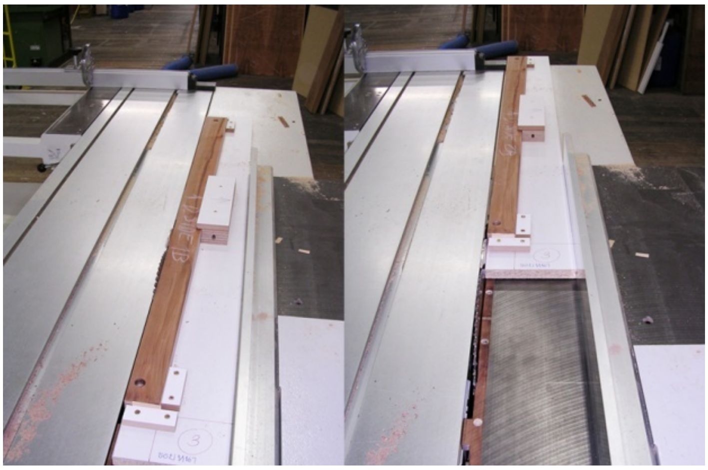


Fig. 55: Tapering one edge of rectangular beam by table saw (Kongsuwan 2009)

Fig. 56: The second assembly of a pair of Trapezoidal and Curvilinear Shelves shows tapering and curved edge of underneath beams. (Kongsuwan 2010)

Secondly, castors were replaced by I-shaped bases. These new foot bases were fixed beneath the bottom board. This new base was made up of three separate components; two foot bases and a single short beam. The former version of two foot bases had a recessed step for creating visual lightness. However, they did not fit with the simplicity of the vertical panels. Consequently, I kept the outline of the new version of foot base straight. In addition, I installed a pair of adjustable feet at the two corners of each foot base in order for the shelving unit to be adjusted if being used on an uneven floor. These adjustable feet also protect a wooden edge from heavy usage such as being dragged on a rough surface of the floor.

Fig. 57: From left to right; the first version of foot base; the feature of I-shaped base; and the demonstration of adjusting the feet (Kongsuwan 2010)

The design outcomes of the Trapezoidal and Curvilinear Shelves

Fig. 58: Two opposite viewpoints of a pair of Trapezoid Shelves (Kongsuwan 2009 & 2010)

By observing from the point of view of the wide end of the vertical trapezoidal panel points the ground, the whole shelving unit appears stable due to its acute angle, while looking from the elevation that the narrow end points the ground, it seems to fall over because of the obtuse angle of vertical board. These opposite viewpoints suggested the sense of twist and ambiguity.

Fig. 59: Two opposite viewpoints of a pair of Curvilinear Shelves with a flat back (Whyte 2012)

Similar to the Trapezoidal Shelves, the Curvilinear Shelves with a flat back seems to twist in the opposite direction. This dynamic effect appears more explicit when two modules with contrasting colours were lined up together, creating a mirror image.

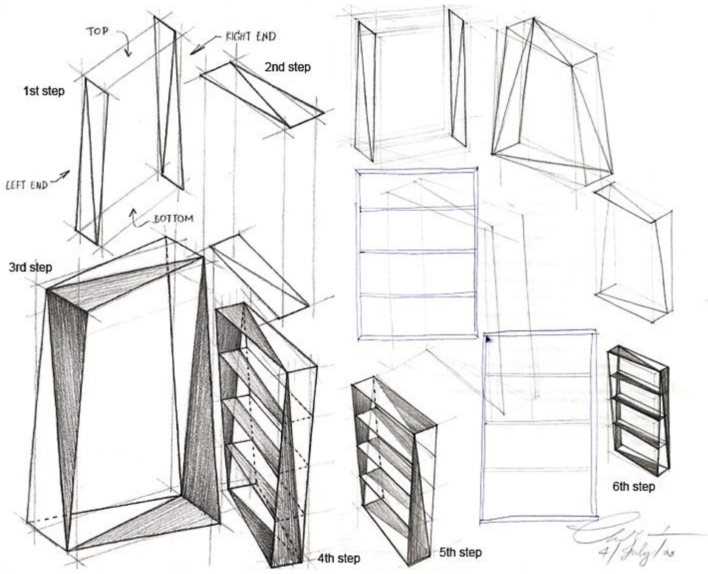
Diagonal Shelves

Unlike the first part of the second experiment, all Diagonal Shelves demonstrated a way of combining the opposite colour of veneer in a singular module.

Initially, I began abstracting and re-composing a single plane of parallelogram in various ways including vertical and horizontal reflection, reverse superimposition and planar break. The vertical and horizontal reflection of rectilinear and curvilinear parallelograms led me to reverse superimposition**,** intersecting angles and curves and then to the break of planar elements. (See diagram 5)

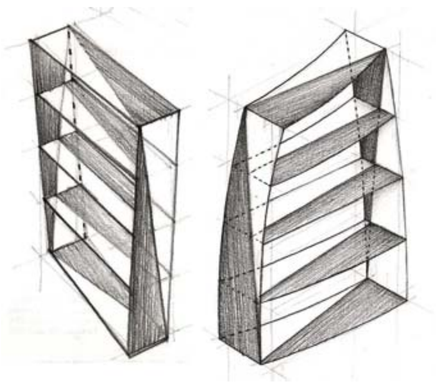
Secondly, I started the design process by placing two reverse parallelograms on the left and the right end of a tall rectangular cube. Then the top and bottom facets of the rectangular cube were filled by two reverse parallelograms. Thirdly, I related vertical and horizontal parallelograms together to observe planar interplay. Fourthly, I began dividing each parallelogram diagonally. This planar break resulted in a pair of reverse identical triangles. Each triangle differed by opposite colours. Breaking each planar component into multi-sections aimed to reduce the massive plane of each board.

Fifthly, three horizontal planes were orderly placed among a solid void between the top and bottom panels. These three additional planes consisted of a pair of identical parallelograms (one was raised above lowest plane and another was elevated beneath the top plane) and a single rectangular plane, situated at the mid height of vertical planes.



Drawing 13: The sequence of events in arranging the plane geometries of parallelogram into the three-dimensional form of the Diagonal Shelves 1 (Kongsuwan 2009)

Aesthetically, a pair of reversed identical patterns with contrasting colours was represented on both surfaces of each individual shelf. The diagonal line on each horizontal board was subjugated by the diagonal lines of reverse vertical panels of the Diagonal Shelves 1. Consequently, the height of three additional shelves cannot be adjusted. The continuity and discontinuity of dark and light patterns on the vertical and horizontal planes can be seen in the fourth to sixth step in Drawing 13. These two interactive effects represented a high and medium degree of visual excitement and conflict.



Drawing 14: From left to right; the perspective drawing of the Diagonal Shelves 1 & 2 (Kongsuwan 2009)

Opposite linear sides of parallelogram were replaced by opposite curved sides to mitigate the stiff outline of Diagonal Shelves 1. This shifted the symmetrical composition of Diagonal Shelves 1 to the asymmetrical composition of Diagonal Shelves 2. In comparison with a pair of reverse identical patterns of Diagonal Shelves 1, each planar element of Diagonal Shelves 2 was divided asymmetrically by a pair of reverse non-identical patterns.

The processes of embodiment

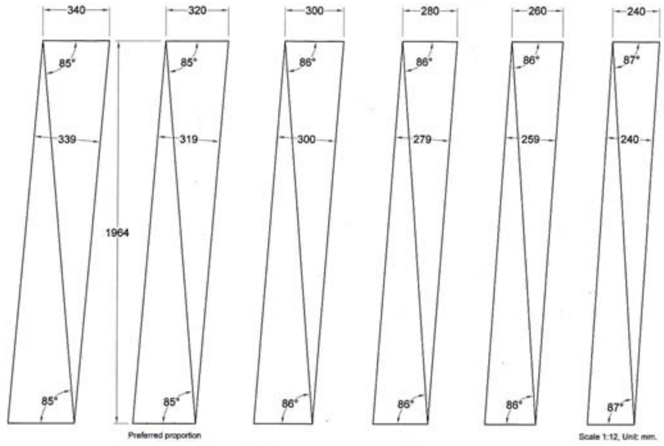
Similar to Trapezoidal and Curvilinear Shelves, the execution of Diagonal Shelves 1 & 2 also has the same procedure, including;

- Developing design proportion and clarifying dimension by CAD drawings;
- Making scaled models to test proportion, appearance and stability; and
- Executing actual pieces.

However, two different methods used were the type of joint and fitting and a more complex arrangement of veneer pattern. These details can be seen in Appendix 4.

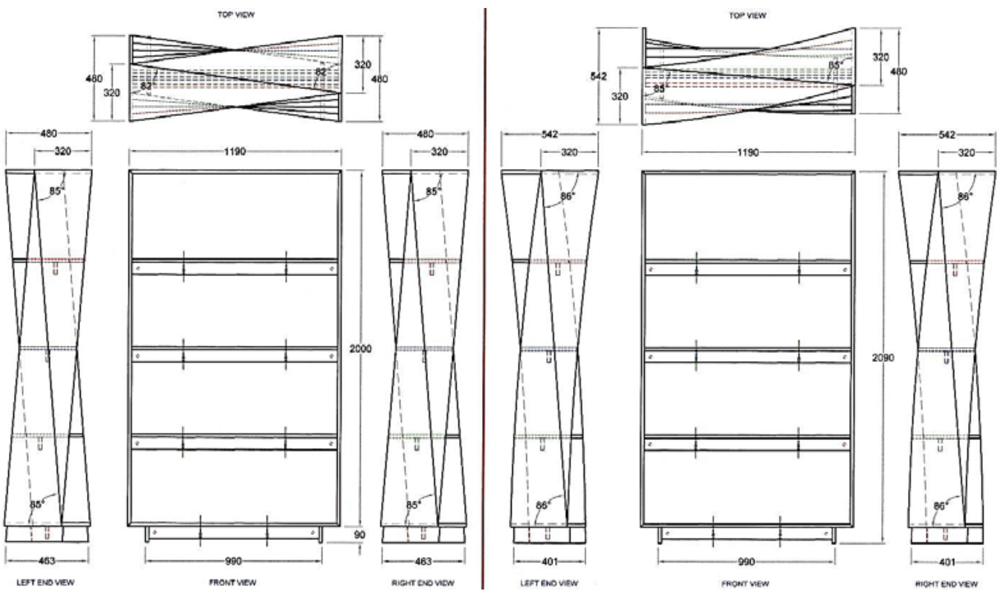
The development of proportion

I then refined the proportion and dimension of vertical and horizontal panels of the Diagonal Shelves in accordance with the Western and Eastern style of storing books on shelving storage. I started by creating six different sizes of vertical parallelograms. For European usage, I selected a 320 mm panel because its moderate width allows a larger size book stand upright on its spine or lean against vertical panels without the spine overhanging. (See mechanical drawing 15)



Mechanical drawing 15: The sequential width of six parallelograms (Kongsuwan 2009)

After finalising the proportions of the vertical parallelogram, I introduced an overlapping element between vertical and horizontal planes. According to Oriental custom, a 320 mm wide panel is also suitable for storing books flat on horizontal shelves with their covers facing up. I also manipulated the final proportion of the rectilinear parallelogram, employing opposite curve sides instead of linear sides for a more subdued contour.



Mechanical drawing 16: From left to right; the four elevations of Diagonal Shelves 1 and 2. Notably, the hidden lines of all beams which appear at the left and right end views do not align vertically.

Scale models

Fig. 60: The miniature models of the Diagonal Shelves 1 and 1B (Kongsuwan 2009)

Fig. 61: The miniature models of the Diagonal Shelves 2 and 2B (Kongsuwan 2009)

All scaled models were based on the scale of 1:7.5. The play of opposites was reflected through the juxtaposition of contrasting veneers and the reverse posture of two modules. I specifically matched Leatherwood with Celery top pine because of the medium intensity of Leatherwood's colour and the pastel tone of Celery top pine.

Fig. 62: Matching Celery top pine and Leatherwood (Kongsuwan 2009)

Actual pieces

Because of the symmetry of geometrical pattern, the process of matching, patching and gluing veneer on both surfaces of plywood needed to be identical and precise. As a result, preparation was more complicated and time-consuming than those shelves in the former experiment.

Aesthetically, I let the grain direction of two different veneers runs parallel to the diagonal line of each panel. When viewing a set of superimposed planes of Diagonal Shelves 1 and 1B from top elevation, it resembles the virile motion of an Oriental folding fan.

Fig. 63: The overlapping shelves plane of Diagonal Shelves 1 and 1B resemble the virile motion of an Oriental hand-held fan. (Kongsuwan 2009) and (Bornoff & Freeman 2002, p.80)

From aerial view, Diagonal Shelves 2 and 2B recalls the gracious movement of the fingers of a classical Thai dancer. Observers have remarked of this kinetic quality that *'these shelves seemed like swirl, vortex or helix.'*

Fig. 64: The overlapping shelves plane of Diagonal Shelves 2 and 2B recall the gracious movement of the hands of a classical Thai dancer. (Kongsuwan 2009) and (Beurdeley 1980, p.104)

The swirly posture also encouraged observers to approach the shelves from various directions.

Fig. 65: Continuing the same colour of veneer pattern creates a harmonious interplay between vertical and horizontal planes. (Kongsuwan 2009)

To further stimulate the eye I continued and discontinued the same colour of veneer pattern between vertical and horizontal panels. These interchangeable effects offered two degrees of visual contrast.

Fig. 66: Discontinuing the same colour of veneer pattern creates an opposite play between vertical and horizontal planes. (Kongsuwan 2009)

Medium and high contrast

The isochromatic arrangement of veneer was designed for people who prefer harmonious colour between vertical and horizontal planes, whereas the chequered arrangement was designed for those who prefer contrasting colour. Both arrangements presented rhythmic upward and downward transformations towards the dual patterns of horizontal boards, depending on the movement of the eye of the observer.

Self-assembly, easy maintenance and transportability

Being made of extra lightweight plywood, these shelves can be assembled and easily broken apart by one person. This allows users to refurbish or replace parts with simple hand tools. Each separate component can also be flat packed, making them very economical to transport.

Fig. 67: The sequence of stages in the shelves' assembly and packing (Kongsuwan 2010)

The design outcomes of all shelving units

Visual movement: When viewing the top and end elevations of Trapezoidal, Curvilinear and Diagonal Shelves 1 & 1B, each set of overlapping elements reveals a singular intersection of oblique angles or curves caused by a symmetrical reflection and superimposition. Although each set of overlapping planes of Diagonal Shelves 2 & 2B depicts various intersections of right angle and curves, this non-symmetrical composition achieved a physical balance.

Although the asymmetrical superimposition of Diagonal Shelves 2 & 2B created the most kinetic expression, the symmetrical overlap of other shelves could also achieve a dynamic interplay between vertical and horizontal planes as well.

Fig. 68: Various views of all shelving units (Whyte 2012)

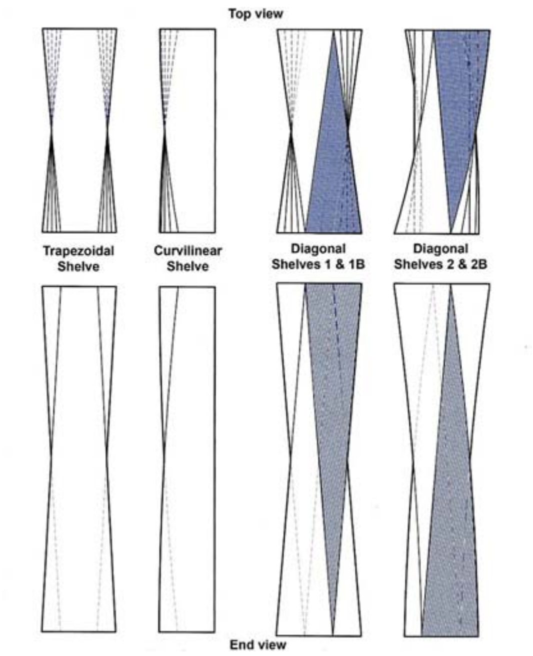


Diagram 6: The top and end elevations of all shelving units reveal eight sets of overlapping planes. (Kongsuwan 2011)

Visual ambiguity: The shelving pairs created visual ambiguity through:

- Stability **versus** instability;
- Symmetry **versus** asymmetry; and
- Static **versus** kinetic.

Floating qualities: All shelving units successfully conveyed floating qualities through their overhanging corners.

An acceleration of scale: All Diagonal Benches successfully represented an acceleration of scale through a sequential change in the size of dual patterns from each horizontal plane to the next ascending or descending one.

Equivocal space: Breaking planar geometries by juxtaposing two contrasting colours of identical veneer suggested negative–positive reversal, whether observers view the dark or the light colours as dominant figure, or vice-versa.

The Third section of Chapter Three: linear experiment

Product: a pair of Dowel Bench Seats (2010)

Medium: Tasmanian Oak dowels (16 and 19 mm), horizontal scrub and marine grade plywood

Finish: hand-oiled

Dimension: Width 519 x Length 2400 x Height 483 mm.

Fig. 69: A pair of Dowel Bench Seats
From left to right; Dowel Bench Seat 19 and 16 mm. (Whyte 2012)

Similar to both volumetric and planar experiments, a thematic design tool of linear experiment also lies in the combination of geometric abstractions, re-compositions and opposite plays. These combined elements led me to approach new organisations of trapezoid in linear mode. (See diagram 7)

Inspirational source

The main inspiration for this experiment lies in assimilating the vernacular attributes of the traditional Thai fishing trap with the pared down aesthetics of geometric abstraction. In this experiment, I concentrated on three main methods of recomposing linear elements: reflecting a set of oblique lines; reversing lineate superimposition; and intersecting various angular lines.

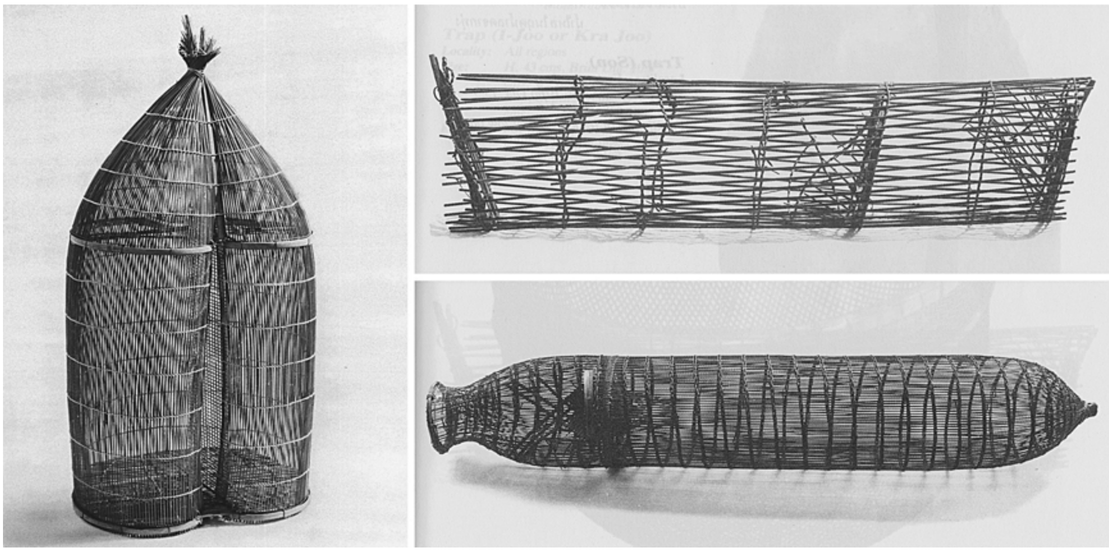
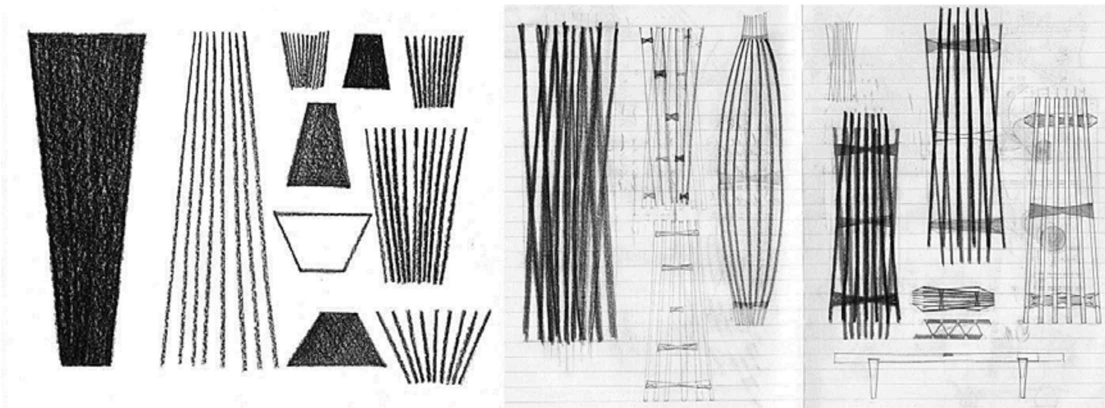


Fig. 70: The linear structure of vernacular Thai fishing traps
From left to right; vertical fishing trap called ‘Lob-Yuen’ made of plaited bamboo (Beurdeley 1980, p.75); and two horizontal traps called ‘Lob-Non’ or ‘Sai’ (Kanokpongchai 1991, p.157 & 159)

Design aim

The main objective of the linear experiment is to break the solid plane of the trapezoid by combining the linear structure of a typical Thai fishing trap with the technique of Kinetic Art and Op Art influences.



Drawing 15: The initial sketched designs of the Dowel Bench Seats (Kongsuwan 2007 & 2008)

The geometric elements involved in the process of designing the Dowel Bench Seats were:

- Solid trapezoidal plane;
- A set of convergent lines (consist of oblique and straight lines);
- A set of divergent lines (consist of oblique and straight lines);
- Trapezoidal frames; and
- Rectangular frame. (See diagram 7)

These geometric elements were abstracted and recomposed to create a linear interplay between horizontal and vertical elements of the Dowel Bench Seats. The seven major stages in abstracting and re-composing the <u>horizontal elements</u> were:

- **Breaking** the solid plane of trapezoid;
- **Reflecting** a set of oblique lines horizontally along the centre line of reflection (a straight line) to generate the mirror image of convergent lineate members;
- **Mirroring** a set of convergent lineate members vertically along the centre line of reflection to generate reverse superimposition;
- The **reverse superimposition** between convergent and divergent lineate members led to intersecting angles;
- **Intersecting angles** leading to a **moiré effect**;
- **Translating** and **suspending** the upper and lower set of lineate members for a more explicit moiré effect; and
- **Adding** two sets of oblique lines among the space between the upper and lower set of lineate members for a more dramatic moiré effect. (See diagram 7)

The major steps in abstracting and re-composing <u>vertical elements</u> were:

- **Reflecting** a set of trapezoidal frames vertically along the centre line of reflection to generate reverse superimposition; and
- The **reverse superimposition** of two sets of trapezoidal frames, resulting in intersecting angles (See diagram 7)

The play of opposites involved in the process of designing Dowel Bench Seats were:

- Vertical versus horizontal movement;
- Fan in versus fan out;
- Upward versus downward glide;
- Convergent versus divergent end; and
- Static versus kinetic spacing. (See diagram 7)

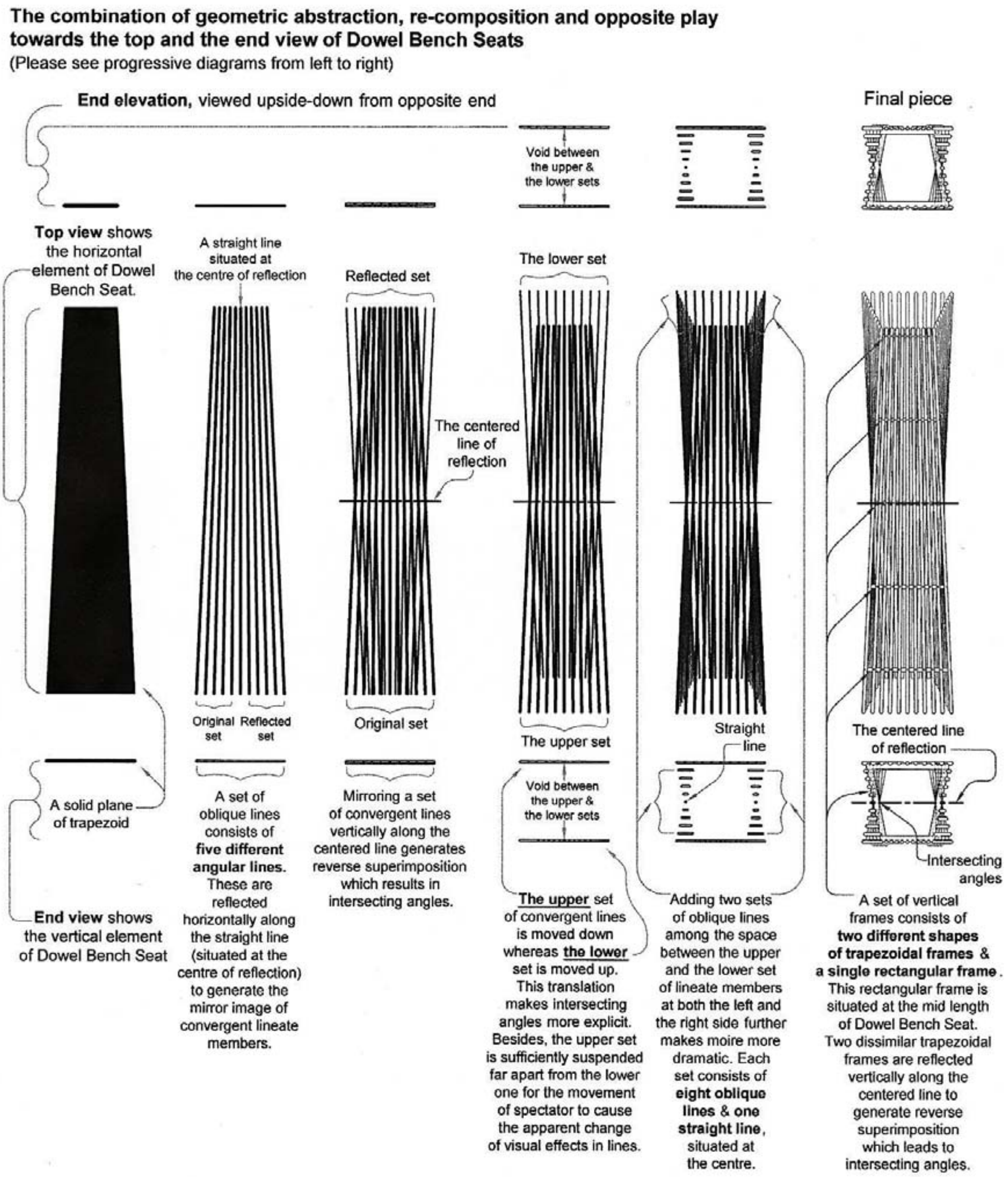


Diagram 7: From left to right; the sequence of stages in abstracting and re-composing the horizontal and vertical elements of the Dowel Bench Seats (Kongsuwan 2011)

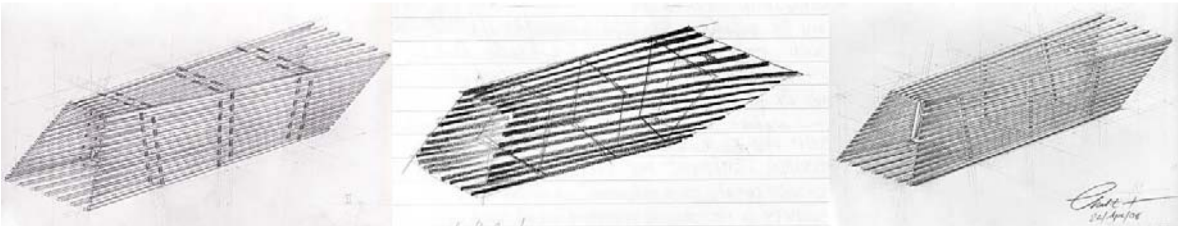
Turning the solid plane of trapezoid into the linear structure of a bench seat

Initially, I broke the solid plane of trapezoid into a set of oblique lines. Then, these linear members were reflected horizontally to generate a set of convergent lines. This mirror image resembles the lineate members of Thai fishing trap, which converge at one end and diverge at the other. I used this perspective device as a way of evoking movements and illusions in association with lines and angles. (See diagram 7)

Later, I mirrored a set of convergent lines vertically along its mid length in order to generate reverse superimposition. The overlap between the sets of convergent and divergent lines resulted in intersecting angles. The intersection of oblique lines at an angle of less than twenty degrees led to a moiré effect. To make the moiré effect more explicit, I moved the upper and lower set of lineate members up and down while keeping the same alignment. This made the moiré effect more dramatic because there was more negative space, magnifying intersecting angles.

In order to shift the two-dimensional effect of moiré to the three-dimensional form of a bench seat, I elevated the upper set of convergent lines apart from the lower one. This elevation fitted Western functionality. The void between the upper and lower sets was filled by two sets of oblique lines at both the left and right side. This addition further enhanced the visual quality of moiré effect.

At the early stage of design, linear members were edge-joined by butterfly keys to form a perspective tunnel in reverse direction. Later, this patchwork structure was replaced by the use of vertical frames to reduce complication. According to Drawing 16, there are three vertical frames that sit across the length of linear members in a regular spacing. The forth and the back frames are identical in size and shape, but they were rotated in reverse direction to suggest an opposite interplay. Unlike a pair of trapezoidal frames, the angle of the middle frame is perpendicular as it is situated at the mid length of the whole structure.



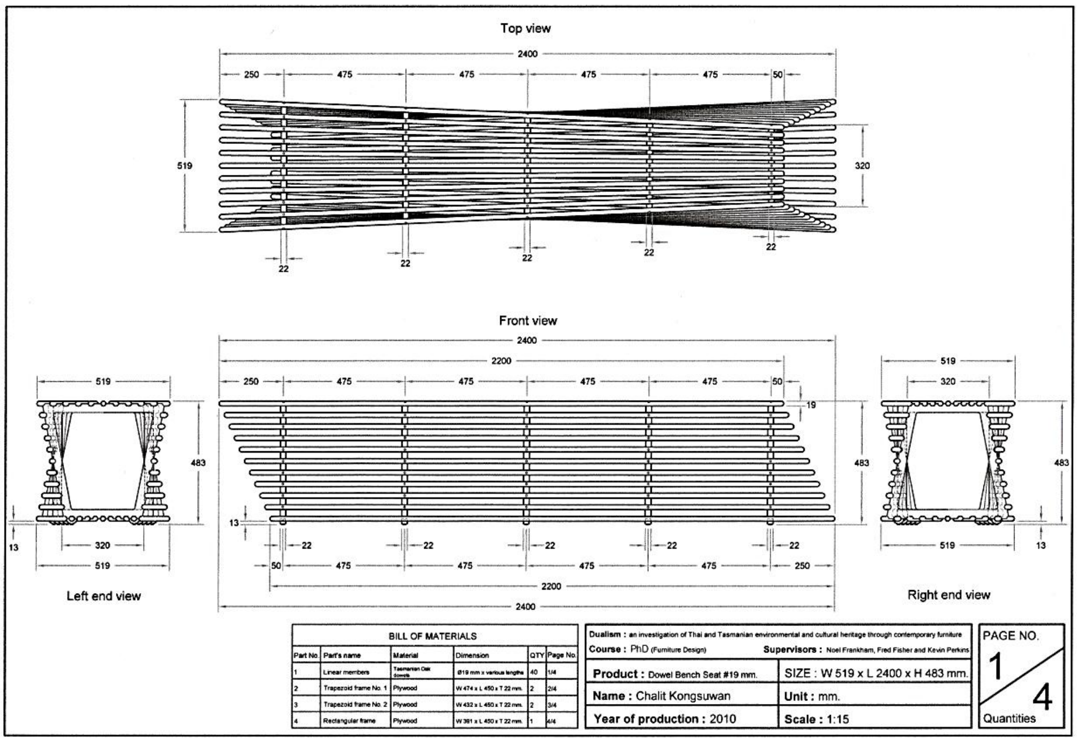
Drawing 16: The perspective drawing of the two early designs of the Dowel Bench Seat
From left to right; patchwork structure and the use of transverse frames (Kongsuwan 2008)

The process of making the actual pieces

The core materials of the Dowel Bench Seat are Tasmanian Oak dowels and marine grade plywood. Both materials were used for decorative and structural purposes. The sequence of stages in executing the Dowel Bench Seats can be seen in Appendix 5.

Structural reinforcement

To be able to withstand the weight of four people at the same time, five vertical frames were used to support all linear elements; one rectangular frame and two pairs of trapezoidal frames. Significantly, each horizontal set of linear members consisted of eleven lengths of dowels while each vertical set consisted of nine lengths. Because of the symmetrical reversal of identical components, spacing between each vertical frame remained equal.



Mechanical drawing 17: The three elevations of the Dowel Bench Seat 19 (Kongsuwan 2010)

Although the linear members flexed at the overhanging ends when sat upon, the bench was strong enough to withstand the load of 75 kilograms.

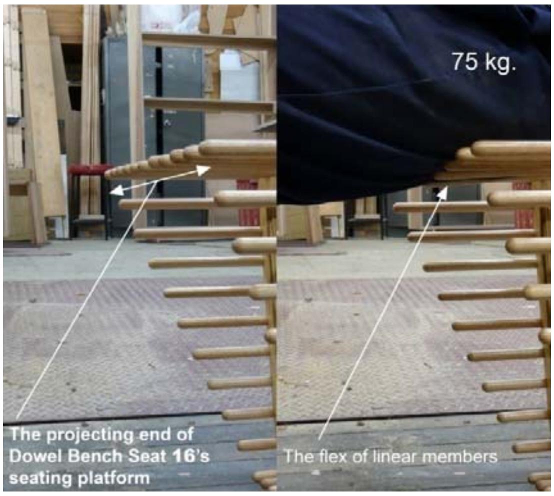


Fig. 71: The strength of the Dowel Bench Seat **<u>16</u>** was tested with a satisfactory outcome. (Kongsuwan 2010)

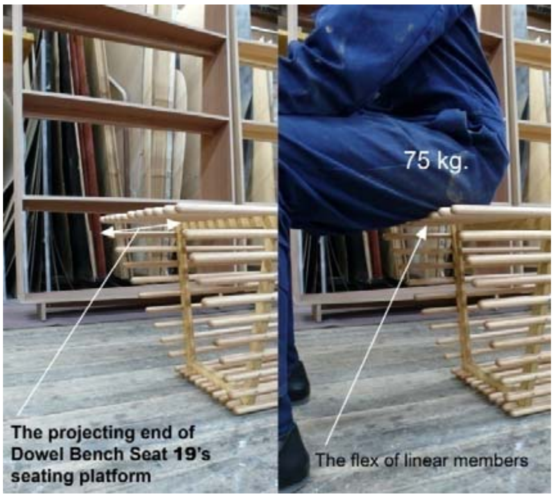


Fig. 72: The strength of the Dowel Bench Seat **19** was tested with a satisfactory outcome. (Kongsuwan 2010)

Durability and safety

If the object was dragged on a rough or uneven floor, the bottom surface could be easily harmed. With this concern, I raised the whole object slightly from the floor by using semi-circular feet made of horizontal scrub timber. Additionally, the sharp end of each dowel was rounded to withstand heavy usage and avoid the risk of injury.

Fig. 73: From left to right; the sequence of stages in executing and assembling the feet of the Dowel Bench Seats, made of horizontal scrub timber (Kongsuwan 2010)

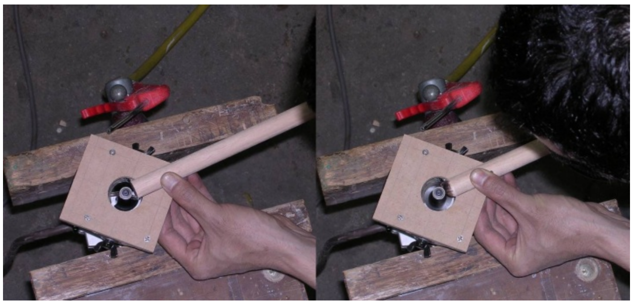


Fig. 74: Rounding the sharp end of each length of dowel (Kongsuwan 2010)

Assembly

In order for each length of wooden dowel to be fixed in place, the outline of each vertical frame was notched in semi-circular shape for letting the correspondent diameter of each dowel sit on securely. Moreover, I had to pre-drill a single hole at the intersection between the tangent of each notch and the half thickness of the frame. For a convenient maintenance and replacement, each length of dowel can be fixed and removed by using five screws.

Fig. 75: The sequence of stages in assembling all linear components with five vertical frames (Kongsuwan 2010)

Cross-cultural aspect

I specified the bench height to approximately 480 millimetres to provide multi-cultural comfort. Most Westerners who are familiar to sit with their legs hanging may do so, while Easterners who prefer sitting with legs and feet up, can sit in the more traditional mat posture by leaning their back against the obtuse slope of the vertical cladding panels.

Fig. 76: The hybrid function of the Dowel Bench Seat (Whyte 2012)

Sustainable aspect

I intended to bridge the gap between custom-made and mass-produced furniture by using commercially viable timber from re-growth forest in Tasmania as a major material. The final outcome demonstrated an alternative way of reconciling the minimal use of native Tasmanian timber and industrial application. This reconciliation is likely to suit a majority of consumers who are looking for unique furniture at a moderate price that can be easily manufactured, transported, used and repaired as well as matched with other objects and living spaces.

Illusion and ambiguity

While walking around the reverse display of the two Dowel Bench Seats, I perceived a sense of illusory movement and curved ambiguity. In actuality, there is no curvilinear element involved in the design of the Dowel Bench Seats except the round profile of the wooden dowels.

Both deceptive motion and curve can be seen from various viewpoints. The lineate members of vertical (side) cladding panels seemed to bend or twist in opposite direction as a result of being sequentially intersected by the acute, right and obtuse angles of the five vertical frames.

Fig. 77: The sense of twist was emerged through vertical cladding panels. (Whyte 2012)

Although the upper and lower sets of linear members have the same length, the opposite end views of the Dowel Bench Seat bring two different depths in distance. This illusion is caused by a perspective influence. When looking towards a convergent end of seating platform, the set of linear members seemed parallel.

Fig. 78: Illusory depths can be found by viewing the Dowel Bench Seat from different perspectives. The upper set of lineate members seems parallel whereas the lower set appears to recede into the distance. These four images were taken towards a **convergent** end of the seating platform. (Kongsuwan 2011)

In contrast, when viewing towards the divergent end of the foot base, the set of linear elements appeared to recede into the distance.

Fig. 79: The change of viewpoints changes the residual space between each linear component. These four images were taken towards a **divergent** end of the seating platform. (Kongsuwan 2011)

Rhythmic effect

Both vertical cladding panels of the Dowel Bench Seat were filled by the monotonous repetition of lineate members. As a result, the gap between each linear component remains steady in rhythm. However, as the eye sweeps along it, the regular spacing appeared irregular. A change in the movement of my eyes resulted in a variation of residual space between each length of dowel. This effect conveyed rhythmic kinetic qualities through the object. (See fig. 77 - 79)

Lateral movement

There was also a lateral movement on both vertical cladding panels. This can be seen from the front and the back views where each linear component steps upward and downward in progression.

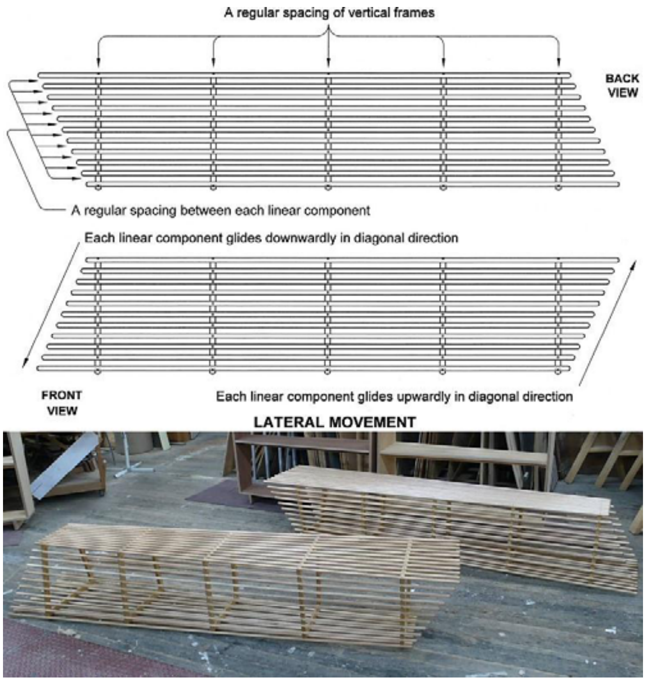


Fig. 80: The lateral movement of the Dowel Bench Seats

From top to bottom; the back and the front views of Dowel Bench Seat 19 and the reverse display of Dowel Bench Seat 16 and 19 (Kongsuwan 2010)

Counter-movement

When observing from the aerial view of the bench, each linear element on both vertical cladding panels fanned in and out in progression.

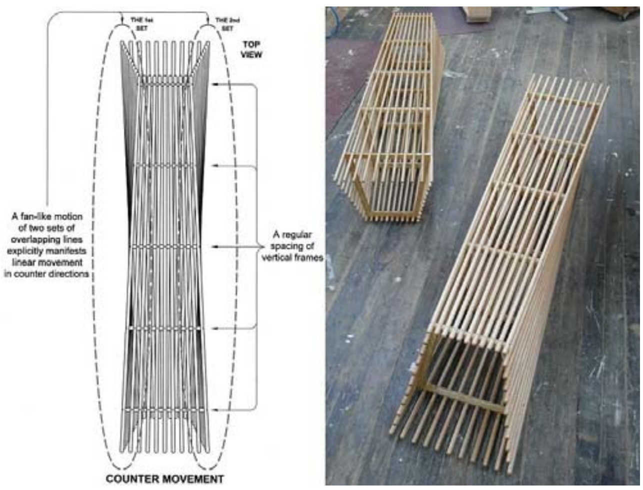


Fig. 81: The counter-movement of the Dowel Bench Seats

From left to right; the top view of Dowel Bench Seat 19 and the reverse display of Dowel Bench Seat 16 and 19 (Kongsuwan 2010)

Similarly, a fan-like motion of five overlapping frames also created counter-movement through the opposite end views of the Dowel Bench Seat. By looking towards a convergent end of the seating platform, the observer will see the **acute-to-obtuse** motion of a set of overlapping frames. In contrast, looking toward a divergent of seating platform, the observer will see an **obtuse-to-acute** motion.

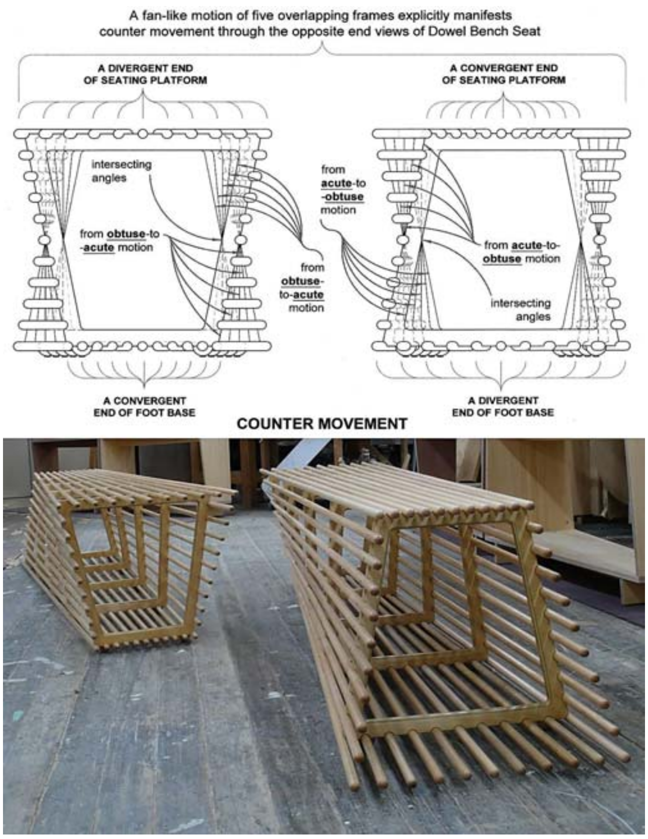


Fig. 82: The counter-movement of the Dowel Bench Seats
From top to bottom; the opposite end views of Dowel Bench Seat 19 and the reverse display of Dowel Bench Seat 16 and 19 (Kongsuwan 2010)

The Design Outcomes of Dowel Bench Seats

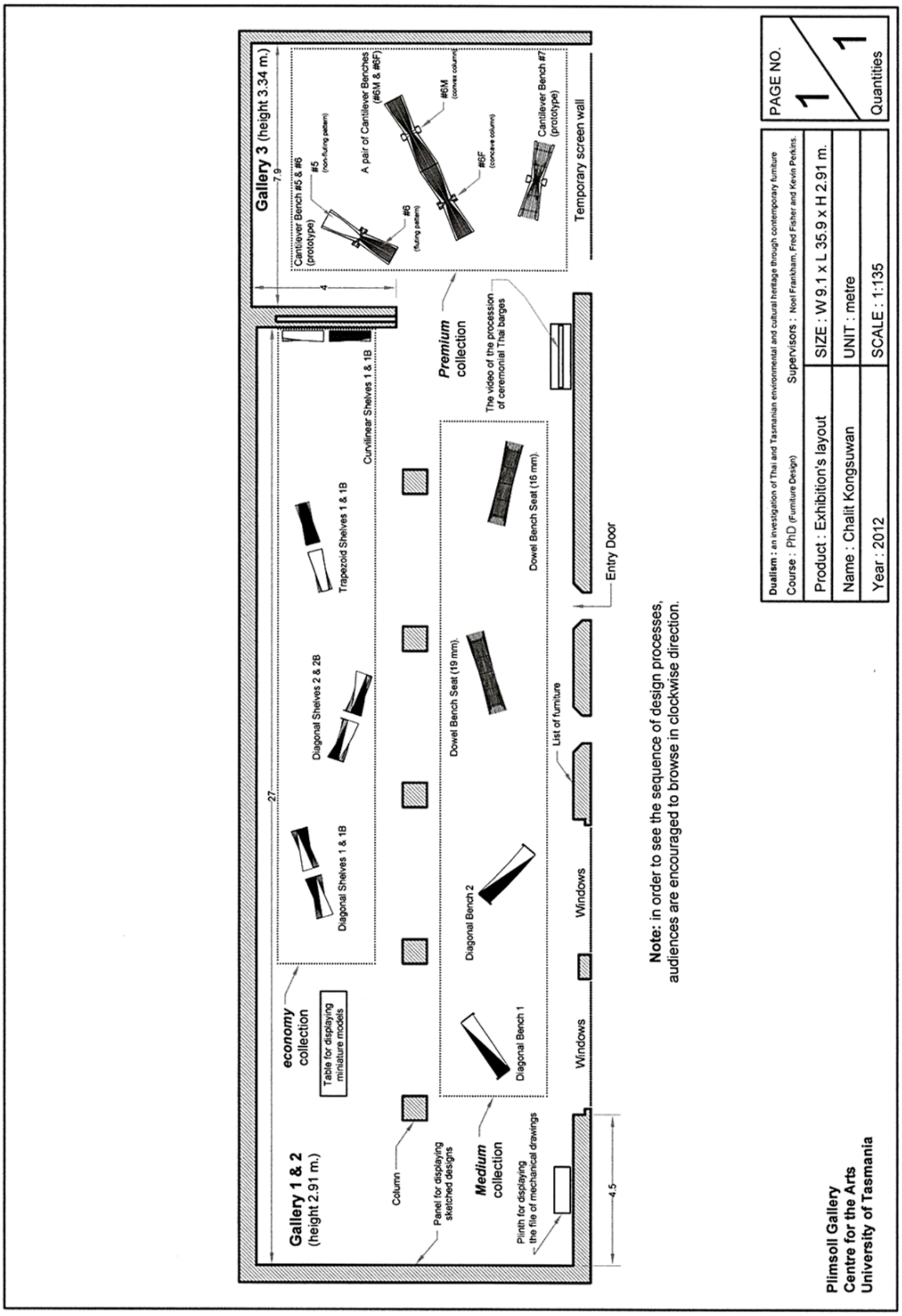
The results of the linear experiment demonstrated how a simple approach can incorporate the linear structure of vernacular Thai form with the play of illusory effects.

Utilising multiple lengths of Tasmanian Oak dowels as a major component of the Dowel Bench Seats, I was able to turn the utility of wooden dowels into the ventilative structure of multi-functional furniture. Moreover, bridging the gap between sustainable design and mass-produced furniture is achievable when combining commercially viable timber from Tasmanian re-growth forest with industrial application.

The reflection of a set of oblique lines was a fundamental step that guided me to new organisations of trapezoids in linear compositions. These include lineate superimposition, intersecting angles, moiré effect, translation and suspension. Moiré effect is the consequence of linear overlap and intersecting angles whereas translation and suspension are supplementary methods that made the expression of moiré more explicit.

Significantly, the illusory effects such as the sense of twist and counter-movement were generated by the interaction between multiple sets of overlapping lines, intersecting angles and the movement of the observer. The play of opposites, including reverse superimposition and translation, can prevent the symmetrical shape of trapezoids from becoming restricted in its uniformity. The rhythmic effects enliven the static spacing between each linear component and the different perspectives. Viewing the convergent and divergent end of linear members stimulated the observer to explore the optical illusions. As an additional conceptual benefit, the floating quality of Thai architectural components was represented through the overhanging feature of the linear seating surface.

The Fourth section of Chapter Three: exhibition



Mechanical drawing 18: exhibition’s layout (Kongsuwan 2012)

The final exhibition aimed to demonstrate how two polarised forces were synergised through the visual, functional and manufacturing qualities of furniture. The synergetic pairs were:

- Dark versus light colour;
- Symmetry versus asymmetry;
- Gentleness versus rigidness;
- Heaviness versus lightness;
- Simplicity versus complexity;
- Static versus movement;
- Positive versus negative space;
- Oriental versus Occidental utility;
- Thai tradition versus Tasmanian timber; and
- The contrived precision of mechanical execution versus the vitality of handwork.

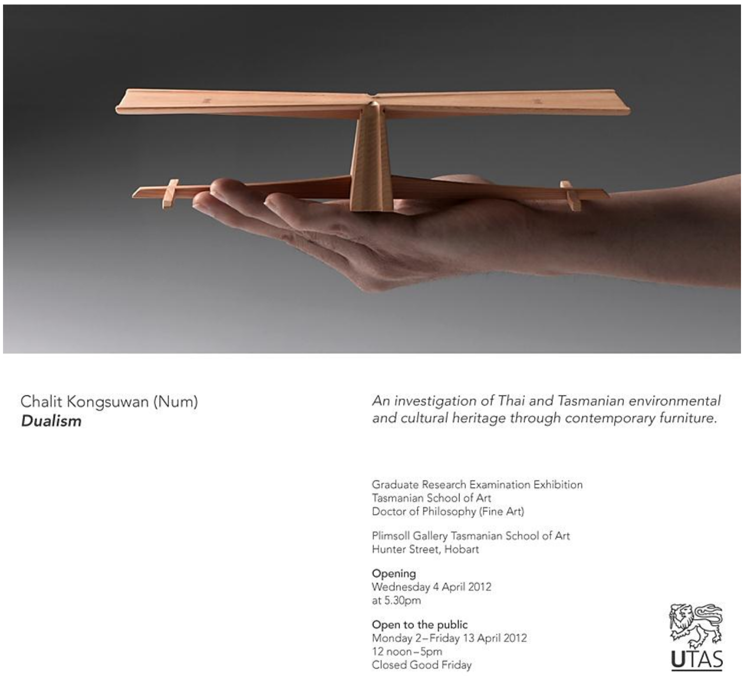


Fig. 83: The electronic invitation of the final exhibition (Whyte & Perkins 2012)

In total, there were **sixteen pieces** in the final exhibition. In order to let people trace the development of design, I exhibited a number of hand and digital drawings, miniature models, two full-scale prototypes and the video of source ideas. (Note: two prototypes were included within the sixteen exhibition pieces.)

In order for viewers to understand the sequence of design process, they were encouraged to browse in clockwise direction. In this case, people were suggested to see the display of sketched designs, mechanical drawings, miniature models and actual pieces respectively.

The sketched designs were made up of seven separate parts. These were grouped alphabetically (from A – G). The design development of each group can be traced from left to right.

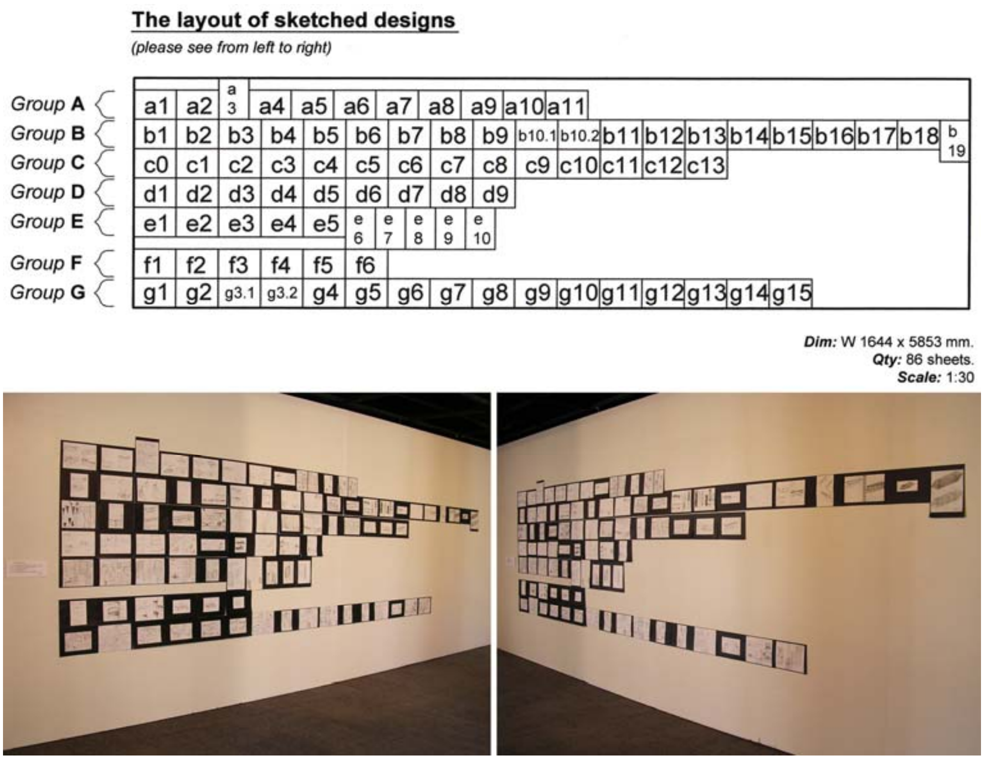


Fig. 84: The display of sketched designs (Kongsuwan 2012)

All mechanical drawings were orderly displayed in file. These were categorised in according to three design experiments; volumetric, planar and linear.

Miniature models were randomly displayed on an elevated platform, set to the average height of mature viewers.

Fig. 85: The display of miniature models (Kongsuwan 2012)

The video of source ideas represented the Royal Barge Procession that took place on the Chao Phraya River during the Sixtieth Anniversary Celebrations of HM the King Bhumibol Adulyadaj's Accession to the Throne 2006. The duration of this video is approximately 33 minutes. The objective of showing this video was to let audience witness where the floating qualities of traditional Thai barges meet the modern influence of cantilever design.

Fig. 86: From left to right; the video of the procession of the Ceremonial Thai Barges was displayed at the entrance of the gallery 3. (Whyte 2012); and the Royal Barge Procession with the background of the Royal Grand Palace, Bangkok, Thailand (Chutintaranond 2002, p.55)

In accordance with the column-and-beam structure of the Plimsoll Gallery, I rejected the use of partitions. The absence of partitions echoes the domestic ambience under the elevated structure of wooden Thai house, which is supported by post-and-beam structures.

Fig. 87: The structural connection between the column-and-beam structure of wooden Thai house and the Plimsoll Gallery (Kongsuwan 2010 & 2012)

I also rejected the use of plinths in order to maintain a domestic ambience. Personally, I think that displaying furniture on a plinth is likely to reduce the audience’s ability to visualise how the actual proportion of furniture and the reality of living space are interrelated. I also let natural light shine through the area where a pair of Diagonal Benches was displayed so the audience can see the natural colour of the wood under realistic conditions of daylight.

To minimise visual obstruction and to maximise their spatial element, I let the tall objects (a series of shelving units) stand behind low objects (a series of benches). Similarly, the solid structure of the Cantilever Benches #5 and #6 was located behind the ventilative structure of the Cantilever Benches #7.

Viewing toward the gallery 3, audiences can see a linear connection between the Dowel Bench Seats and the prototype of the Cantilever Bench #7 whereas looking toward the gallery 1 and 2 viewers can appreciate a planar connection between each pair of shelving units.

Fig. 88: The ambience of the exhibition (viewed toward Gallery 3) (Whyte 2012)

To let people sense the kinetic and illusory qualities of my furniture, most objects were positioned away from the wall, however, the Curvilinear Shelves 1 & 1B (with flat back) were close to the wall due to the shelves' traditional usage.

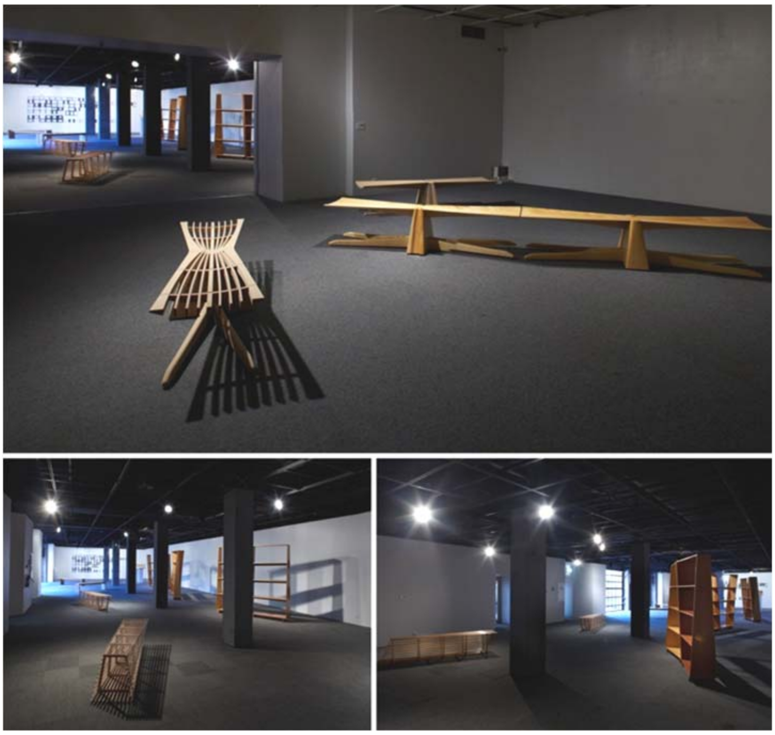


Fig. 89: The ambience of the exhibition (viewed toward Gallery 1 & 2) (Whyte 2012)

With the exhibition layout I sought to reinforce my choices of materials, technological application and hands-on execution. The series of Cantilever Benches was exclusively displayed in Gallery 3 to show the preciousness of Huon pine, the finesse of digital technology (seen in the preciseness of fluting pattern) and the delicacy of hand-oiled finish. Due to being made of readily viable Tasmanian timbers and pre-machined wooden products, the Diagonal and Dowel Bench Seats and a series of shelving storages were clustered in Gallery 1 and 2. The fabrication of these items relied on the use of traditional hand-tools and modern machinery.

The materials and making processes also suggested potential pricing of the finished items. Throughout the project I have considered issues of sustainability, durability, transportability and affordability. Collectively, the three sets of objects comprising the final exhibition represented three variations on pricing scales due to these factors.

The Cantilever Benches (two pieces) used a rare species (solid Huon pine) and have been made with a greater handwork than other pieces. **The Dowel and Diagonal Bench Seats** (four pieces) suggested a 'middle ranking' in terms of potential cost being substantially handmade, but using more readily available timber. **The shelving units** (eight pieces) utilised prefabricated materials, were mostly machine made, and can be self-assembled following flat pack transportation, making them likely to be the least expensive the produce.

Conclusion

The four groups of design works in my project were Cantilever Benches, Diagonal Benches, Shelving Units and Dowel Bench Seats. The trapezoid of traditional Thai walls, cabinets and revealed joinery became a thematic device for integrating vernacular Thai design with Modernism. According to my design strategy, I combined geometric abstraction, re-composition and the play of opposites as a means of seeking new decorative patterns and functional forms of the trapezoid in planar, linear and volumetric modes.

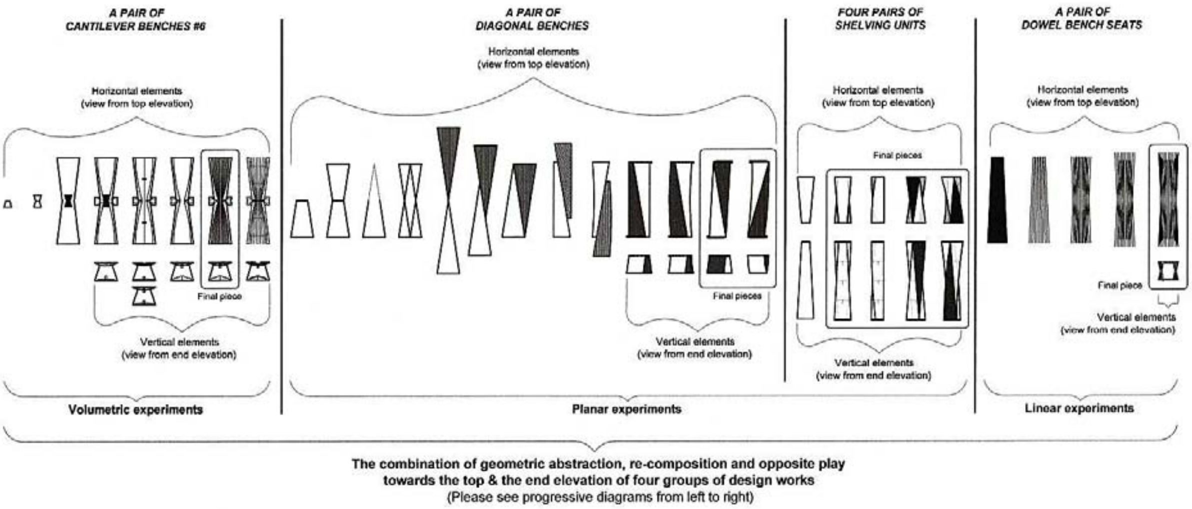


Diagram 8: The four groups of design works were separated by three modes of experimentation including volume, plane and line. (Kongsuwan 2011)

Reflection, juxtaposition, superimposition, fraction, translation and manipulation were methods I used to abstract and re-compose the geometric elements of my design works. Within the four bodies of works, a play of opposites can be seen in opposite angle, colour, contour, composition, direction, function, installation, massing, profile, scale, slant and texture.

The combination of geometric abstraction, re-composition and play of opposites led me to find simple ways to incorporate the visual qualities of Thai architectural components (including its floating feature, contrasting colours, dynamic expression and overlapping elements) with hybrid utility, spiritual metaphor and sustainability. Thus, I will summarise the design outcomes of this project in **visual, multi-functional, spiritual** and **sustainable** aspects.

Visual aspects

The visual outcomes of the design were intended to be stimulating in scale, balance, visual lightness, kinetic effect and illusion.

A pair of Cantilever Benches (#6M & #6F) increases the scale of the butterfly key motif to form the outline of the object. The juxtaposition of the same motif in different scales received positive reactions from observers. The large motif of the dovetail pin and the butterfly key is obvious in the overlapping planes of the Diagonal Benches and Shelving Units.

All Diagonal Shelves achieve variations in scale: as the eye of the observer sweeps up and down, the size of reversible patterns in contrasting colours appear to increase or decrease in progression from each plane to the next. The Dowel Bench Seats successfully reinvented the Thai moiré effect on a large scale.

All pieces utilised mirror images to produce balance through reverse superimposition in symmetrical compositions. A pair of Cantilever Benches achieved unity while retaining the duality of butterfly key motif, with two wings united by a trapezoidal column. Both Diagonal Bench 2 and Diagonal Shelves 2 & 2B successfully achieved balance in non-symmetrical composition.

All pieces manifested a sense of visual lightness through their cantilevered structures or overhanging corners, recalling the floating quality of Thai architecture and enhancing the objects' spatial value. A series of Cantilever Benches illustrated a means of letting the condition of light and shadow vary on fluted texture or hollowing surface manipulate the visual width and weight of a trapezoidal plane.

All pieces are evocative to encourage the eye to explore kinetic qualities such as fan-like motion, vertical twist, lateral movement or counter-movement. The fluting pattern of Cantilever Benches (#6M & #6F) and the linear structure of Cantilever Bench #7 recall the intense flow of stream demonstrating fluidity. The curving lines of Diagonal Shelves 2 and 2B echo the gracious movement of the fingers of a classical Thai dancer. Dowel Bench Seats generate changing visual effects in overlapping lines and frames.

All shelving units encouraged spectators to investigate visual ambiguities such as stability versus instability or curve versus straight. Diagonal Bench 2 suggested an illusory effect through its curvilinear contour. The Dowel Bench Seats brought the illusion of distance and space.

Multi-functional aspects

I believe I successfully merged the unconstrained utility of Oriental floor seating and the rigid standard of Western ergonomics into multi-functional furniture.

A pair of Cantilever Benches provided extra length, sufficient height as well as various seat depths for comfort in various positions to suit users from various cultures. Diagonal Benches allow users to recline, sleep or sit with legs hanging or folded, or lean against the bench. A series of shelving units accommodated Western and Eastern styles of storing books. Curvilinear Shelves 1 & 1B can be affiliated to the wall while the other Shelves can be used as room dividers in-fitting both traditional and modern modes of installation. Dowel Bench Seats provided sufficient lengths, height and seat depths to suit the customs of Westerners or Thais.

Spiritual aspects

The spiritual aspects of objects were intended to be evocative in nostalgic a sense and according to Buddhist dualism. All pieces were constructed by vertical and horizontal members in reference to the post-and-beam structure of vernacular Thai houses. The mirroring of forms was reminiscent of the reflective image of wooden boat (as seen in the Cantilever Benches #6M & #6F), evoking memories and emotions that associated with a river-based culture and traditional craftsmanship both in Thailand and Tasmania. In addition, Huon pine elicits a very specific sense of place with its local Tasmanian and historical qualities.

Throughout the project, I juxtaposed opposing elements as a means of infusing the dual aspects of Buddhism. These complementary opposites embodied the Buddhist philosophy towards the duality of nature, synthesised with the spatial value of cantilevered structure. The harmony and synergy of each individual piece emerged from their polarised character and dualistic display. However, this juxtaposition was not the only factor with a power to elicit the sense of synergy. In fact, there were intrinsic forces that hint at a synergetic power through the processes of designing, executing and finishing. For instance, the painstaking process of sanding and oiling resulted in a highly resolved surface quality and tactile satisfaction. Complex experimentation and reflection processes led to simpler design solutions and greater clarity of intention. This simplicity concealed both the complexity of programming computer numerical control (CNC) and the effort of handcraftsmanship such as veneering, shaving and carving. Consequently, the interrelation between modern technology and traditional handwork can be implied as complementary opposites.

Sustainability

Cantilever and Diagonal Benches were made of native Tasmanian timbers, which made the products more durable due to being suitable for use in their geographic and climatic locations. The furniture also possessed qualities of renewability, biodegradability, non-toxicity as well as non-carbon emission.

All shelving units were made of thin veneer and lightweight plywood and joined by industrial fittings. Consequently, they can be dismantled and packed flat taking up less room and weight in a container which resulting in best utilising non-renewable energies in freight.

Dowel Bench Seats were made of Tasmanian Oak dowels and plywood. Utilising pre-machined wooden products from re-growth forest in Tasmania made design output more viable and affordable.

All pieces were finished by hand-rubbed oil. Natural oil causes less deterioration and is a way of maintaining a positive correlation between consumption, production and the environment.

In conclusion, the final outcomes of this project successfully illustrated an alternative way of assimilating the attributes of traditional Thai designs with the simple aesthetics of Modernism while embracing them with natural, cross-cultural and spiritual references. I believe the paradigm of this PhD project makes a contribution to those designers and makers who are seeking to find ways of reinvigorating Modernism with the regard of vernacular content.

Appendix 1: the detail of fabricating a pair of Cantilever Benches (#6M & #6F)

Because each module comprises three main components, the process of executing Cantilever Benches #6 was made up of three separate sections: the X-shaped foot base; the butterfly-shaped platform; and the trapezoidal column.

X-shaped foot base

The processes of making the foot base consisted of sixteen major steps.

1. **Selected** long rectangular slabs that suit the dimension of final design;
2. **Hand and machine planed** the top and bottom surfaces of selected boards roughly to check grain direction, colour and natural defect;
3. **Trimmed and planed** one natural edge to create a square reference;
4. **Started slicing** Huon pine slab using band saw;
5. **Made a fine trim** to a specified length and width;
6. **Sanded** one surface of each slice by Thickness Sander;
7. **Sanded** another surface: This process required a special mould. This mould has a very gentle curve. The deepest curve locates at the mid length and gradually gets shallower to both ends. I glued sand paper (150 grit) on curved surface. The roughness of sand paper held each slice of Huon pine in place while being fed through the Thickness Sander. The objective of using this additional mould is to let each slice have a variation of thickness which enhancing its aesthetic value;
8. **Started the process of lamination**: One foot base comprises two identical parts. Each laminated component was made up of nine layers of Huon pine slice. Each slice was glued (Polyvinyl acetates glue called ‘PVA’), bent and then clamped with prepared mould;

9. **Trimmed** one edge of laminated component to create a square reference. This process was done by table saw;
10. **Marked** specified contour in according to prepared template. This template was made of 3 mm. MDF and cut by computer numerical control (CNC);
11. **Cut** laminated component according to the mark. This was executed by small band saw;
12. **Sanded** the mark of band saw by machine and hand respectively;
13. **Created rounded profile** by hand router;
14. **Pre-drilled** holes for installing five adjustable feet;
15. **Polished** wooden surface. This process was divided in three separate parts;

- Sanding was done progressively from 100 grit to 400 grit sand papers;
- The process of pre-oiling consisted of four coats of Rustin's Danish oil. Each coat needed to be dried at least overnight before applying more coats. To avoid leaving finger marks while oiling, I made two specific jigs to hold the foot base's component. In order to achieve a satin finish, I used steel wool (No. 000) to wipe off the third coat before applying the final coat. I preferred a hand-rubbed oiled to a sprayed lacquer because it does not completely film pores of wooden surfaces. Moreover, oil mix finishes can be easily repaired, revived and maintained to;
- Pre-waxing.

16. **Glued** two identical components by using epoxy adhesive. I put a thin sheet of solid Huon pine (5.5 mm.) in between two main parts to get rid of an acute angle of negative space. This additional sheet potentially reduced the risk of breaking an acute element of trapezoidal column. During the process of gluing, three components were aligned by two hidden dowels.

Butterfly-shaped platform

The processes of executing a butterfly-shaped platform of Cantilever Benches #6 consisted of twenty major steps.

1. **Selected** proper boards that suit the dimension of final design. Fortunately, there was one length of Huon pine's slab that fits two lengths of seating platform. Consequently, when two modules were lined up, people can appreciate the continuity of natural grain and colour;
2. **Hand planed** the top and bottom surfaces of selected boards roughly to check grain direction, colour and natural defect.
3. **Trimmed** both ends of a selected slab slightly to see the feature of end grain;
4. **Halved** the single length of Huon pine's slab;
5. **Trimmed** natural edges of two slabs to create a square reference;
6. **Flattened** the top and bottom surfaces of each slab by using computer numerical control (CNC). Due to a cupped surface, I started flattening a convex surface first. Once one side got a flat reference, I turned the board upside down to flatten a concave surface.
7. **Routed** fluting pattern;
8. **Routed** sloping surface;
9. **Marked** the centre line at both ends of each board to maintain the alignment between the top and bottom surfaces;
10. **Turned** the board upside down;
11. **Started routing** convex profile;
12. **Rebated** at the centre of each board;
13. **Cut** each board to butterfly-shaped contour. During a final cut, there was a longitudinal crack along a butterfly-shaped outline. This accident was caused by a

diagonal path of router bit that cut against a long grain of wood. To avoid breaking another board, I did not let a router bit cut through the thickness of wood. As a result, I had to make a final cut by using a Japanese handsaw. Again, I found that making a diagonal cut manually also causes a longitudinal crack. This painful experience let me understand that working with organic material like Huon pine is not always controllable;

Fig. 1: From left to right; the processes of fluting and sloping the top surface of seating platform (Kongsuwan 2011)

Fig. 2: From left to right; the processes of routing the bottom surface of seating platform (Kongsuwan 2011)

Fig. 3: From left to right; a longitudinal crack caused by letting the router bit run diagonally against a long grain of wood (Kongsuwan 2011)

14. **Got rid of** the marks of router bit underneath a butterfly-shaped platform by using traditional hand-tools including chisel and spoke shave;

Fig. 4: Shaving the convex profile underneath a butterfly-shaped platform (Kongsuwan 2012)

15. **Smoothed** convex surface by sanding;
16. **Glued** a single beam with seating platform by epoxy adhesive. This beam was made of solid Huon pine and cut by CNC. The beam was sanded before being glued. The reason of gluing these two components in an early stage is to prevent the warp of solid timber;
17. **Trimmed** both ends of butterfly-shaped platform equally;
18. **Hand shaved** the edge of butterfly-shaped platform;
19. **Hand planed** the top surface of butterfly-shaped platform; and
20. **Polished** wooden surface. This final stage was divided in three separate parts;

- Sanding was done progressively from 80 grit to 400 grit sand papers;
- The process of oiling consisted of five coats of Rustin's Danish oil. Each coat needed to be dried at least overnight before applying more coats. Before applying the fifth coat, I used steel wool (No. 000) to wipe off the fourth coat for creating a satin finish.
- Waxing.

Trapezoidal column

Due to having an extra thickness (200 mm.), each column was made of three laminations of solid Huon pine. The processes of execution comprised twelve major steps.

1. **Selected** six proper boards that suited specified dimension;
2. **Hand and machine planed** the top and bottom surfaces of selected boards roughly to check grain direction, colour and natural defect;
3. **Trimmed** natural edges of each wooden board to create a square reference;
4. **Flattened** the top and bottom surfaces of each board by Thickness Sander;
5. **Cut** each board in specified shape by CNC;
6. **Tapered** the left and the right boards by Thickness Sander. This process required oblique jig to securely hold wooden board before being fed through machine. (Note: the middle board do not need to be tapered);
7. **Glued** three layers of solid Huon pine by PVA adhesive. Three composite boards were aligned by three hidden dowels before being clamped. It took overnight to let the glue dry completely;
8. **Pre-drilled** holes for installing five adjustable feet;
9. **Executed joined components**: The specifications of joints were adjusted in according to the actual dimension of X-shaped foot base and butterfly-shaped platform;
10. **Created concave and convex profiles** by hand-carving;
11. **Polished** wooden surface: This process was divided in three separate parts;

- Sanding was done progressively from 80 grit to 400 grit sand papers;

- The process of pre-oiling consists of four coats of Rustin’s Danish oil. To achieve a satin finish, I used steel wool (No. 000) to wipe off the third coat before applying the final coat;
- Pre-waxing.

12. **Started gluing** trapezoidal column with seating platform and foot base respectively by using epoxy glue.

Appendix 2: the detail of fabricating a pair of Diagonal Benches

The processes of making the Diagonal Benches consisted of thirteen major steps.

1. **Dressed** timber surface;
2. **Matched** colour and grain direction of wooden composite board. In order to represent two options of linear effect, I let the grain direction of wood run differently. For the horizontal board of the Diagonal Bench 1, the grain direction of wood runs parallel a diagonal glued line whereas the wooden grain of the Diagonal Bench 2's platform runs across a diagonal line;

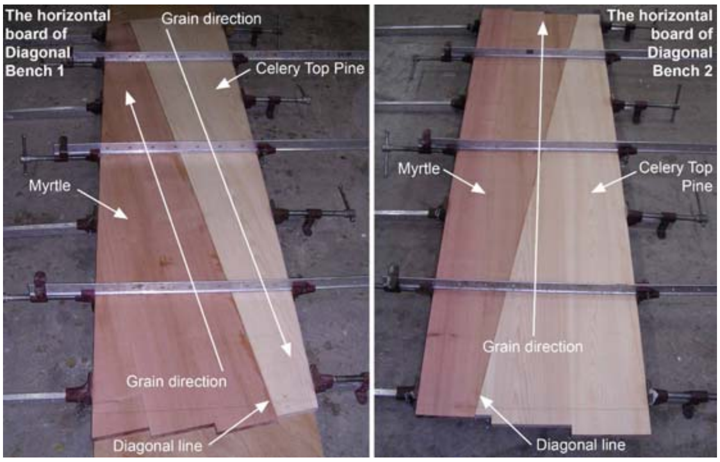


Fig. 5: From left to right; the horizontal board of Diagonal Bench 1 shows the linear parallel between wooden grain and diagonal glued line whereas Diagonal Bench 2 illustrates the linear opposition. (Kongsuwan 2009)

3. **Equalised** the thickness of each plank by thickness sander;
4. **Planed** the edge of each plank: In order to prevent the wood's expansion after gluing composited boards, I had to create a shallow hollow along both longitudinal edges by hand plane;
5. **Marked and cut** crescent shaped slots for biscuit joint;
6. **Placed** an oval-shaped of biscuit in pre-cut crescent mouths;

7. After **applying glue** on the joined edges of wooden composite board, they were **clamped** together and left for overnight. Then, I let the glued board stay separately in the same climatic condition for a year in order to observe the reaction of shrinkage and expansion between Myrtle and Celery top pine. The result was successful as there was no gap between glued lines;
8. **Made a rough cut** by electrical hand saw;
9. **Made a fine cut** by running a hand-router counter-clockwise along the contour of templates;
10. **Subdued** the stiffness of vertical boards. By looking at the front elevation of scaled models, the right angle of the bench's legs appeared very stiff. Then, I made full scale mock-ups to search for ways to mitigate its stiff appearance. In doing so I increased the thickness of vertical panels for creating two optional tapers (oblique and concave). Despite this, the figure of both options appears thicker at foot base and gets slimmer upwardly; the visual outcome of concave slope looks more subtle. Although the oblique taper is not as subtle as the concave one, it makes manufacturing process a lot easier and more economical. As a result, I chose the oblique taper for a final fabrication.

Fig. 6: The processes of subduing the stiff appearance of bench's legs (Kongsuwan 2009)

11. **Pre-sanded and oiled** the underneath surface of seating platforms and the inner panel of vertical legs in order to avoid the difficulty of sanding and oiling after fixing a longitudinal beam;
12. **Joined and glued** horizontal and vertical elements together by the combination of mitre and biscuit joints. The whole structure was consolidated by a longitudinal beam that runs beneath the sitting platform. This single beam was firmly fixed with horizontal and vertical boards by the use of glue, screws and wooden dowels;

Fig. 7: The processes of joining and gluing horizontal and vertical boards (Kongsuwan 2010)

13. **Polished** the top surface of the seating platforms and the outer panel of vertical legs. This final stage was divided in three separate parts:

- Sanding was done progressively from 100 grit to 400 grit sand papers;
- The process of oiling consisted of four coats of Rustin's Danish oil. Each coat needed to be dried at least overnight before applying more coats. The final coat was applied after I had used steel wool (No. 000) to wipe off the third coat.
- Waxing.

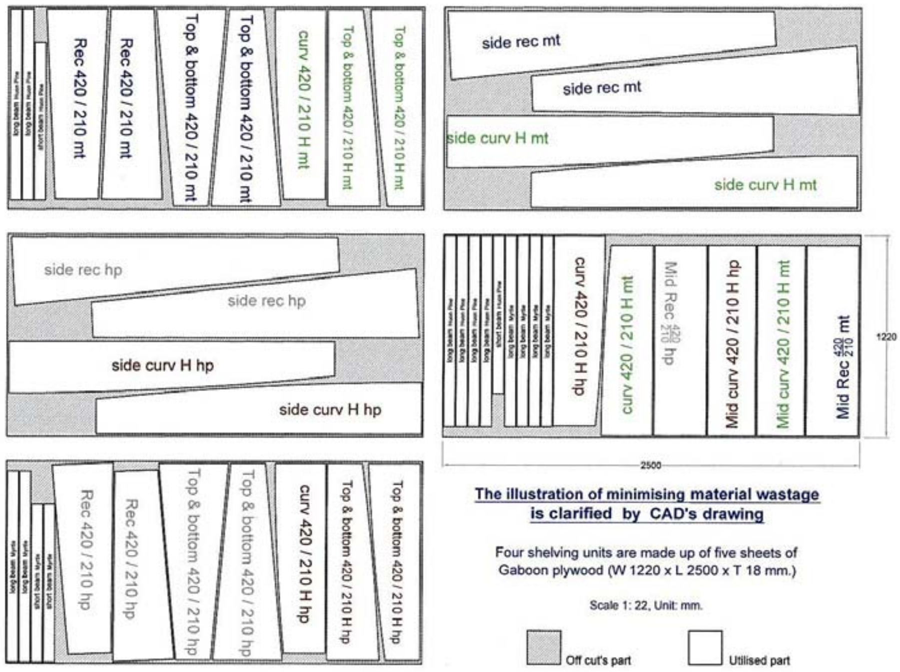
Appendix 3: the detail of fabricating Trapezoidal and Curvilinear Shelves

The processes of making Trapezoidal and Curvilinear Shelves consisted of five major steps.

- **Minimising** the wastage of plywood;
- **Specifying** the position, diameter and depth of drilling holes in accordance with the specification of industrial fittings;
- **Pre-cutting** Gaboon plywood;
- **The process of veneering**; and
- **The finishing processes**.

Minimising the off-cut of plywood

The process was started by breaking all components of shelving units apart. In this case, each module is made up of seven separated boards, four beams and two foot bases. The seven boards comprise three pairs of identical boards and a single rectangular board. Due to being made of the same components repeatedly, it offered economy in production. Making four shelving units consumes five sheets (W 1220 x L 2500 x T 18 mm.) of Gaboon plywood. (See mechanical drawing 19)



Mechanical drawing 19: The illustration of minimising material wastage (Kongsuwan 2009)

The process of clarifying drilling system

Due to the intention of saving production and logistic costs, every component of shelving unit was designed to be jointed and dismantled by using one type of industrial fitting. This type of fitting consists of two major parts. In order to connect vertical and horizontal boards securely, the specifications (position, diameter and depth) of drilling's system must coincide with the size of connector housing and connecting bolt.

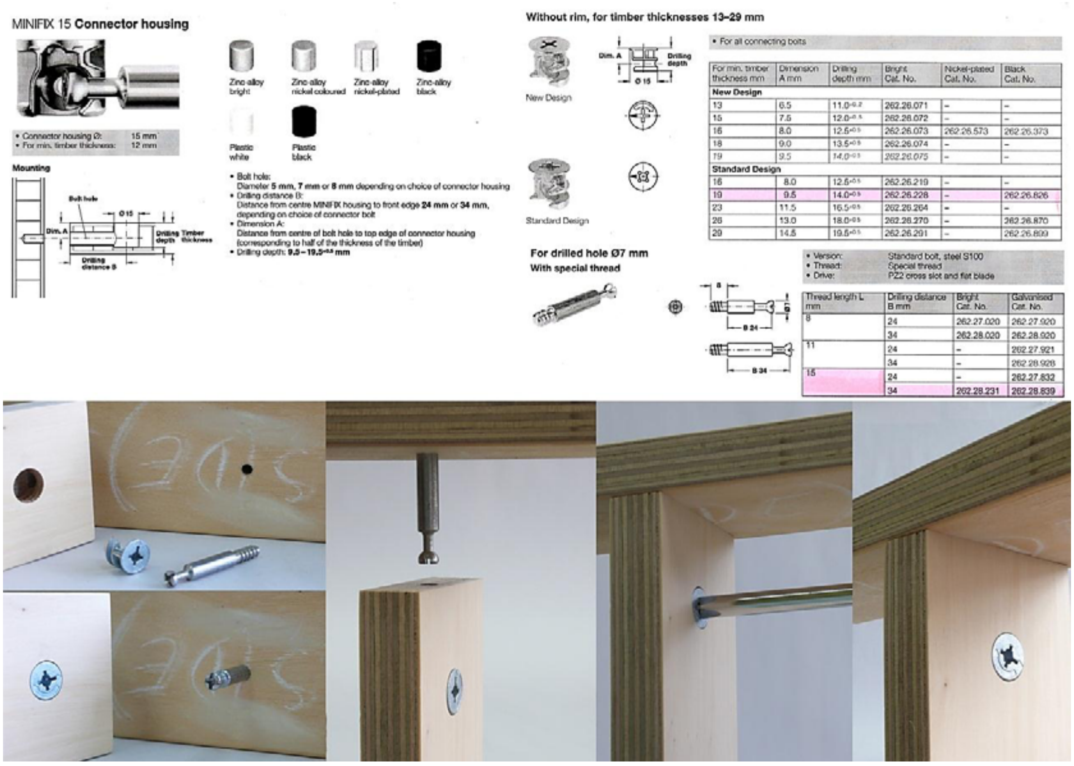


Fig. 8: From top to bottom; the specification of Trapezoidal & Curvilinear Shelves' fittings (www.hafele.com); and the sequence of stages in joining two components of industrial fittings (Kongsuwan 2009)

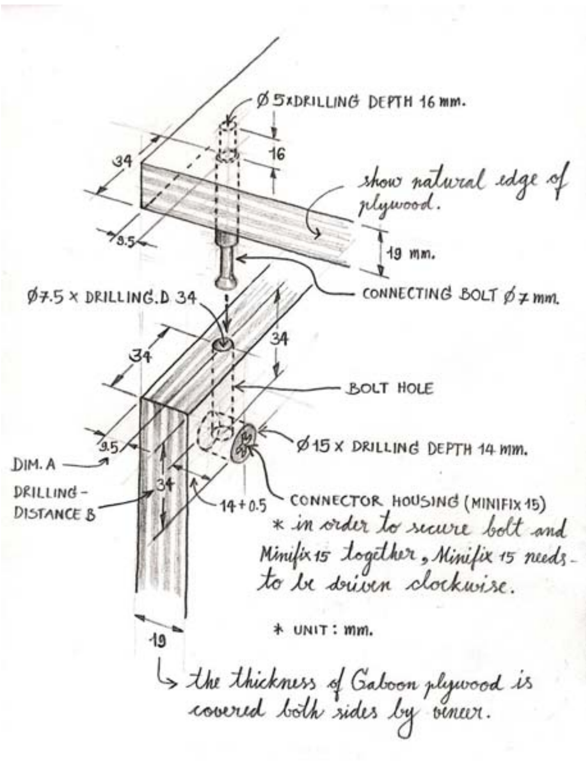
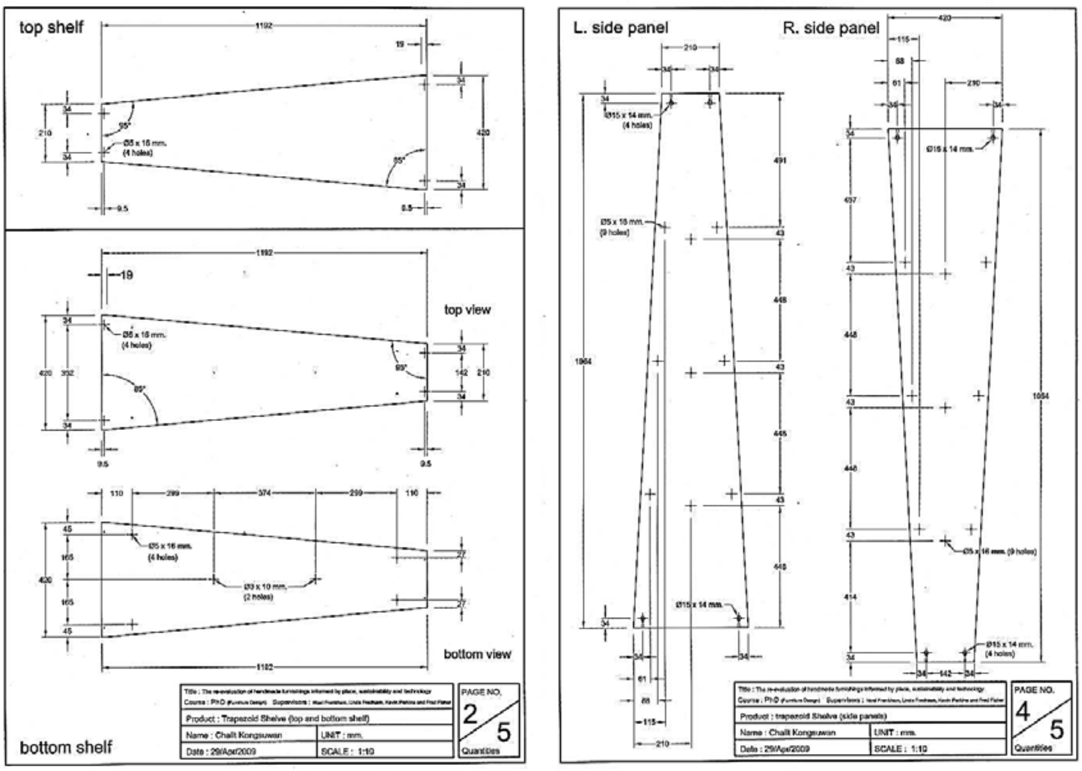


Fig. 9: The three-dimensional detail of drilling specification (Kongsuwan 2009)

After selecting the type of fitting, I began making mechanical drawings in order to clarify the system of drilling hole in response to the specification of fitting and the thickness of material. In this case, I selected 18 mm thick Gaboon plywood. With this medium thickness, it is likely for horizontal boards to be bent by a heavy load. In order to reinforce the structure of each shelf, all horizontal boards (except the top board) were supported underneath by a single beam. Each beam was fixed by couple screws. The addition of beams is not solely beneficial for structural reinforcement. In fact, they also facilitate the process of assembly.



Mechanical drawings 20 & 21: The drilling detail for the shelves' components
From left to right; the top, bottom and vertical boards of Trapezoidal Shelve (Kongsuwan 2009)

Pre-cutting plywood

After clarifying the drilling system, I transferred CAD drawings to CNC (computer numerical control) for cutting the templates of all shelving components. These templates were used for drawing the outline of each shelving panel on plywood. Each panel was cut roughly by electrical handsaw. This rough cut needed to be far (about 10 mm.) from the marked outline.

Although Gaboon plywood was prefabricated, I had to flatten the lumpy surface by using a thickness sander before the process of veneering. Consequently, the original thickness of material was decreased by 0.2 - 0.3 mm. However, both surfaces of plywood were covered by veneer. There were two types of veneer; Huon pine (1 mm. thick) and Rain Drop Myrtle (0.6 mm. thick). Therefore, the actual thickness of material after gluing veneer became thicker and varied.

Fig. 10: While 9 mm of MDF was cutting by CNC in order to produce the shelves' template. (Kongsuwan 2009)

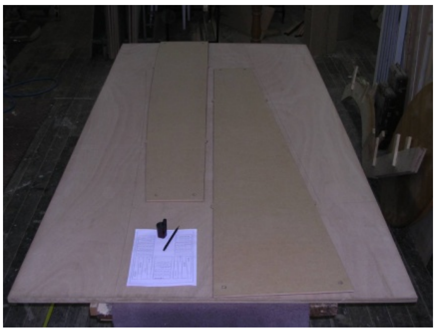


Fig. 11: Each template was used during the process of marking the outline of each component on plywood. (Kongsuwan 2009)

The process of veneering

The objectives of utilising veneer were:

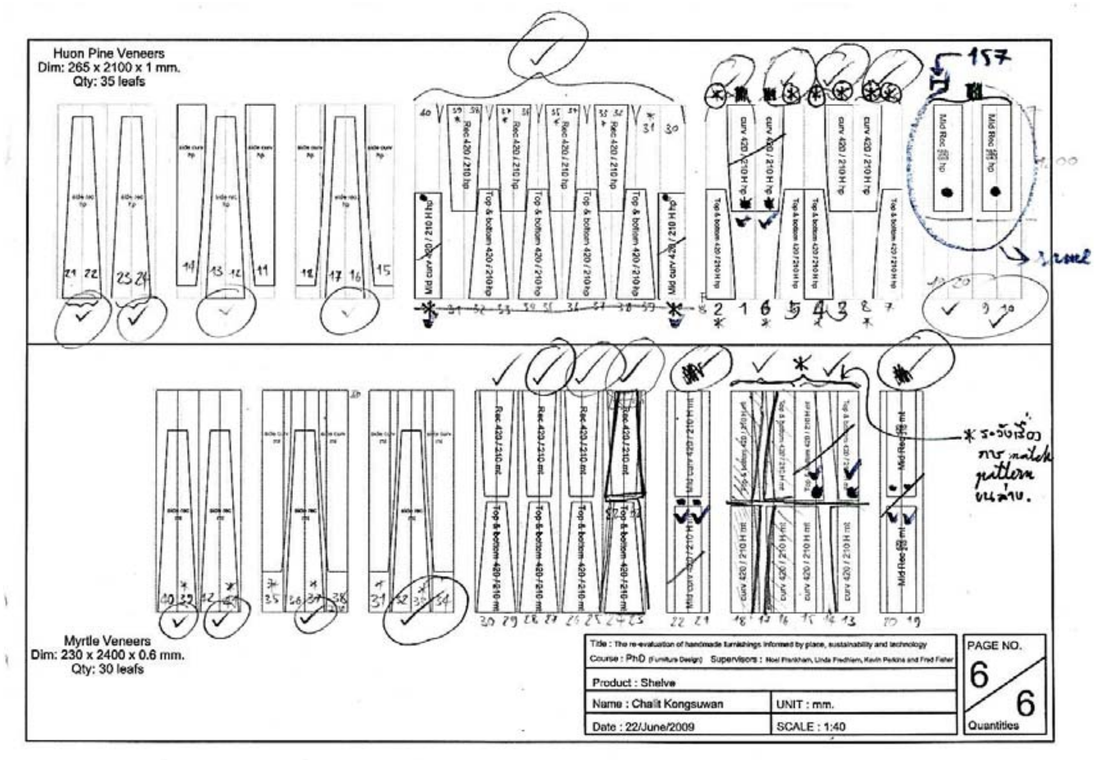
- To accommodate the minimal use of solid timber with modern lightweight material; and
- To give these shelves a sense of indigenous materials and craftsmanship.

I chose Rain Drop Myrtle veneer because its literal effect can be clearly manifested through vertical elements of shelving storage. In order for a pair of identical shelves to represent a subtle contrast, the reddish tone of Rain Drop Myrtle was matched with the yellow tone of Huon pine veneer.

Fig. 12: The juxtaposition of Huon pine and Rain Drop Myrtle (Kongsuwan 2009)

The process of veneering consisted of seven main steps

1. **Marginalised** the off-cut area of veneer. First of all, I needed to know the actual size of veneer leaves before calculating utilised and off-cut areas. In actuality, there were 35 leaves of Huon pine and 30 leaves of Myrtle veneers (See mechanical drawing 22);



Mechanical drawing 22: The illustration of both utilised and under-utilised area of veneer (Kongsuwan 2009)

2. **Numbered** each leaf of veneer for sequential match;
3. **Planed** both edges of veneer leaves. In this case, ten leaves of sequential veneer were grouped in a separate set before being clamped and hand-planned;
4. **Book-matched** two leaves of sequential veneers by letting two adjoining surfaces mirror each other in pattern;

Fig. 13: The feature of book-matched veneer (Kongsuwan 2009)

Fig. 14: The feature of sequential or slip matched veneer (Kongsuwan 2009)

Fig. 15: The processes of book-matching and patching veneer (Kongsuwan 2009)

5. **Patched** each leaf together;
6. **Cut** patched veneer in shape; and
7. **Glued** pre-cut veneers on both surfaces of pre-cut plywood. The pattern of veneer on the top surfaces also mirrored the bottom.

Fig. 16: Gluing pre-cut veneer with pre-cut plywood (Kongsuwan 2009)

The finishing processes can be divided in four major stages:

1. **Made** a final trim using a hand router. In this case, each template was clamped and screwed with a pre-veneered board before being trimmed. The centre of all holes needed to be marked in accordance with the reference of each template;
2. **Drilled** holes at the edge and planar surface of all shelving boards for housing fittings;
3. **Punched** inscriptions on every component for the convenience of grouping and reassembly; and

Fig. 17: Inscriptions were made by punching before the process of sanding, oiling and waxing. (Kongsuwan 2009)

4. **Polished** wooden surface

This final stage was divided in three separate parts including sanding, oiling and waxing.

- Due to the thinness of veneer leaf (about 0.6 – 1 mm.), sanding was done progressively from 150 grit to 400 grit sand papers;
- The process of oiling consisted of three coats of Rustin’s Danish oil. Each coat needed to be dried at least overnight before applying more coats; and
- Waxing.

Appendix 4: the detail of the joint, fitting and veneer's arrangement of Diagonal Shelves

Drilling system

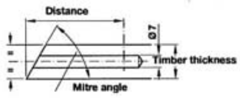
In order to let the dualistic pattern of the veneer to connect seamlessly with the inner and outer surfaces, two vertical boards as well as top and bottom panels were mitred. In this case, I selected a specific type of industrial fittings for mitre joint. This type of fitting consists of three main parts; two connector housings and one mitre-joint connector. These can be assembled and disassembled using a Phillips screw driver. For the best performance, the drilling system must coincide with the size of connector housing and connecting bolt. (Note: All other horizontal boards, beams and foot bases were connected by the same type of fittings that were used for the Trapezoidal and Curvilinear Shelves).

MINIFIX GV **Mitre-joint connector**
With bolt head Ø6.8 mm

- Material: Steel

Steel
galvanised

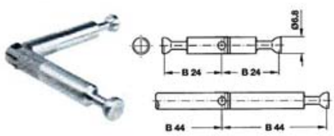
Note
The distances in the table apply to mitre-joint connectors with drilling distance of **B 44**
For drilling distance **B 24, 20 mm** must be deducted from the specified dimensions.



Inset distance table

Mitre cut	Timber thickness mm												
	12	13	15	16	17	18	19	20	21	22	23	29	32
20°	60.5	61.9	64.6	66.0	67.4	68.7	70.1	71.5	72.8	74.2	75.6	83.9	88.0
22.5°	58.5	59.7	62.1	63.3	64.5	65.7	66.9	68.1	69.3	70.6	71.8	79.0	82.6
25°	56.9	57.9	60.1	61.2	62.2	63.3	64.4	65.4	66.5	67.6	68.7	75.1	78.3
30°	54.4	55.3	57.0	57.9	58.7	59.6	60.5	61.3	62.2	63.1	63.9	69.1	71.7
35°	52.6	53.5	54.7	55.4	56.1	56.9	57.6	58.3	59.0	59.7	60.4	64.7	66.9
40°	51.2	51.7	52.9	53.5	54.1	54.7	55.3	55.9	56.5	57.1	57.7	61.3	63.1
45°	50.0	50.5	51.5	52.0	52.5	53.0	53.5	54.0	54.5	55.0	55.5	58.5	60.0
50°	49.0	49.5	50.3	50.7	51.1	51.6	52.0	52.4	52.8	53.2	53.6	56.2	57.4
55°	48.2	48.6	49.3	49.6	50.0	50.3	50.7	51.0	51.4	51.7	52.1	54.2	55.2
60°	47.5	47.8	48.3	48.6	48.9	49.2	49.5	49.8	50.1	50.4	50.6	52.4	53.2
65°	46.8	47.0	47.5	47.7	48.0	48.2	48.4	48.7	48.9	49.1	49.4	50.8	51.5
67.5°	46.5	46.7	47.1	47.3	47.5	47.7	47.9	48.1	48.3	48.6	48.8	50.0	50.6
70°	46.2	46.4	46.7	46.9	47.1	47.3	47.5	47.6	47.8	48.0	48.2	49.3	49.8
75°	45.6	45.7	46.0	46.1	46.2	46.4	46.5	46.7	46.8	46.9	47.1	47.9	48.3
80°	45.0	45.1	45.3	45.4	45.5	45.6	45.7	45.8	45.9	45.9	46.0	46.6	46.8
85°	44.5	44.6	44.7	44.7	44.7	44.8	44.8	44.9	44.9	45.0	45.0	45.3	45.4
90°	44.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0
	Inset distances **for drilling distance B 44 mm** in mm												

For double-sided installation



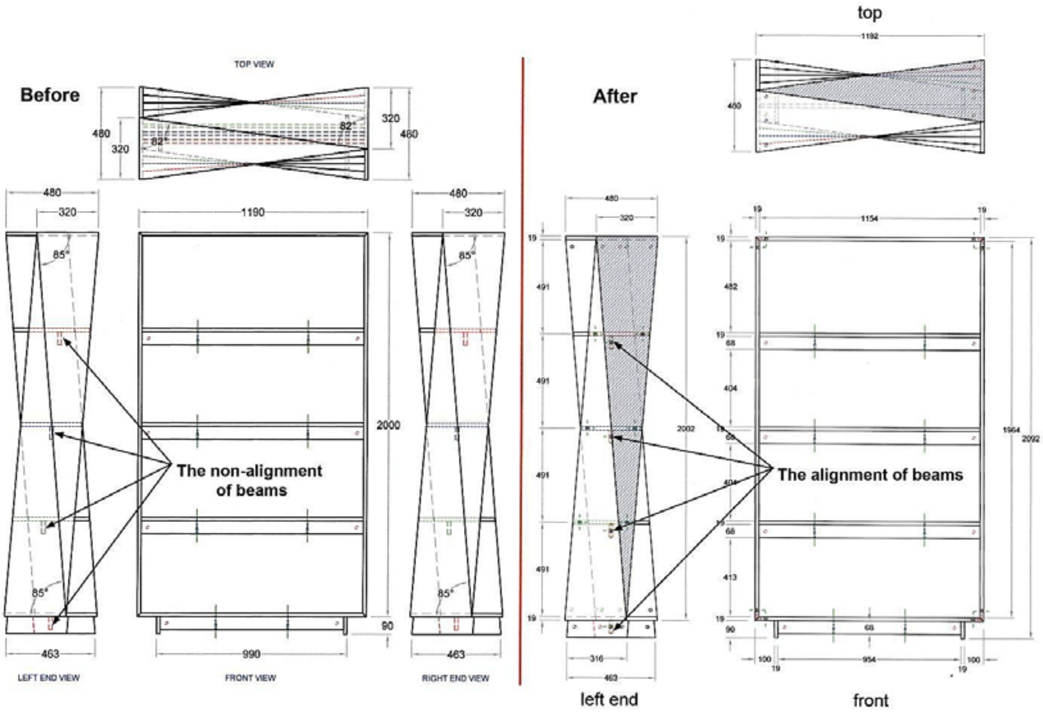
- Area of application: For mitre cuts of 20° to 90°
- Version: Double bolt with joint

Drilling distance B mm	Bright Cat. No.	Galvanised Cat. No.
24	262.12.153	262.12.859
44	262.12.037	262.12.939

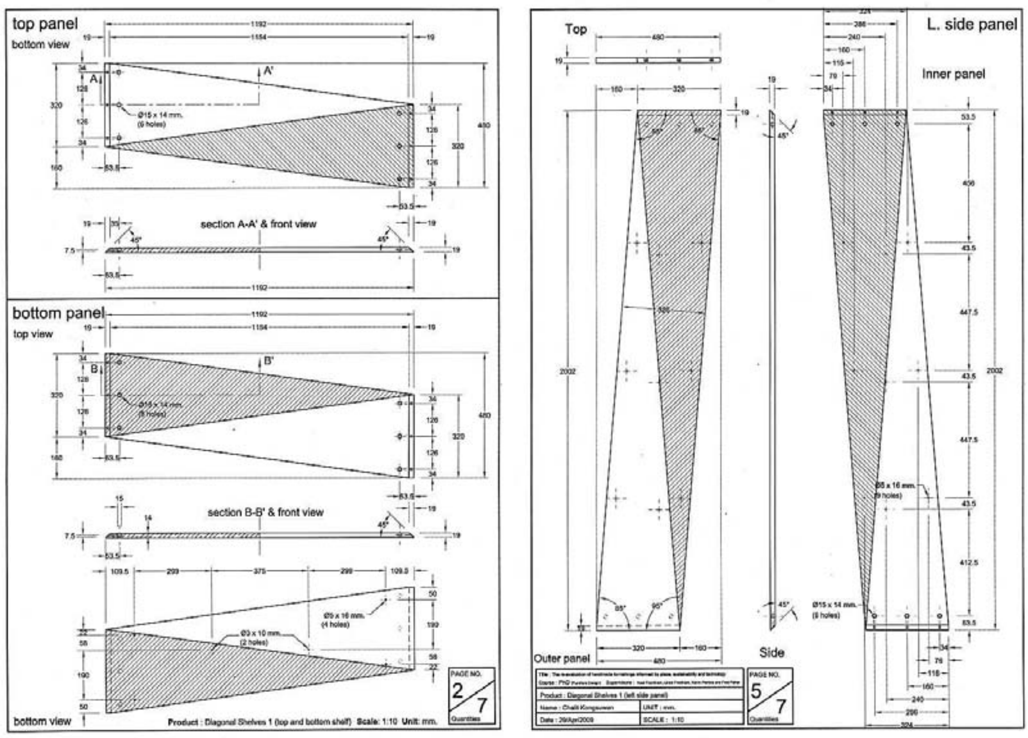
Packing: 100 and 500 pieces

Fig. 18: From top to bottom; the specification of Diagonal Shelves' fittings (www.hafele.com); and the sequence of stages in joining three components of industrial fittings (Kongsuwan 2009)

Then, I began clarifying the system of drilling holes in response to the specification of fitting and the thickness of Gaboon plywood. All horizontal boards (except the top panel) were also reinforced by a single beam, which was fixed underneath by couple screws. By noticing from the end view, it can be seen that the hidden lines of all beams were later aligned vertically. This alignment aimed to help balance the shelves' structure. (See mechanical drawing 23)



Mechanical drawing 23: Both the former and later mechanical drawings of Diagonal Shelves 1 depict the different alignment of beams. (Kongsuwan 2009)

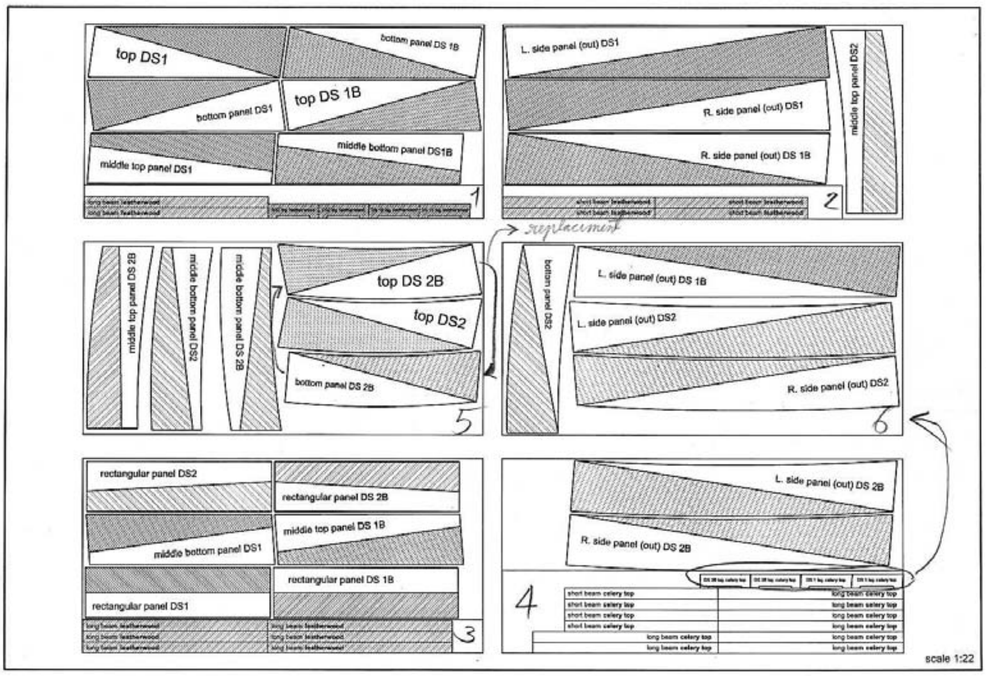


Mechanical drawing 24: The detail of the drilling's system of the top, bottom and vertical boards of Diagonal Shelves 1 (Kongsuwan 2009)

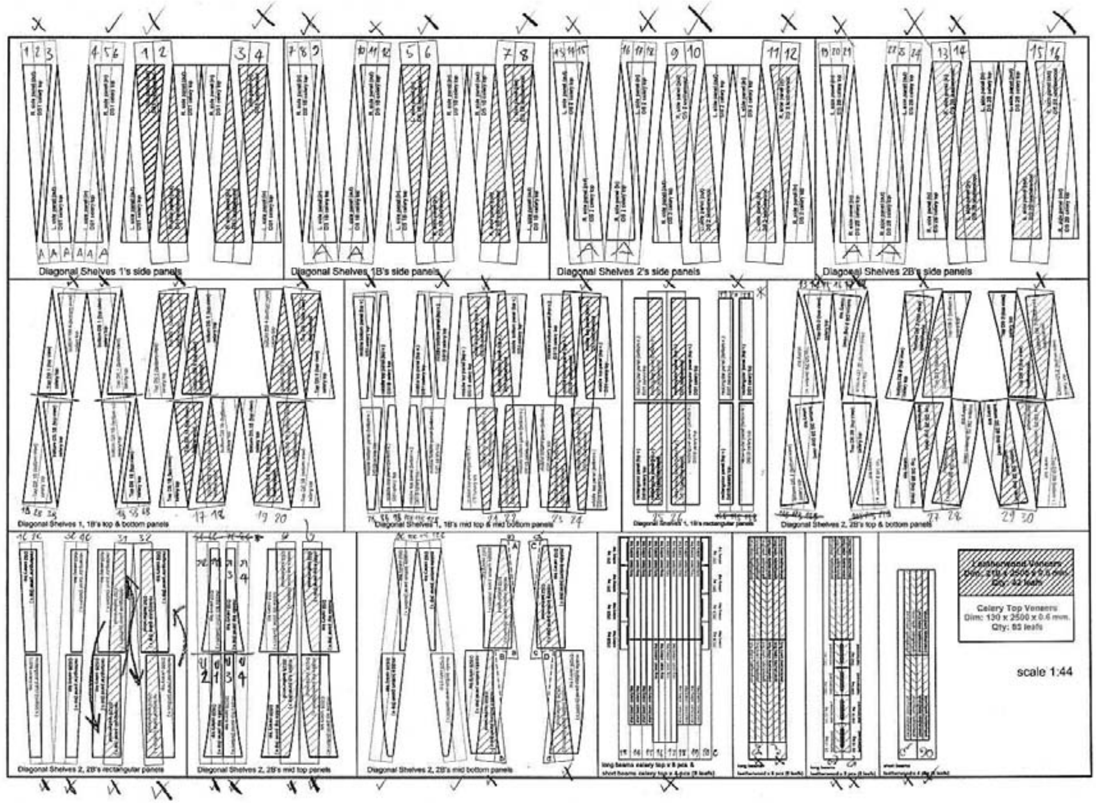
Minimising the wastage of plywood and veneer

I calculated the utilised and off-cut area of both plywood and veneer by CAD drawings. Due to not having a narrow end like those trapezoid boards, all Diagonal Shelves were made up of six sheets of Gaboon plywood (W 1220 x L 2500 x T 18 mm). Moreover, both surfaces of each shelving board were covered by two types of veneers. Consequently, the calculation needs to be doubled. In this case, there were 42 leaves of Leatherwood and 65 leaves of Celery top pine. (See mechanical drawing 25 and 26)

Each shelving unit was made up of seven separate boards of plywood; three pairs of identical boards and a single rectangular board. Each module also contained three pieces of long beams, a singular short beam and two foot bases. Consequently, each shelf required seven templates for the process of marking, pre-cutting and trimming the edge.



Mechanical drawing 25 shows minimising the wastage of plywood. Shaded and unshaded areas signify the juxtaposition between Leatherwood and Celery top pine's veneer. (Kongsuwan 2009)



Mechanical drawing 26 illustrates both utilised and under-utilised areas of Leatherwood and Celery top pine’s veneer (Kongsuwan 2009)

Appendix 5: the detail of fabricating a pair of Dowel Bench Seats

In order to embody the linear structure of the bench seat, I employed the multiple lengths of Tasmanian Oak dowel to form a linear cladding structure. Utilising pre-machined wooden products in Tasmania like this made design output more viable and affordable. All linear elements were supported by five vertical frames, made of plywood.

Because they have two major components, the process of making the Dowel Bench Seats can be divided in two separate parts; linear members and frame structure.

Linear members

The process of fabricating lineate members consisted of six major steps:

1. **Selected** three sizes of dowels; 16, 19 and 22 millimetres, to study a correlation between appearances, strength, ventilation and transportability. It can be concluded that the bigger diameter, the more expensive and chunky whereas the smaller diameter, the weaker structure but more spatial. Finally, I decided to use 16 and 19 millimetre dowels for final fabrication. In order to reinforce the strength of each wooden dowel, the direction of end grain was arranged vertically;

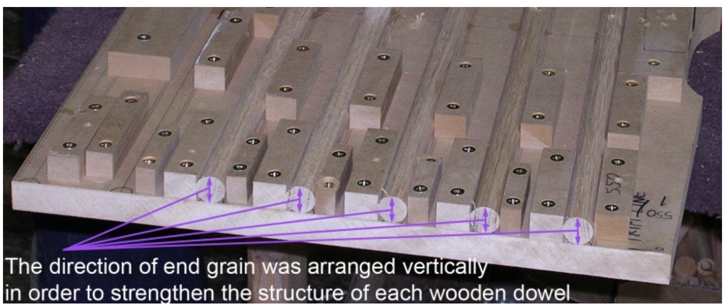


Fig. 19: The vertical arrangement of the end grain of each wooden dowel (Kongsuwan 2010)

Fig. 20: From left to right; a group of 19 millimetre dowels and a group of 16 mm dowels (Kongsuwan 2010)

2. **Pre-drilled** through the diameter of each dowel. I developed a series of jigs to achieve the accuracy of drilling;

Fig. 21: Various jigs were developed for achieving an accurate drill (Kongsuwan 2010)

3. **Cut** each length of wooden dowel by table saw. This process also required a special jig to securely hold a set of dowels in place;

Fig. 22: A special jig was used to hold a set of dowels during the process of cutting. (Kongsuwan 2010)

4. **Inscribed** each length of dowel for the convenience of grouping and reassembly;

Fig. 23: Alphabetical inscription (Kongsuwan 2010)

5. **Rounded** the sharp end of each length of dowel by hand router. This process required specific jigs; and
6. **Pre-polished** wooden surface

This final stage was divided into three separate parts including sanding, oiling and waxing.

- Sanding was done progressively from 150 grit to 400 grit sand papers;
- The process of pre-oiling consisted of three coats of Rustin's Danish oil; and
- Waxing.

Fig. 24: Each length of dowel was hand-oiled. (Kongsuwan 2010)

Frame structure

All vertical frames were made of Marine Grade plywood (22 mm.) which has a regular density. This type of plywood is suitable for exterior usage as it is waterproof.

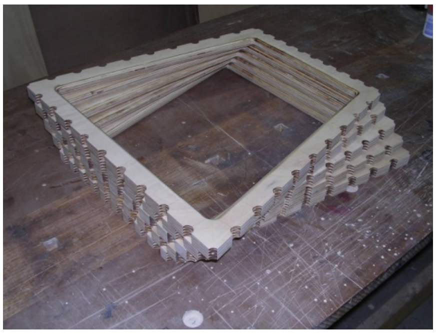


Fig. 25: All structural frame of Dowel Bench Seat 19 were piled up in angular sequence. (Kongsuwan 2010)

The processes of fabricating frame structure consisted of four major steps:

1. **Cut** the contour of each frame by CNC router;
2. **Pre-drilled** a single hole at the intersection between the tangent of each semi-circular notch and the half thickness of the frame;

Fig. 26: While pre-drilling holes at frame’s edge (Kongsuwan 2010)

3. **Pre-polished** wooden surface. This process was divided in three separate parts including sanding, oiling and waxing;

- Sanding was done progressively from 150 grit to 400 grit sand papers;
- The process of pre-oiling consisted of three coats of Rustin's Danish oil;
- Waxing; and

4. **Assembled** a set of wooden dowels with frame structure. This process required a specific jig to firmly hold five frames in upright position. Each length of dowel was fixed with frame structure by five screws.

Fig. 27: Five vertical frames were arranged in place by a special jig. (Kongsuwan 2010)

Fig. 28: The sequence of stages in the Dowel Bench Seat's assembly (Kongsuwan 2010)

Appendix 6: selected support designs

Selected support designs can be separated into two groups. The first group illustrated how the trapezoidal geometry of the butterfly joint, cantilever influence and dynamic expression were interrelated with the concept of dualism.

The second group aimed to create a collective set of contemporary furniture that can be linked with the design of the Cantilever Bench. The design concept lay in the combination of the elevated floor of the vernacular Thai house and the oblique taper of traditional Thai building.

The processes of embodiment included sketched designs, computer-aided design (CAD) and miniature models (1:7.5).

The first group consisted of three designs.

Product: Diagonal Benches #A, #B and #C (2008)

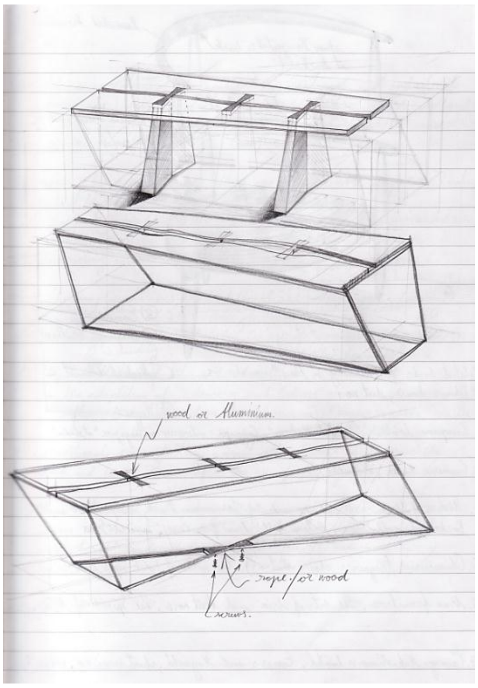
Medium: solid Celery top pine, Huon pine, Blackwood and stainless steel rod

Scale: 1:7.5

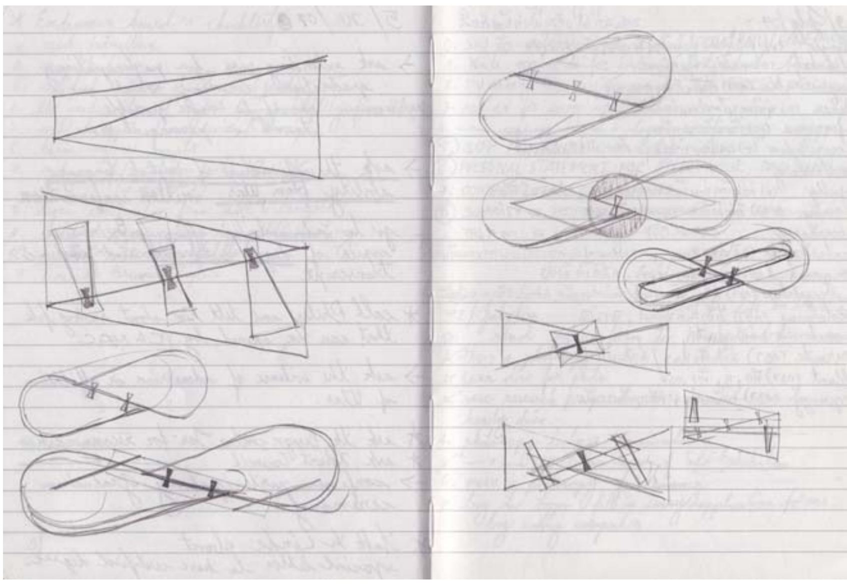
Fig. 29: From left to right: Diagonal Benches #A, #B and #C (Kongsuwan 2008)

Design aim

I attempted to utilise the venerated motif of the butterfly key inlay in a contemporary way. Drawing 1 depicts three benches. The seating platform of each bench was made up of two separate identical boards joined by triple butterfly keys.

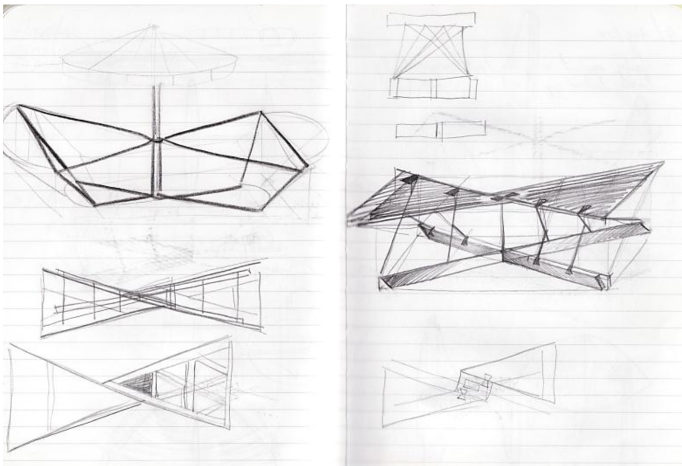


Drawing 17 (Kongsuwan 2007)



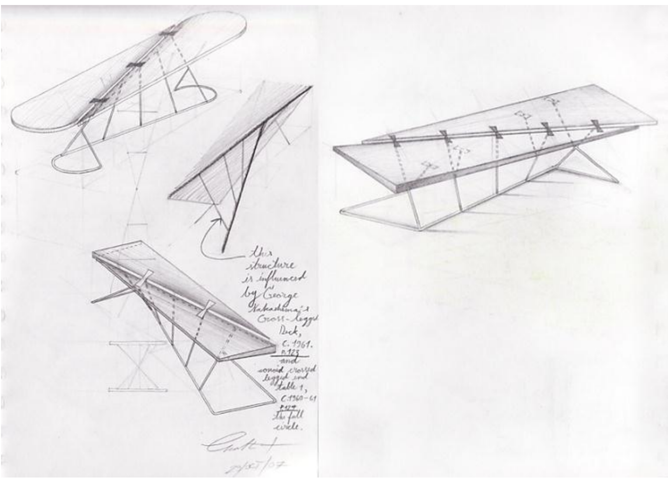
Drawing 18 (Kongsuwan 2007)

I tried both retaining and adapting the form of butterfly key by using them to join various pairs of identical elements. Notably, the outline of some designs enlarged the small scale of butterfly key motif.



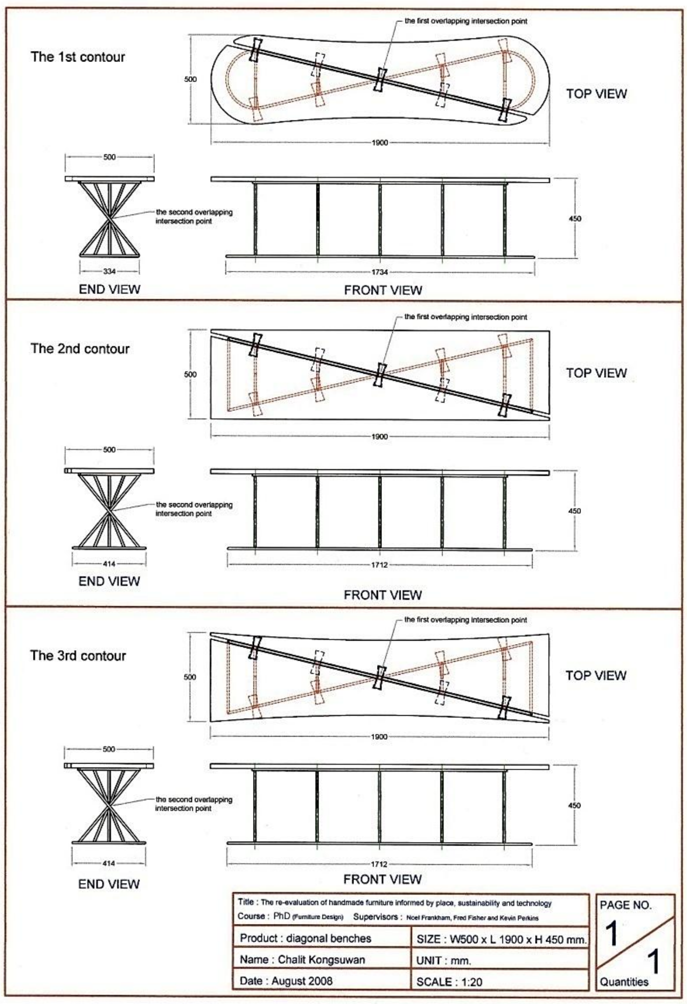
Drawing 19 (Kongsuwan 2007)

Drawing 19 reveals perspective drawings. By comparison to Drawing 17 & 18, it can be seen that retaining, enlarging and breaking apart the plane geometry of the butterfly key motif became a basic method to search for a new decorative pattern and functional form.



Drawing 20 (Kongsuwan 2007 & 2008)

Drawing 20 shows the perspective views of four benches that were developed from previous designs. Before studying the interrelation between proportion, appearance, stability and spatial element in three-dimensional form, I used computer aided-design (CAD) to clarify each design's dimension.



Mechanical drawing 27: the three elevations of Diagonal Benches #A, #B and #C (Kongsuwan 2008)

Mechanical drawing 27 illustrates three different contours of seated platform. By looking at the top elevation of all designs, they reveal the similarity of each overlapping frame's structure. Similarly, by directly view from end elevation, each design shows the linear superimposition of three different angles.

Fig. 30: Small jigs were used to achieve the precision of making miniature models. (Kongsuwan 2008)

I then started making three scaled models (1:7.5). Each model consisted of two main components. The first element is a seated platform, which comprises of a pair of reverse identical boards. Each pair was joined by five pieces of butterfly keys. The second element is a stainless steel frame. The reason that the planar component was elevated on a linear structure of stainless steel frame was to make the solid plane seem floating.

Fig. 31: These scaled models represent the complementary opposites of yin and yang through the reverse identical components of seating platform and frame’s structure. (Kongsuwan 2008)

Because of the influence of Buddhist dualism, I represented the polarised character of yin and yang through four pairs of opposite interplay. These are:

- The curvilinear and rectilinear outline of wooden platform;
- The acute and obtuse angles of linear structure;
- The contrasting colours between butterfly keys and wooden primary boards; and
- The solid plane of wooden platform and the ventilative structure of stainless steel frame.

Joining different species of wood

In order to cope with the irregularity of organic material, I left the diagonal gap between each pair of identical board to allow the wood to expand and contract in response to the climate fluctuations and humidity in different locations. Moreover, I matched three kinds of Tasmanian timber with a similar percentage of shrinkage and expansion.

Visual outcomes

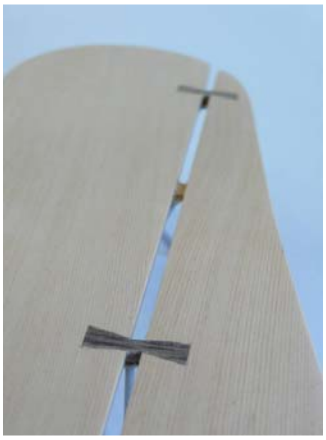


Fig. 32: The detail of butterfly joints (Kongsuwan 2008)

I let the grain direction of wood run parallel with the diagonal gap to create a harmonious echo between the rigid edge of machine cut and the longitudinal grain of wood. In contrast, I let the grain direction of the butterfly key run against the grain direction of identical primary boards to strengthen the joint structure.

Fig. 33: Three miniature models (Kongsuwan 2008)

While I was walking around the scaled models, I observed that a lineate structure of stainless steel frame deceptively moved in angular motion. This illusory effect reminded me of the sway of overlapping bamboo. Later, this dynamic quality became the driving force of my inspiration.

Although the processes of embodying Diagonal Benches #A, #B and #C introduced me how the conventional motif of revealed joinery can be incorporated with modern influences such as cantilever design and Kinetic Art, the use of butterfly joints remained indebted to traditional mode. Moreover, if the frame’s structure of these three designs were produced in a real manufacturing process, it required labour intensive for joining and cleaning a great number of welding spots. Due to being made of stainless steel, this synthetic material needs to be imported from other countries. The use of exotic material goes against the concept of sustainable design. As a result, I did not count these three designs in the final fabrication.

The second group consisted of six designs.

Product: a series of cabinets and a chest of drawers (2009)

Medium: solid Huon pine and Horizontal

Scale: 1:7.5

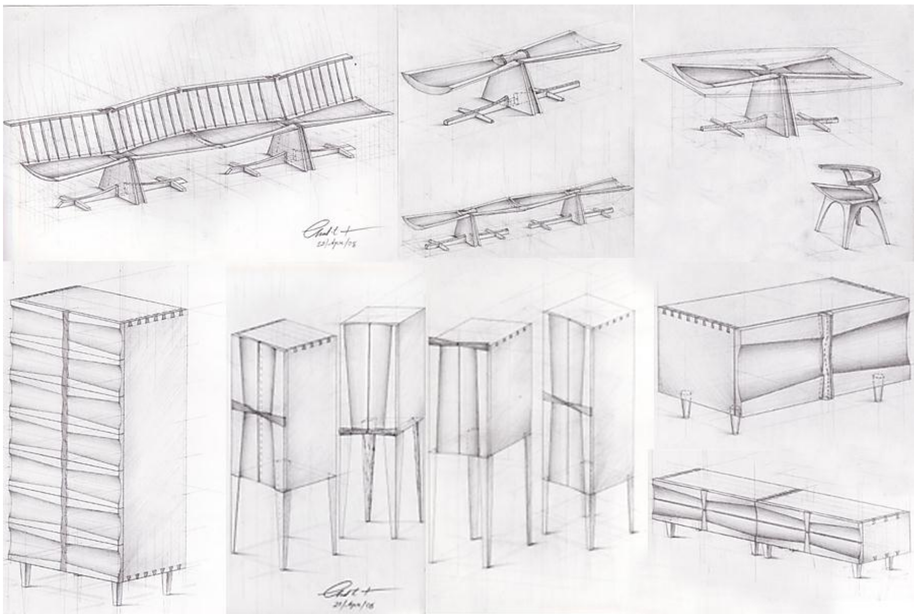
Fig. 34: A series of cabinets and chest of drawers (Kongsuwan 2009)

Design aim

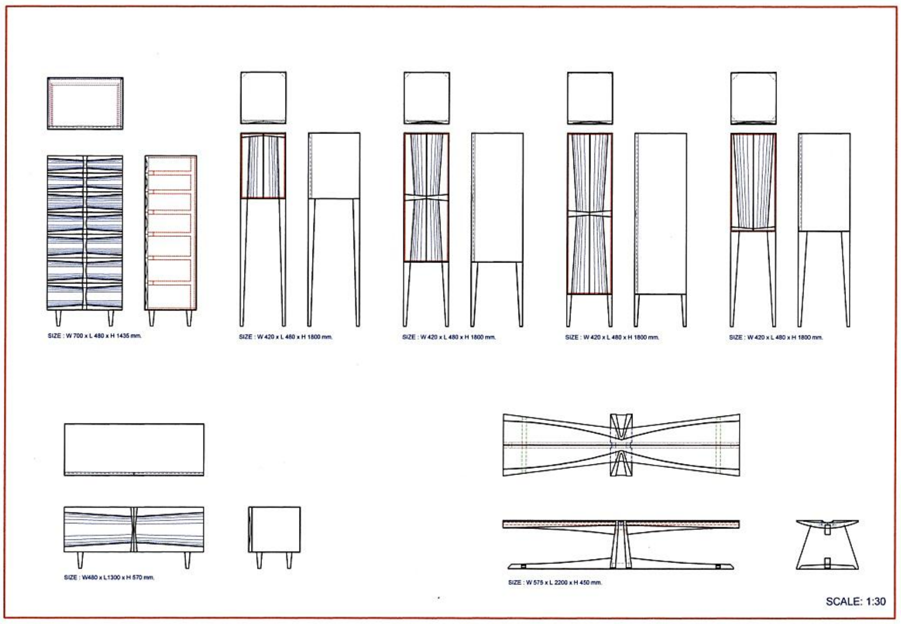
The objective of designing a series of cabinets and a chest of drawers was to explore how the elevated floor of the vernacular Thai house and the trapezoidal geometries of revealed joint are interconnected through contemporary furniture. The results of this experiment created a series of miniature models that can be coalesced with the butterfly-shaped platform of Cantilever Bench's scaled model.

Fig. 35: The interplay between the miniature model of Cantilever Bench, a series of cabinets and chest of drawers (Kongsuwan 2009)

As is shown in Drawing 21 and Mechanical drawing 28, I reiterated the large scale of the butterfly key motif as a thematic link to create a cohesive group of furniture consisting of a chest of drawers, five cabinets, cantilever settees, dining table and chair.



Drawing 21 shows how various scales of butterfly key motif were utilised as configurative, decorative, structural and thematic purposes. (Kongsuwan 2008)



Mechanical drawing 28 (Kongsuwan 2009)

The cabinets and a chest of drawers differed by various heights of four-legged structure. This variety made reference to the elevated floor of vernacular Thai houses in four different regions.

In addition, the concave shape of the gable Thai roof was represented through a hollowing surface at the front of drawers and cabinet’s door. This aimed to suggest an inviting expression to users.

In response to the trapezoidal taper of conventional Thai walls, I attempted to represent the opposite interplay between acute and obtuse angle through furniture’s component. This representation can be seen from the front view of the drawers, cabinet door, the border of hollowing surface, and the contour of the legs.

In order to make symbolism as significant as functional consideration, the handles of a chest of drawers and cabinets resembled the venerated motif of revealed joinery. When drawers and cabinet doors were closed, the handle revealed the motif of the butterfly joint. Once one door of tall cabinets was pulled out, it recalled the form of a dovetail joint. Moreover, the butterfly-shaped handles were positioned in various heights and axes to reflect the animate characteristic of butterflies.

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24. Kongsuwan, C., ***the revision of the foot base of Cantilever Benches #5, #6 and #7,*** Hobart, 2011

25. Kongsuwan, C., ***the front elevation of Cantilever Benches #5, #6 and #7,*** Hobart, 2011

26. Whyte, P., ***Cantilever Bench #7's prototype,*** Hobart, 2012
Kongsuwan, C., ***the structural test of Cantilever Bench #7,*** Hobart, 2011

27. Whyte, P., ***Cantilever Benches #6M & #6F,*** Hobart, 2012

28. Kongsuwan, C., ***the convex and concave profile of Cantilever Benches #6M & #6F,*** Hobart, 2012

29. Kongsuwan, C., ***the harmonious ensemble between the convex profile of the underneath of the seating platform and the curvilinear ends of the beam,*** Hobart, 2012

30. Van Beek, S., ***a Thai boat train along a canal***, 2004, p.9; and
Whyte, P., ***the continuity of fluting pattern,*** Hobart, 2012

31. Kongsuwan, C., ***the combination of technological application and hands-on execution,*** Hobart, 2011

32. Whyte, P., ***Diagonal Benches 1 & 2,*** Hobart, 2012

33. Whyte, P., ***all shelving units,*** Hobart, 2012

34. Kongsuwan, C., ***the miniature models of Diagonal Benches 1 and 2,*** Hobart, 2008

35. Kongsuwan, C., ***the lineate conflict of Diagonal Bench 1's scaled model,*** Hobart, 2008

36. Kongsuwan, C., ***the sliding function of Diagonal Benches 1 & 2's scaled model,*** Hobart, 2008

37. Kongsuwan, C., ***the cluster of three Diagonal Benches' scaled models,*** Hobart, 2008

38. Kongsuwan, C., ***two options of joining method,*** Hobart, 2008

39. Kongsuwan, C., ***testing the stability of Diagonal Benches 1 and 2's scaled models,*** Hobart, 2008

40. Kongsuwan, C., ***cutting the templates of Diagonal Benches,*** Hobart, 2009

41. Kongsuwan, C., ***the revision of Diagonal Bench 1,*** Hobart, 2010

42. Kongsuwan, C., ***the revision of Diagonal Bench 2,*** Hobart, 2010

43. Whyte, P., ***Diagonal Benches 1 & 2,*** Hobart, 2012

44. Kongsuwan, C., ***an ambiguous form of Diagonal Bench 2's legs ,*** Hobart, 2009

45. Whyte, P., ***Curvilinear & Trapezoidal Shelves,*** Hobart, 2012

46. Whyte, P., ***Diagonal Shelves,*** Hobart, 2012

47. Panero, J., and Zelnik, M., 1979, ***the maximum shelf height for male and female reach,*** 1979, p.173

48. Kongsuwan, C., ***developing the shelves' proportions,*** Hobart, 2008

49. Kongsuwan, C., ***the difference between Trapezoidal and Curvilinear Shelves' scale models,*** Hobart, 2008

50. Kongsuwan, C., ***Trapezoidal Shelves' scaled model with additional function,*** Hobart, 2008

51. Kongsuwan, C., ***the sequence of developing the sliding utility of modular shelves,*** Hobart, 2009

52. Kongsuwan, C., ***the problem of using castors,*** Hobart, 2009

53. Kongsuwan, C., ***two options of shelves' installation,*** Hobart, 2008

54. Kongsuwan, C., ***the first assembly of Trapezoidal and Curvilinear Shelves,*** Hobart, 2009

55. Kongsuwan, C., ***tapering one edge of rectangular beam,*** Hobart, 2009

56. Kongsuwan, C., ***the second assembly of Trapezoidal and Curvilinear Shelves,*** Hobart, 2010

57. Kongsuwan, C., ***the development of Trapezoidal and Curvilinear Shelves' foot base,*** Hobart, 2010

58. Kongsuwan, C., ***two opposite viewpoints of a pair of Trapezoid Shelves,*** Hobart, 2009 & 2010

59. Whyte, P., ***two opposite viewpoints of a pair of Curvilinear Shelves,*** Hobart, 2012

60. Kongsuwan, C., ***the miniature models of Diagonal Shelves 1 and 1B,*** Hobart, 2009

61. Kongsuwan, C., ***the miniature models of Diagonal Shelves 2 and 2B,*** Hobart, 2009

62. Kongsuwan, C., ***the combination of Celery top pine and Leatherwood veneer,*** Hobart, 2009

63. Kongsuwan, C., ***Diagonal Shelves 1 and 1B,*** Hobart, 2009; and
Bornoff, N., & Freeman, M., ***the virile motion of an Oriental hand-held fan,*** 2002, p.80

64. Kongsuwan, C., ***Diagonal Shelves 2 and 2B,*** Hobart, 2009; and
Beurdeley, J., ***the gracious movement of the hands of a classical Thai dancer,*** 1980, p.104

65. Kongsuwan, C., ***a harmonious interplay between vertical and horizontal planes of Diagonal shelves,*** Hobart, 2009

66. Kongsuwan, C., ***an opposite interplay between vertical and horizontal planes of Diagonal shelves,*** Hobart, 2009

67. Kongsuwan, C., ***the sequence of stages in the shelves' assembly and packing all shelving units,*** Hobart, 2010

68. Whyte, P., ***various views of all shelving units,*** Hobart, 2012

69. Whyte, P., ***a pair of Dowel Bench Seats,*** Hobart, 2012

70. Beurdeley, J., ***a vertical version of Thai fishing trap***, 1980, p.75
Kanokpongchai, S., ***two horizontal versions of Thai fishing trap,*** 1991, p.157 & 159

71. Kongsuwan, C., ***the structural test of the Dowel Bench Seat 16,*** Hobart, 2010

72. Kongsuwan, C., ***the structural test of the Dowel Bench Seat 19,*** Hobart, 2010

73. Kongsuwan, C., ***the sequence of stages in executing and assembling the feet of the Dowel Bench Seats,*** Hobart, 2010

74. Kongsuwan, C., ***rounding the sharp end of each length of dowel,*** Hobart, 2010

75. Kongsuwan, C., ***the sequence of stages in assembling the Dowel Bench Seats,*** Hobart, 2010

76. Whyte, P., ***the hybrid function of the Dowel Bench Seats,*** Hobart, 2012

77. Whyte, P., ***the sense of twist,*** Hobart, 2012

78. Kongsuwan, C., ***illusory depths,*** the Long Gallery, Hobart, 2011

79. Kongsuwan, C., ***the changes of residual space,*** the Long Gallery, Hobart, 2011

80. Kongsuwan, C., ***the lateral movement of the Dowel Bench Seats,*** Hobart, 2010

81. Kongsuwan, C., ***the counter-movement of the Dowel Bench Seats (viewed from top elevation),*** Hobart, 2010

82. Kongsuwan, C., ***the counter-movement of the Dowel Bench Seats (view from end elevation),*** Hobart, 2010

83. Whyte, P., & Perkins, Megan., ***the electronic invitation of the final exhibition***, Hobart, 2012

84. Kongsuwan, C., ***the display of sketched designs,*** the Plimsoll Gallery, Hobart, 2012

85. Kongsuwan, C., ***the display of miniature models,*** the Plimsoll Gallery, Hobart, 2012

86. Whyte, P., ***positioning the video of the Royal Barge Procession***, the Plimsoll Gallery, Hobart, 2012; and

Chutintaranond, S., ***the Royal Barge Procession with the background of the Royal Grand Palace***, Bangkok, Thailand, 2002, p.55

87. Kongsuwan, C., ***the post-and-beam structure of Wat Yai Sudthawad***, Pretchaburi, Thailand, 2010; and

Kongsuwan, C., ***the column-and-beam structure of the Plimsoll Gallery,*** Hobart, 2012

88. Whyte, P., ***the ambience of exhibition (viewed toward Gallery 3),*** the Plimsoll Gallery, Hobart, 2012

89. Whyte, P., ***the ambience of exhibition (viewed toward Gallery 1 & 2),*** the Plimsoll Gallery, Hobart, 2012

Appendices

Figure: ***Source:***

1. Kongsuwan, C., ***the processes of routing the top surface of Cantilever Benches,*** Hobart, 2011

2. Kongsuwan, C., ***the processes of routing the bottom surface of Cantilever Benches,*** Hobart, 2011

3. Kongsuwan, C., ***a longitudinal crack,*** Hobart, 2011

4. Kongsuwan, C., ***shaving the convex profile underneath a butterfly-shaped platform,*** Hobart, 2012

5. Kongsuwan, C., ***the two options of arranging the wooden pattern of the Diagonal Benches,*** Hobart, 2009

6. Kongsuwan, C., ***the processes of subduing the stiff appearance of the bench's legs,*** Hobart, 2009

7. Kongsuwan, C., ***the processes of joining and gluing horizontal and vertical boards,*** Hobart, 2010

8. http://www.hafele.com, ***the specification of Trapezoidal & Curvilinear Shelves' fittings***; and

Kongsuwan, C., ***the sequence of stages in joining two components of industrial fittings***, Hobart, 2009

9. Kongsuwan, C., ***the three-dimensional detail of drilling specification***, Hobart, 2009

10. Kongsuwan, C., ***cutting shelves' template,*** Hobart, 2009

11. Kongsuwan, C., ***the process of marking the outline of shelves' component,*** Hobart, 2009

12. Kongsuwan, C., ***the juxtaposition of Huon pine and Rain Drop Myrtle,*** Hobart, 2009

13. Kongsuwan C., ***the feature of book-matched veneer,*** Hobart, 2009

14. Kongsuwan C., ***the feature of sequential or slip matched veneer,*** Hobart, 2009

15. Kongsuwan, C., ***the processes of book-matching and patching veneer,*** Hobart, 2009

16. Kongsuwan, C., ***gluing pre-cut veneer with pre-cut plywood,*** Hobart, 2009

17. Kongsuwan, C., ***inscriptions,*** Hobart, 2009

18. http://www.hafele.com, ***the specification of the Diagonal Shelves' fittings***; and

Kongsuwan, C., ***the sequence of stages in joining three components of industrial fittings***, Hobart, 2009

19. Kongsuwan, C., ***the vertical arrangement of the end grain of each wooden dowel,*** Hobart, 2010

20. Kongsuwan, C., ***two groups of prefabricated dowels (16 and 19 mm.)***, Hobart, 2010

21. Kongsuwan, C., ***various jigs for achieving an accurate drill,*** Hobart, 2010

22. Kongsuwan, C., ***the process of cutting a set of dowels,*** Hobart, 2010

23. Kongsuwan, C., ***inscriptions,*** Hobart, 2010

24. Kongsuwan, C., ***hand-oiled finish,*** Hobart, 2010

25. Kongsuwan, C., ***all structural frame of the Dowel Bench Seat 19,*** Hobart, 2010

26. Kongsuwan, C., ***pre-drilling holes at frame's edge,*** Hobart, 2010

27. Kongsuwan, C., ***the arrangement of five vertical frames,*** Hobart, 2010

28. Kongsuwan, C., ***the sequence of stages in the Dowel Bench Seat's assembly***, Hobart, 2010

29. Kongsuwan, C., ***the scaled models of Diagonal Benches #A, #B and #C,*** Hobart, 2008

30. Kongsuwan, C., ***the process of making Diagonal Benches #A, #B and #C's scaled models,*** Hobart, 2008

31. Kongsuwan, C., ***the representation of the complementary opposites of yin and yang through the Diagonal Benches #A and #B's scaled models,*** Hobart, 2008

32. Kongsuwan, C., ***the detail of miniature butterfly joints ,*** Hobart, 2008

33. Kongsuwan, C., ***Diagonal Benches #A, #B and #C's scaled models,*** Hobart, 2008

34. Kongsuwan, C., ***a series of cabinets and chest of drawers on 1:7.5 scale,*** Hobart, 2009

35. Kongsuwan, C., ***the interplay between the scaled models of Cantilever Bench, a series of cabinets and chest of drawers,*** Hobart, 2009

Appendix 9: list of furniture and selected models included in Examination Exhibition

1. 

Product: *Cantilever Benches (#6M & #6F)*
Medium: *Solid and laminated Huon pine*
Finish: *hand-oiled*
Dimension: *W575 x L 2200 x H 450 mm.*
Year of production: *2011 – 2012*
Photographed by: *Peter Whyte (2012)*

2. 

Product: *Cantilever Benches #5 & #6's prototype*
Medium: *medium and low density fibreboard (MDF & LDF)*
Finish: *unfinished*
Dimension: *W575 x L 2200 x H 450 mm.*
Year of production: *2011*
Photographed by: *Peter Whyte (2012)*

3. 

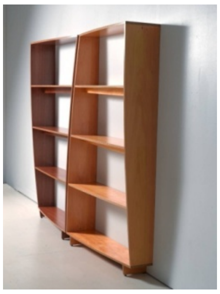
Product: *Cantilever Bench #7's prototype*
Medium: *medium and low density fibreboard (MDF & LDF)*
Finish: *unfinished*
Dimension: *W575 x L 2200 x H 450 mm.*
Year of production: *2011*
Photographed by: *Peter Whyte (2012)*

4. 

Product: *Diagonal Benches 1 & 2*
Medium: *solid Myrtle and Celery top pine*
Finish: *hand-oiled*
Diagonal Bench 1: *W 630 x L 1950 x H450 mm.*
Diagonal Bench 2: *W 526 x L 1950 x H 450 mm.*
Year of production: *2009 – 2010*
Photographed by: *Peter Whyte (2012)*

5. 

Product: *Trapezoidal Shelves 1 & 1B*
Medium: *plywood, covered by Huon pine and Myrtle veneer*
Dimension: *W 420 x L 1192 x H 2092 mm.*
Finish: *hand-oiled*
Year of production: *2009 – 2010*
Photographed by: *Peter Whyte (2012)*

6. 

Product: *Curvilinear Shelves 2 & 2B*
Medium: *plywood, covered by Huon pine and Myrtle veneer*
Dimension: *W 315 x L 1192 x H 2092 mm.*
Finish: *hand-oiled*
Year of production: *2009 – 2010*
Photographed by: *Peter Whyte (2012)*

7. 

Product: *Diagonal Shelves 1 & 1B*
Medium: *plywood, covered by Leatherwood and Celery top pine veneer*
Dimension: *W 480 x L 1192 x H 2092 mm.*
Finish: *hand-oiled*
Year of production: *2009 – 2010*
Photographed by: *Peter Whyte (2012)*

8. 

Product: *Diagonal Shelves 2 & 2B*
Medium: *plywood, covered by Leatherwood and Celery top pine veneer*
Dimension: *W 542 x L 1192 x H 2092 mm.*
Finish: *hand-oiled*
Year of production: *2009 – 2010*
Photographed by: *Peter Whyte (2012)*

9. 

Product: *Dowel Bench Seats (16 and 19 mm.)*
Medium: *Tasmanian Oak dowel, horizontal scrub and plywood*
Finish: *hand-oiled*
Dimension: *W 519 x L2400 x H 483 mm.*
Year of production: *2010*
Photographed by: *Peter Whyte (2012)*

10. 

Product: *miniature models*
Medium: *assorted Tasmanian timbers & veneers, plywood and stainless steel rod*
Scale: *1:7.5*
Finish: *unfinished*
Year of production: *2008 – 2009*
Photographed by: *Peter Whyte (2012)*

Appendix 10: curriculum vitae

EDUCATION

2012 **The University of Tasmania,** Hobart, Tasmania, Australia ***(Doctor of Philosophy)***, PhD, Fine Art

2007 **TAFE Metal Trades,** Bender Drive, Tasmania, Australia ***(****completed selected competencies from* ***the Diploma of Mechanical Engineering)***

2007 **The University of Tasmania,** Hobart, Tasmania, Australia ***(Master of Fine Art and Design)*** with a high distinction, MFAD, Furniture Design

1997 **Rangsit University**, Phathumthani, Thailand ***(Bachelor of Fine Arts****)* BFA, Product Design

EMPLOYMENT

2001 – 2003 **New Siam Frames (1986) Co., Ltd.** Bangkok, Thailand (senior product designer)

1998 – 1999 **Housewares 2000 Co., Ltd.** Nonthaburi, Thailand (product designer)

1997 – 1998 **S.B. Furniture Industry Co., Ltd.** Nonthaburi, Thailand (product designer)

1994 **WE-EF Lighting (Thailand) Co., Ltd.** Samutprakarn, Thailand (Summer Internship)

AWARDS AND SCHOLARSHIPS

2009 **Received** notable mentions from *Georg Jensen Design Awards 2009 in product design category*, Australia

2008 **Won** the premier prize of the Tasmanian Wood Design Collection (TWDC) Biennial Acquisitive Exhibition for 2008, Australia

2008 **Won** the 2007 environment prize from *Claudio Alcorso Foundation*, the University of Tasmania, Hobart, Australia

2008 **Received** *an IDP Student Mobility Scholarship* (2008 Postgraduate Research Scholarship) for undertaking postgraduate research in Australia, the University of Tasmania, Hobart

2007 **Awarded** *a 2008 Endeavour International Postgraduate Research Scholarship* (EIPRS) to undertake study towards a Doctor of Philosophy, the University of Tasmania, Hobart, Australia

2007 **Won** the first prize of *the inaugural Accommodation Services Acquisitive Art Prize 2007*, the University of Tasmania, Hobart, Australia

2007 **Acquired** Highly Commended Award from *Clarence Prize 2007 for excellence in furniture*, Clarence, Tasmania, Australia

1995 **Received** a scholarship from *Thailand International Furniture Fair (TIFF)*, Bangkok, Thailand

EXHIBITIONS/PUBLICATIONS

2012 **Solo exhibition,** *Dualism: the combination of Thai and Tasmanian heritage through contemporary furniture,* the Design Centre Tasmania, Launceston, Australia, Sep – Nov

2012 **PhD (Research) Examination Exhibition**, *Dualism: an investigation of Thai and Tasmanian environmental and cultural heritage through contemporary furniture,* the Plimsoll Gallery, Hobart, Australia, 2 –13 April

2011 **Finalist's Exhibition**, *the Tasmanian Wood Design Collection Biennial Acquisitive Exhibition*, at Hobart and Launceston, Australia, Feb – Mar 2011

2010 **Group Exhibition**, *Magister: the Master of Fine Art and Design and Master of Visual Communication students' exhibition,* the Plimsoll Gallery, Hobart, Australia, 19 -21 November

2009 **Finalist's Exhibition**, *Clarence Prize 2009 for Excellence in Furniture*, at the Barn, Rosny farm Clarence, Tasmania, Australia, 31 July – 23 August

2008 **Finalist's Exhibition**, *the Tasmanian Wood Design Collection Biennial Acquisitive Exhibition*, at Hobart and Launceston, Australia, Nov – Dec 2008

2007 **Group Exhibition**, *the Acquisitive Art Prize 2007*, at Accommodation Services, the University of Tasmania, Hobart, Australia, 25 – 28 August

2007 **Finalist's Exhibition**, *Clarence Prize 2007 for Excellence in Furniture*, at the Barn, Rosny farm Clarence, Tasmania, Australia, 6 July – 5 August

2007 **Group Exhibition**, *the Antarctic Midwinter Festival*, at the Prince Wharf No.1, Hobart Waterfront, Tasmania, Australia, 23 – 24 June

2007 **Solo exhibition**, *Craftnology*, the Design Centre Tasmania, Launceston, Australia, 8 June – 6 July

2007 **Solo exhibition**, *Craftnology*, the Waterside Pavilion, Mawson Place, Hobart, Tasmania, Australia, 28 February – 6 March

2007 **Group Exhibition**, International Australian Furniture Fair 2007, *the Edge 2007: an Inspirational Showcase of Design Talent*, invitational design competition, exhibited *Lounge chair*, Sydney Exhibition Centre, Australia, 7 – 9 February

REVIEWS AND CITATIONS

2009 **Belle**, magazine article about two notable design works (the Blackwood & Myrtle Benches) for Georg Jensen Design Awards 2009, Holiday Issue, December 2009/January 2010 (p.104)

2008 **Unitas** (the regular newsletter of the University of Tasmania) article and interview about the winning of the 2007 environment prize from *Claudio Alcorso Foundation*, issue 319, May 2008, (p.8)

2008 **ABC Radio**, live interview and broadcast about the winning of the 2007 environment prize from *Claudio Alcorso Foundation*, Tuesday, March 18, 2008, Hobart

2008 **Southerncross**, interview and broadcast about the winning of the 2007 environment prize from *Claudio Alcorso Foundation*, Tuesday, March 18, 2008, Hobart

2007 **Unitas** (the regular newsletter of the University of Tasmania) article and interview about winning the UTAS Accommodation Services Acquisitive Art Prize, issue 313, September 2007, (p.7)

2007 **The Examiner**, article and interview about winning the UTAS Accommodation Services Acquisitive Art Prize, Saturday, September 1, 2007 (p.39)

2007 **The Examiner**, article and interview about Solo exhibition, *Craftnology* at the Design Centre Tasmania, Launceston, Saturday, June 9, 2007 (p.3)

2007 **The Mercury**, article and interview about Solo exhibition, *Craftnology* at Waterside Pavilion, Mawson Place, Hobart, Tasmania, Friday, March 2, 2007 (p.40)

1995 **Décor International**, magazine article and interview about design work, No.38, February 1995 (p.118)

1995 **Best Design**, magazine article and interview about design work, No.3, October 1995 (p.34-35)